

MENDELOVA UNIVERZITA V BRNĚ – MENDEL UNIVERSITY IN  
BRNO  
LESNICKÁ A DŘEVAŘSKÁ FAKULTA – FACULTY OF FORESTRY  
AND WOOD TECHNOLOGY

---



## Forest Dendrology

Doc. Ing. Luboš Úradníček, CSc.

2014

V tomto učebním textu jsou uvedeny vybrané druhy zejména lesnický a krajinářsky významných dřevin, perspektivní druhy pro podmínky střední Evropy. První část obsahuje popis čeledí, rodů a druhů dřevin. Druhá část pak obrazové tabule významných druhů dřevin a mapy přirozeného rozšíření významných druhů dřevin.

This textbook presents selected woody species, especially forestry and landscape important trees, prospective species for the conditions of Central Europe. The first section contains a description of the families, genera and species. The second part contains pictorial boards of selected woody plant species and maps of natural distribution of important species.

Na přípravě skript se podíleli -team of authors:

Doc. Ing. Luboš Úradníček, CSc. – editor in chief, text and pictures

Ing. Soňa Tichá, Ph.D. – technical cooperation

Ing. Boleslav Jelínek, Ph.D. - technical cooperation

©Luboš Úradníček, 2014

**Tato skripta byla vytvořena v rámci projektu InoBio – Inovace biologických a lesnických disciplín pro vyšší konkurenceschopnost, registrační číslo projektu CZ.1.07/2.2.00/28.0018. za přispění finančních prostředků EU a státního rozpočtu České republiky.**



# Content

Woody plant species .....	3
Pictorial boards .....	58
Native distribution maps .....	111
Index of scientific names .....	118
Index of common names .....	122

# DENDROLOGY AND ECOLOGY OF FOREST TREES

In this university textbook, selected species are given of particularly forest trees important from forestry aspects, species perspective for conditions of Central Europe or site-important and often occurring shrubs. The first part of the textbook includes conifers, the second part broadleaved species. In a supplement, plates and ranges of important species are given.

## Conifers

Conifers represent the group of families of gymnosperms (*Gymnospermae*) showing shoots with characteristic assimilatory organs in the form of needles. A number of woody species ranked among conifers shows leaves which are, however, of a scale type as usual in the family of *Cupressaceae* or foliar leaves, eg in the genus of *Aghatis* (family *Araucariaceae*). Thus, conifers do not form an integrated group of plant taxonomy including families of various higher units. Therefore, we can encounter their different classification in the plant system according to particular authors.

The basic taxonomic classification of living woody species is usually as follows:

Kingdom: *Vegetabilia* - plants

Subkingdom: *Cormobionta* – higher plants

Phylum: *Angiospermae* - angiosperms

Phylum: *Gymnospermae* - gymnosperms

- Section:
1. *Cycadophyta*
  2. *Gnetophyta*
  3. *Welwitschiophyta*
  4. *Ephedrophyta*
  5. *Ginkgoophyta*
  6. *Pinophyta*

Typical conifers are included into the section of *Pinophyta* (*Coniferophyta*). Also members of the sections are sometimes ranked among conifers.

All conifers are usually divided into eight families:

1. *Pinaceae*
2. *Cupressaceae*
3. *Sciadopityaceae*
4. *Araucariaceae*
5. *Cephalotaxaceae*
6. *Podocarpaceae*
7. *Phyllocladaceae*

Families mentioned above belong to the class of *Pinopsida*

8. *Taxaceae* - (belong to the separate class of *Taxopsida*)

Moreover, the family of *Ginkgoaceae* including *Ginkgo* with foliar leaves is ranked among conifers.

All economically important European coniferous species such as spruce (*Picea*), fir (*Abies*), pine (*Pinus*) and larch (*Larix*) are included into the family of *Pinaceae*. As for *Taxaceae*, only yew (*Taxus*) is a native species. As for *Cupressaceae*, only the genus juniper (*Juniperus*) is naturally distributed in Central Europe.

Nearly all conifers are evergreen. Only members of genera *Larix*, *Pseudolarix*, *Metasequoia*, *Glyptostrobus* and some species of the genus *Taxodium* are deciduous.

In total, there are about 65 genera of coniferous trees in the world amounting to about 600 species. It is a mere fraction as compared with the amount of existing broadleaved species. In the area of the Czech Republic, 9 species of conifers from 6 genera occur naturally. As for growing under conditions of Central Europe, only one third of the whole amount of coniferous species is suitable and, thus, the selection of species for forest management is further substantially narrowed. Nevertheless, there is a number of promising coniferous species waiting for testing.

### **Family : Pinaceae**

Species with spirally arranged needles, sometimes in fascicles. They are monoecious, unisexual. Their characteristic “fruit” is a cone consisting of a spindle and spirally arranged scales provided usually with supporting squames. Every scale bears two winged seeds (only some pines with large seeds lack a wing.). Wood and sometimes only bark and needles show usually resin canals.

As for European species, following genera rank among the family: spruce (*Picea*), fir (*Abies*), pine (*Pinus*) and larch (*Larix*). As for foreign species of the family, Douglas fir (*Pseudotsuga menziesii*) is important for Europe. In collections, hemlock (*Tsuga*) and cedar (*Cedrus*) are grown rather frequently while *Pseudolarix*, *Keteleeria* and *Cathaya* are grown rarely.

### **Spruce - *Picea***

The genus includes 40 species in the European, Asian and N American range. Trees with a straight stem, verticillate branching and conical crown. Annual shoots are grooved showing protruding leaf “cushions”. Conelets are distributed separately, male strobili individually, female strobili at the end of shoots. Cones are pendent, supporting scales do not protrude maturing in the same year and fall away as a whole. Seeds are winged. Testa and wings are not connate. Wood is not differentiated into heartwood and sapwood and includes resin canals.

### **Norway spruce - *Picea abies* (L.) Karst., syn. *Picea excelsa* (Lam.) Link**

**Description:** A tree with a straight stem and regular verticillate branching. It reaches an age of 350-400 years, height about 50 m and stem diameter 1.5 m. The biggest specimens reach a volume over 30 m<sup>3</sup>. Up to its high age, Norway spruce maintains a slim cone-shaped top. Needles persist usually 6 to 9 years.

The species begins to bear seed in stands from about 60 years of its age and seed years repeat after 4 to 5 years. Exceptionally, it is possible to note premature fertility in quite young trees vegetating on extreme sites. Cones are most frequently of green colour before maturation, however, there are also types with red-violet cones occurring often in mountains.

Its root system is distributed near the surface. Thus, spruce is poorly anchored in soil and windbreaks occur, therefore, very easily and frequently. At the upper forest limit, branches hanging down to soil often take roots and, thus, groups occur bordering a parent tree. Root swellings are well developed. Germination and growth on fallen trees result in the origin of

prop roots. Spruce does never form shoots on pruned stems and takes roots only very heavily from cuttings. It tolerates shading and pruning quite well (Tab. 1).

**Distribution:** Norway spruce shows a European range. An Asian range with the adjacent part of the coldest NE Europe belongs already to Siberian spruce *P. obovata* Led. (Tab. 1). The dividing limit of European and Siberian spruce runs roughly from the Kola peninsula to southern promontories of the Ural Mts.

The actual European range of Norway spruce is divided into two separated parts.

1. Scandinavian region; it contacts there with the range of Siberian spruce occupying nearly the whole Scandinavia reaching southerly to the Baltic and towards east through the centre of the European part of Russia to the Ural Mts.

2. Central-European-Balkan region; the region occupies mountain systems of Central and SE Europe. In the second part, the range is disjunctive breaking into particular mountains particularly in the south. These are:

(a) The Hercynian-Carpathian region; it extends from the Black Forest in the west through adjacent German highlands towards east and through mountain regions of the Czech Republic and further through the whole Carpathians to the Transylvanian Alps.

(b) The Alpine region; it includes the whole Alpine system with its foothills from the north.

(c) The Dinaric (Illyrian) region; it extends in the highest parts of the Dinaric mountain system. It continues to the Alps and through Serbia it goes up to Albania.

(d) The Rhodope region; it occupies above all mountains of southern Bulgaria (the Rila, Pirin, Rhodopy Mts) and further the highest locations of the Stara Planina Mts and Vitosha Mts.

Other parts of Europe, ie particularly the whole Western Europe and the Mediterranean are out of the range of Norway spruce.

The vertical distribution of spruce differs considerably in relation to latitude. In the north of Europe, spruce grows in lowlands and uplands up the altitude of several hundreds of metres. In Central Europe, spruce becomes a submontane and montane species rising up to the upper forest limit. Optimum locations of spruce occur at an altitude of 600 - 1000 m. In the Austrian Alps, the optimum distribution of spruce occurs at an altitude of 800 - 1200 m. Even there, spruce reaches a forest limit at an altitude of 1700 - 1900 m. In the warmest parts of the range, ie in the Rhodope region or in the southern part of the Swiss Alps, spruce grows at an altitude of 1600 - 1900 m reaching the upper forest limit at an altitude of 2000 - 2200 m.

Due to forest management, spruce was secondarily heavily distributed everywhere in central Europe during last 200 years.

**Ecology:** Spruce is a light-requiring species tolerating shading in its young age. It is also one of reasons why spruce easily infiltrates into stands of other species occupying their position. As a semi-sciophilous species, it occurs sometimes typically in the second storey in commercial forests, for example under Scots pine or European larch.

Because it shows a surface root system spruce is considerably demanding for soil moisture and dry summers can affect it easily. Favourable sites are characterized by uniform moisture. Spruce thickets demonstrate large consumption of water and thus originally wet soils under spruce stands can get dry (land reclamation). Thus, in drier and poorer soils of small water during dry years. Spruce tolerates well excessive moisture surviving even stagnant water of swamps and peat bogs. However, a moisture deficit becomes a limiting factor of its good growth.

Spruce does not show great requirements for soil and a parent rock creating stands on acid igneous rocks, limestones and alluvial soils of various types only when they are not too dry or extremely poor in nutrients. On limestone soils, it is evidently replaced by beech. Under con-

ditions of sufficient moisture, it colonizes even rather shallow soils covered by humus. However, on poor siliceous soils and acid peat bogs it grows badly. Insufficient aeration of soils affects its growth very unfavourably. Spruce thrives best on moist loamy-sandy soils; however, it grows well also on heavy loamy soils and sands if they are sufficiently moist tolerating chernozems under conditions of admixed moisture. Near the upper forest limit, spruce often grows on stony or even boulder soils. Spruce stands are heavily affected by soil-forming factors above all the formation of raw humus.

Spruce is not demanding for climate. Heavy winter frosts affect its growth only rarely. However, it is much more sensitive to high temperatures and low relative air humidity. In its young age, spruce is less endangered by late frosts than eg silver fir and, therefore, it is suitable for regeneration on clear-cut areas. However, it suffers more from snow and winter than silver fir. Late autumn frosts can delay the development of young forest plantations through the permanent freeze of shoots for a long time. In mature trees, late frosts damage main lateral buds which results in the origin of narrow crowns. In climatically exposed mountain ranges and peaks, the species forms unilateral flag trees and “bayonet” tops due to the effect of wind and snow.

Spruce is more likely adapted to the short growing season. Short and cold summers are most suitable for its growth. Growing under conditions of a long growing season results in a too early budbreak and easy fungal attack causing decay. A dangerous red rot occurs just at lower climatically temperate locations. In warmer regions, therefore, it is suitable to grow spruce only in deep valleys where moist and cold air is accumulated and excessive moisture occurs. Thus, moisture deficit together with too mild winter and a long growing season are another limiting factor for growing Norway spruce.

Spruce is sensitive to air pollution and does not suit for parks of larger towns and cities. It is very susceptible to industrial pollutants (particularly SO<sub>2</sub>) which were demonstrated by extensive die-back of stands in Central Europe.

**Use:** Spruce is the main commercial species of Europe and, therefore, it is the basis of timber industry. It is processed for sawn timber, paper and fuelwood; it provides timber for building purposes, timber for joiners and toolmakers. Spruce wood of special quality from selected localities is processed for resonance wood serving for the manufacture of musical instruments. Resin is processed for cooper pitch, colophony and turpentine. Bark peeled from felled stems is an important raw material for the production of tan. Spruce young-growth stands provide the largest amount of necessary Christmas trees. In horticulture, it provides brushwood serving for the winter protection of sensitive plants and for the manufacture of decorative garlands and bunches.

### **Serbian spruce - *Picea omorica* (Pančić) Purkyně**

**Description:** A tree with a slender stem and a narrow conical crown. Exceptionally, it reaches a height of 50 m, however, on typical sites its height is far lower. Its branches are thin, short and bent. Needles are flat, with two white strips of stomata, dense, covering a twig from above. It begins to bear cones very early. Violet-brown cones with scales converging to a peduncle persist on a tree for about 3 years (Tab. 2).

**Distribution:** The spruce is an endemic species of the Balkan peninsula in the Dinaric Mts in the central reach of the Drina River. It refers to several localities of a total area of about 15 x 35 km on limestone rocks and their vicinity at an altitude of 700 - 1500 m.

In plantations, it was rather rare previously. In recent years, it has been planted in forest stands far outside its range growing in Scandinavia and taiga.

**Ecology:** It is a light-demanding species tolerating shading a little more than Norway spruce. It adapts itself to the various conditions of available water although it grows naturally on heavily drying substrates. Original sites occur exclusively on limestones, however, it can grow on acid soils or even peat soils. It tolerates very different climatic conditions, viz both oceanic and continental climate. It is resistant to early and late frosts showing a potential to tolerate careless treatment during transplanting. It is also resistant to air pollution in towns.

**Use:** The species is grown in forest plantations since 1880. It is used not only in forestry but particularly in amenity planting in towns and industrial regions. The spruce is very popular in horticultural practice.

### **Colorado spruce, blue spruce - *Picea pungens* Engelm.**

**Description:** A medium large tree reaching rarely a height of 50 m and stem diameter 120 cm. Its stem is generally straight. The tree crown is wide conical with regular whorls of rectangularly protruding branches. Hard prickly needles are variously coloured, sometimes even silver-bluish (“silver spruce”). Cones with soft grooved scales persist after maturation to the next year and then fall off.

Blue spruce grows more slowly than Norway spruce forming to a small extent sprouts on its stem (Tab. 3).

**Distribution:** A North American species with a small range in the western part of the continent. It grows in southern promontories of the Rocky Mountains, along watercourses in ravines and in wetlands at an altitude of 2000 to 3000 m usually with *Picea engelmannii*, exceptionally in inverse locations of larger canyons.

**Ecology:** It is a markedly light-demanding species being not capable to adapt itself to slight shading. Even a lateral shading results in needle fall and drying up branches. In forest plantations, it tolerates shallow drying up sites, of course, its growth is rather limited. The species is not demanding for soils.

**Use:** It was introduced to Europe in 1877. The spruce is used as a decorative species tolerating the environment of towns and cities.

### **Sitka spruce - *Picea sitchensis* (Bong.) Carr.**

**Description:** A tree of large dimensions reaching a height of 80 m and stem diameter of even 400 cm. Needles are thin, flat and very prickly. Cones with soft scales fall early after seed maturation. Sitka spruce shows a potential to form sprouts on a stem which is marked after release (Tab. 4).

**Distribution:** North American species the range of which extends along the Pacific coast of the NW part of the continent from Alaska to NW California (its name is according to the island of Sitka). It grows from the sea level to 1100 m alt.

**Ecology:** It is a medium light-demanding species tolerating only a slight shadow smaller than Norway spruce. The species requires markedly oceanic climate – frequent fogs and high relative air humidity. It needs also sufficient soil moisture. Sitka grows particularly on acid parent rocks. It tolerates well permanent wind.

**Use:** In the USA, sitka spruce is a valuable fast-growing commercial species providing high yields. Since 1831, the species is grown in Europe, at present mostly in the United Kingdom and in Ireland.



## **Fir - *Abies***

About 50 species are distributed in Europe, N Africa, Asia and North America. Their range extends from forest-tundra in the north to the mountains of the subtropics in Guatemala, N Africa and the Himalayas. In Europe, in addition to silver fir *A. alba* there is Spanish fir *A. pinsapo* (Tab. 8), Grecian fir *A. cephalonica* and Sicilian fir *A. nebrodensis*. From Japan, it is for example *A. veitchi* (Tab. 8) and *A. homolepis*. Firs are trees, bark on stems of young trees is thin, often with resin “blisters”. In old trees, the bark is thick and fissured. Annual shoots (without leaf “cushions”) are usually smooth, rarely grooved. Cones are upright (erect) maturing in the same year. In some species, there are markedly developed supporting scales overlapping fruit scales. Cones crumble away. Bare spindles remain on twigs for a number of years. Seeds are triangular, bright, with connate wings. Wood lacks resin which occurs in bark, needles and cones.

### **European silver fir - *Abies alba* Mill.**

**Description:** A tree of large dimensions reaching a height of 55 - 60 m, stem diameter 2 m and volume 45 m<sup>3</sup>. Its crown is initially conical, later cylindrical, in old age with an indistinct top as though truncated (“stork’s nest”). Needles are flat persisting rather long (about 8 - 11 years). Buds lack resin.

Fertility in stands begins at an age of about 40 - 60 years. Seed years occur rather sparsely and irregularly at a range of 2 - 6 years. Silver fir is fertile up to its high age (500 years).

The species shows a marked tap root and also lateral roots create deeply reaching anchoring roots. Under the gust of heavy wind, breakages occur more likely. Old trees show robust root swellings. Silver fir has a potential to form sprouts on stems. After top breakages, it creates easily new leaders from dormant buds (Tab. 5).

**Distribution:** Silver fir is a European species. Its range is concentrated in mountain groups of central and southern Europe. The centre of its distribution is the Hercynian-Carpathian and Alpine regions. The boundary of its distribution is formed by the eastern part of the Pyrenees in the west, French middle mountains. The islet-type isolated occurrence of silver fir in Normandy is of great interest. The northernmost occurrence of the species is reached south of Warsaw. An islet of silver fir in the Bialowieza National Park is also considered to be original. Further, the boundary embraces the whole Carpathian arch. Inside the Alps system, silver fir is more abundant in border regions and foothills. The Swiss Jura Mts with the renowned virgin forest “Dürsrütwald” are considered to be the best sites of silver fir. In the Czech Republic in the “Mionši” virgin forest in the Beskids, silver fir reaches the same dimensions. Southwards, the Alps range protrudes to the south of the Apennines peninsula. In the Balkans, it passes across the Dinaric Mts, north of Greece up to the mountains of Bulgaria. Silver fir also occurs in mountains of Corsica. This range is closely connected with very related taxa in Sicily (*A. nebrodensis*) and in the Balkans (*A. borisii-regis*).

Vertical distribution of silver fir is related to its latitude. In the northernmost point of its distribution, it occurs at an altitude of only several hundreds metres. In the CR, it is a species of lower mountain regions its optimum being between 500 and 1100 m alt., southwards it occurs even at an altitude of 1800 m. In the Pyrenees, it occurs at the highest altitudes growing from 900 m up to the tree line from 1800 to 2100 m.

**Ecology:** Silver fir is a species tolerating long-term deep shading without losing vitality. It survives for long decades under the shelter of a parent stand (with the stem diameter of 5 - 8 cm it can reach even 100 years of age) and after cutting down the stand, it begins to grow rapidly. The species shows considerable requirements for moisture and its distribution during the year. It does not grow on dry sites and avoids also waterlogged localities. Silver fir demonstrates higher requirements for the content of nutrients in soils as compared with Norway

spruce and requires also deeper soils. Sometimes, its optimum is on limestones while it is missing on peat soils. Soil is used by deep-rooting silver fir rather evenly.

Natural distribution of silver fir shows that it is a species of oceanic climate. In regions of warmer climate it is related to mountains. The species badly tolerates hot and dry summers and particularly heavy frosts. If its biological requirements are neglected it loses resistance to pests being easily attacked by insect or fungi. During recent decades, regeneration of the species occurs and according to the results of research silver fir belongs to the most air-pollution resistant coniferous species.

**Use:** Silver fir wood is of the same use as spruce wood. It is well cleavable which was advantageous in the manufacture of shingle. In hydraulic structures, the high durability of its wood under water was appreciated. Regularly grown wood of silver fir is also used as resonance wood. Formerly, silver fir trees were very appreciated as Christmas trees. At present, its decorative foliage is more used.

### **Grand fir - *Abies grandis* (Dougl.) Lindl., syn. *Abies excelsior* Franco**

**Description:** A robust tree reaching a height of about 90 m, stem diameter over 1.5 m and age 250 years. Its stem is straight and slender, crown regular, conical. Needles smell good after crushing between fingers. Buds contain resin. It is a fast-growing species reaching a height over 40 m already at an age of 50 years. In this aspect, it can exceed other conifers and become equal as Douglas fir (Tab. 6).

**Distribution:** A North American species distributed in the Pacific part of the continent. The coastal part of its range includes the Cascade Mountains from the borderline of Canada and the USA to N California. The continental part of the range includes the Rocky Mountains from Canada to Idaho and Montana.

**Ecology:** The species tolerates shading and survives for a long time in the second storey. It requires sites with the sufficient amount of precipitation and soil moisture. The species occurs on various soils, from acid ones to limestones. The best sites occur, however, on deep permeable valley alluvia. In Europe, it is sometimes damaged by frosts.

**Use:** In the region of its range, grand fir is one of important commercial species. It was introduced to Europe in 1831. During the last century, it began to be introduced into forest stands in many countries, mostly successfully. It provides valuable decorative foliage and Christmas trees.

### **Caucasian fir - *Abies nordmanniana* (Stev.) Spach.**

**Description:** A tree reaching a height of 50 m and stem diameter 1.5 m. Needles dark-green, bright covering a twig from above. Buds are without resin. Cones similar to those of *A. alba* up to 20 cm long, with protruding supporting scales (Tab. 7).

**Distribution:** The species is distributed in mountains of the W Caucasus and in the Pontic Mts in NE Turkey. It grows at an altitude of 600 - 2200 m.

**Ecology:** Caucasian fir tolerates deep shading, however, it grows well also in insolated areas. The species requires higher atmospheric humidity, tolerates drying out soils in summer months being not damaged by spells of drought. It grows both on acid rocks and on limestones. The species is often attacked by *Adelges nordmannianae*.

**Use:** In the area of natural occurrence, it is an important commercial species. Its wood is of the same quality as the wood of *A. alba*. The fir was introduced to Europe in 1848. It belongs to the most frequently planted ornamental conifers being favoured as a Christmas tree. It also provides decorative foliage.

### **White fir - *Abies concolor* (Gord. & Glend.) Lindl.**

**Description:** A tree reaching a height of 50 m and stem diameter even 1.5 m. Long soft needles are sickle-shaped. Resin buds are of a yellow-brown colour. Cones are up to 10 cm long. Root system is multilaterally developed (Tab. 6).

**Distribution:** A North American species with its range in the SW and W of the USA, sporadic localities occur also in Mexico. Height distribution is extraordinarily extensive in relation to climate, viz. from 500 m alt. in the NW part of the range to 3200 m alt. in the SE part of the USA.

**Ecology:** The species tolerates only small shading. Natural pruning of its stems is bad. Requirements for soil moisture are not high. It occurs on various soils if at least favourably supplied by moisture. The species also tolerates climatic extremes.

**Use:** It was introduced to Europe in 1873. From forestry aspects, it is of marginal importance. It is, however, important as an ornamental species particularly its form with blue-silver needles.

### **Pine - *Pinus***

The genus includes over 140 species distributed in Eurasia and North America, from the region of taiga to the subtropics and tropics. The only species growing in Sumatra oversteps an equator, viz. *P. merkusii*. In mountains of the SW USA, there is a renowned *P. longaeva* reaching an age of 5000 years or *P. ponderosa* with three needles (Tab. 15). *P. wallichiana* (Tab. 13) is a species of the Himalayas. In Europe, there are endemic pines in the Balkans, viz. *P. peuce* (Tab. 13) and *P. leucodermis*, in the Mediterranean it is *P. pinea*, *P. halepensis* and *P. maritima* (*pinaster*). In the CR, three species of the genus *Pinus* grow spontaneously, viz. *P. sylvestris*, *P. mugo* and *P. uncinata* subsp. *uliginosa*.

Two to five (eight) needles in a fascicle, cones do not disintegrate or are semi-disintegrating, seeds are winged or without wings. Cones mature usually during the second year. Wood including heartwood contains large amounts of resin.

### **Scots pine, Scotch pine - *Pinus sylvestris* L.**

**Description:** A tree of medium dimensions reaching a height of even 40 m, stem diameter 1 m and age 500 years. The tree crown is sometimes regular, conical, another time asymmetric, dome-shaped or even umbrella-shaped. Needles (two each) are compacted in bunches on small brachyblasts and persist for about 3 years. Predominantly male or female trees can exist. Mature cones are of very variable shape. Sometimes they are slightly unsymmetrical and on their convex side blunt thorns grow up from hila; another time they are regular and apophyses are generally flat. According to the morphology of cones a number of forms is distinguished. The root system of the species is characterized by deep-reaching tap roots and also lateral roots penetrate far. Therefore, the pine is well anchored in soil and does not suffer from wind-falls. Scots pine never forms sprouts on stems and does not take roots from cuttings. It does not show any dormant buds and, thus, damaged buds cannot be replaced (Tab. 9).

**Distribution:** Scots pine shows a very extensive range occupying nearly the whole Europe and substantial part of forest regions in Asia. In Europe, it is completely missing as an indigenous species above all in lowlands with oceanic climate (Denmark, Ireland etc.). It does not also occur in the whole Hungarian lowland. To the north, it occurs beyond the Arctic Circle, farther than spruce. There, it shows low growth even after transplanting. In the British Islands, it grows in Scotland. In the extensive region of the Alps, it is necessary to differentiate several markedly different ecotypes. From the range of the Alps, Scots pine proceeds westwards through French midmountains and the Pyrenees to the south of Spain. It reaches the northern

part of the Apennines, through the Balkans to the Rhodope Mts and then eastwards to the mountains of the whole northern part of Asia Minor particularly in the Pontic Mts from lowlands up to 2100 m alt.

In the east in the European part of Russia, it occupies vast areas from tundra in the north up to steppe regions in the south. Separated areas of occurrence are in Crimea and in the Caucasus. Eastwards, the range of Scots pine extends in the substantial part of taiga through the whole Siberia to the Sea of Okhotsk. There, it occurs on an area over 100 million ha. Extensive stands of Scots pine in Nordic forests are supported by periodic fires originating without the effect of man.

As a very variable and adaptable species Scots pine creates many ecotypes differing in growth, crown type and branching. The whole CR includes the range of Scots pine, viz Hercynian ecotype. The Hercynian pine occurred naturally only in "isles" in the forest region of uplands and lower mountains on extreme sites of rocky spurs and slope debris. The majority of pine stands in the region of the CR were grown from imported seed.

**Ecology:** Scots pine is a markedly light demanding species unable to regenerate under shading conditions. Therefore, it is very suitable for establishing stands on bare areas. The species is able to cover water consumption from large depth and, therefore, it occurs on extremely dry sites. The pine can germinate even in fissures of bare rocks. Scots pine occurs in areas with large precipitation differences from 400 to more than 1000 mm.

The species grows on various soils of different parent rocks. Under natural conditions it is forced out by shade-tolerating species from better sites. Therefore, extreme sites such as dry sands, peat, limestone rocks etc where competition of other species does not come on force are typical of Scots pine. Thus, extreme edaphic conditions support the occurrence of Scots pine. Some ecotypes of steppe pine from the south of the European part of Russia able to tolerate saline soils appear to be an interesting edaphic deviation. Within the ecological variability of the species it is perhaps one of the most marked peculiarities. Experiments indicate that pines growing on different soils are specialized to a great extent and, therefore, they cannot be arbitrarily used elsewhere.

The species is demanding for climate. It can tolerate even extreme temperature conditions. It can cope very well with large differences in the growing season – from 90 to 200 days. It is a species of pioneer properties able to colonize open areas of various type, however, it does not suit for the environment of cities and industrial regions.

**Use:** Scots pine is the most important coniferous species after Norway spruce and its wood is virtually of the same use. It provides excellent material for building constructions, cabinet making, manufacture of wooden sleepers, telegraph poles etc. Pine wood shows large differences in the quality according to particular classes – from quality logs to fuelwood. For its chemical use, the content of resin (which, however, considerably fluctuates) is decisive. Horticultural use of Scots pine is limited.

### **Black pine - *Pinus nigra* Arn., syn. *Pinus laricio* Poir.**

**Description:** A robust tree reaching a height of 50 m and stem diameter over 1 m. Two needles in a fascicle. The needles are long, dark-green, rigid and usually densely crowded. They persist for 4 to 5 years. Larger cones with light apophyses mature in the second year and soon fall away.

The species root system is characterized by a marked tap root. On rocks, roots embrace often even large boulders and penetrate into fissures and so windfalls do not occur (Tab. 12).

**Distribution:** It is a south-European species distributed in the whole Mediterranean region from the Pyrenees in the west through the Apennines and the Balkans to the east up to Asia

Minor. It reaches Crete, Corsica and Sicily and an isolated locality occurs in Morocco. In the east, it occurs particularly in the Pontic Mts and in the Taurus Mts; isolated localities are in Crimea, in the Caucasus and in Cyprus.

**Ecology:** It is a light-demanding species, very demanding for moisture. The species tolerates shallow drying soils in warm regions. Typical sites occur on limestone rocks where it grows on very inaccessible places. Within its range in warm regions, it tolerates climatic extremes, however, badly adapts itself to short growing seasons at higher latitudes. The species is very suitable for the city environment.

**Use:** Black pine is here and there an important commercial species grown already since 1759. It has proved good particularly for afforestation purposes in warm regions especially on rocky limestone substrates. The pine is an important ornamental species.

### **Lodgepole pine - *Pinus contorta* Dougl. ex Loud.**

**Description:** A shorter tree 10 - 25 m (35 m) tall, often only a shrub, usually with crooked branches. It shows two needles in a fascicle, shoots are glabrous. Cones are small (max. 3 cm in diameter), short prickles on apophyses. Its stem can be straight (*P. c.* subsp. *latifolia*) or variously crooked. The pine crown is usually irregular and very thin. The species creates a tap root or a bundle-type root system (Tab. 14).

**Distribution:** It is a North American species. Its extensive range occurs in the western part of the continent. The species is distributed from the central Yukon in W Canada up to S Colorado in the USA and the N part of Mexico. It grows from the Pacific Ocean, virtually from the sea level up to 3900 m altitude.

**Ecology:** It is a light-demanding species tolerating only slight lateral shading. It creates open pure stands similarly as jack pine. Relationships to moisture are very different in various ecotypes. Southern pines subsp. *murrayana* and *bolanderi* are rather undemanding for moisture and tolerate drying soils even in summer months. The species grows on any soils, from limestone to peat, more likely on acid gravelly substrates. It is generally resistant to air pollution.

**Use:** An important commercial species in many regions of the USA. It often germinates on a mass scale in burned areas (eg Yellowstone National Park etc.). Since 1858, the species is also used in forest plantations in Europe, particularly in S Scandinavia and N Germany but also in New Zealand.

### **White pine, eastern white pine, Weymouth pine - *Pinus strobus* L.**

**Description:** A tree max. 60 m in height, stem diameter up to 3 m. Soft long needles are grouped five each in a fascicle. Shoots are tomentose. Conspicuous elongated cones with sparsely arranged scales. The cones fall away soon after maturation. Its root system is characterized by several thick main roots growing obliquely to depth. Sprouts on a stem are not formed (Tab. 13).

**Distribution:** A North American species with its range in the east of the continent. It grows in the vicinity of Great Lakes in Canada up to New Foundland, in the USA through the Appalachian Mts to N Georgia. It occurs from the sea level (north) to an altitude of 1200 m.

**Ecology:** It is a light-demanding species tolerating only slight lateral shading. It grows in regions with considerable atmospheric humidity. The species also requires sufficient soil moisture. It tolerates stagnant water rather badly. The pine grows on various substrates preferring, however, acid soils. It is resistant to climate growing rather well in the urban environment.

**Use:** In the USA, the pine represents one of the main commercial species and its wood shows versatile use. The species was tested for forestry purposes in Europe as early as after 1705. Gradually, it has become one of the most frequently planted exotic species. White pine suffers

from a number of pests and mass outbreak caused particularly by aphids and fungi is rather frequent in the species. The species also suffers from snow breakages. It is a favoured park species.

### **Larch -*Larix***

In cold regions of Europe, Asia and North America, there are over ten species of larch. One species occurs in the Himalayas. In the CR, there is the only autochthonous species, viz European larch - *L. decidua* which is an important commercial species. As for introduced tree species, Japanese larch - *L. kaempferi* is grown most frequently in collections. Potential forestry use can be expected in a well-growing western larch - *L. occidentalis* from North America or Siberian larch - *L. sibirica* from Russia. Other species are very rare in plantations.

It is a tree with a straight stem and branches arranged in irregular whorls. Needles are deciduous. They are distributed individually in a spiral on long shoots, otherwise they are crowded in fascicles on striking brachyblasts. Male and female strobili are placed individually on the brachyblast ends. Cones are small mostly erect. They mature in the first year persisting several years on branches. Its wood is differentiated to heartwood and sapwood being usually covered by thick rough bark.

#### **European larch - *Larix decidua* Mill., syn. *Larix europaea* DC.**

**Description:** A tree reaching a height of 50 m and stem diameter over 1 m, with a straight stem, sometimes sabre-shaped bent at base, high-placed conical crown. Maximum age is 500 years. In old age, a trend predominates to form thick branches perpendicular to the tree stem and showing ends of branches sickle-shaped bent up. Branches of the lower order are hanging down. Deciduous needles are coloured with pastel yellow tints in autumn.

Larch begins to produce seed in stands already between 20 and 30 years of its age, in mountain locations a little later. The size of cones rather differs according to particular ecotypes. After maturation, cones persist on trees for several years and seeds are released gradually. Supporting scales protrude only underneath cones or cannot be seen at all. Growth in young age is very fast. The root system of larch is of a tap root type at first. Later, the main root intensely ramifies and a multilaterally developed heart-shaped root system originates. Larch preserves dormant buds even on large-diameter stems and so, there is a possibility to form sprouts here. After pruning, fine shoots occur on its stem (Tab. 16).

**Distribution:** European larch shows a markedly disjunctive range in Central Europe limited particularly by the Alpine and Carpathian regions, with other smaller ranges in uplands of southern Poland and in the Nížký Jeseník Mts. Elsewhere in Europe, *Larix decidua* is not an autochthonous species. Alpine larch is distributed throughout the mountain system of the Alps, usually where continental features of climate predominate. Vertical distribution of the species markedly differs, viz from 300 to 2 500 m altitude. Types with large cones predominate. The centre of the distribution of larch is the Tatra Mts and the Transylvanian Mts regions which are interconnected with a number of islets of smaller localities. The species occurs at altitudes from 300 to 1850 m. Polish larch is connected with the Alpine larch range reaching up to Warsaw northward. It grows usually from 200 to 600 m altitude. Thus, it refers to a lowland ecotype.

Silesian larch (Sudeten larch) occurs naturally in a negligible area in the western part of the Nížký Jeseník Mts. Its altitude ranges from 350 to 750 m. The present distribution of larch is related to anthropic activities.

**Ecology:** Larch is markedly a light-demanding species suffering considerably from shading. Stands of larch are always open with large spacing of trees. Due to its sparse crown larch

conditions good growth of grass cover enabling thus a suitable connection between the forest and pasture in mountains. The species shows medium requirements for water both in soil and atmosphere. Drying up soils do not suit to it. The species avoids regions with the occurrence of low precipitation. Most frequently, it grows on fresh, deep, weathered soils but also on shallow slope debris soils with sufficient moisture. It occurs on various parent rocks preferring soils rich in nutrients. As compared with other ecotypes, Polish larch is better adapted to grow on acid and nutrient-poor soils approaching thus to Siberian larch. Larch is medium-sensitive to air pollution. It is a pioneer species particularly in mountain locations.

**Use:** Larch wood, heartwood is highly appreciated because it is strong, resilient, durable, of nice colour and shine. It is a valuable timber for building constructions and furniture manufacture and its nice curly-grain veneer is broadly used particularly for linings of internal walls. Larch wood is very durable under water. In the Alps, resin was obtained from larch (“Venice turpentine”). In horticulture and in amenity planting, larch finds smaller use, however, formerly it was planted in avenues at higher locations.

**Japanese larch - *Larix kaempferi* Sarg., syn. *Larix leptolepis* (S. et Z.) Gord.**

A deciduous tree is reaching a height of 30 m and stem diameter 1 m. It is used as an ornamental species since 1861. From Scotland, a hybrid with *L. decidua* is known, viz *L. ×eurolepis* in which hybrid vigour manifests itself. The hybrid is resistant to cancer.

**Douglas fir - *Pseudotsuga***

Evergreen monoecious trees. Needles are flattened, soft, with whitish strips of stomata on the abaxial face of leaves, tapered at base (pedunculated). In old age, deeply cracked thick cork bark. Cones are pendent with markedly protruding supporting scales, not disintegrating, maturing in the first year. Seeds are winged, triangular, dull.

There are about 15 species in the Northern Hemisphere, more known from North America (eg *P. menziesii*, *P. glauca*, *P. macrocarpa*) and from Asia (*P. japonica*, *P. wilsoniana*, *P. sinensis*). In plantations, an American species Douglas fir - *P. menziesii* is broadly used. In Europe, it is successfully introduced into forest stands.

**Douglas fir - *Pseudotsuga menziesii* (Mirb.) Franco, syn. *Pseudotsuga menziesii* var. *menziesii*, *Pseudotsuga taxifolia* (Lamb.) Britt., *Pseudotsuga douglasii* (Lindl.) Carr.**

**Description:** A robust tree reaching a height of 100 m and stem diameter 5 m. The species can live more than 500 (800) years. It creates a slender straight stem, in young age with smooth bark with resin blisters. Needles are fine, green, after crushing between fingers they smell after citrus. Buds are pointed. Wood is differentiated to heartwood and sapwood being rather resinous. Cones show markedly protruding supporting scales. The species root system is heart-shaped being thus well anchored in soil. Douglas fir does not suffer from windfalls and does not create sprouts on stems (Tab. 17).

**Distribution:** Douglas fir is a North American species distributed in mountains along the Pacific coast. Its range extends from British Columbia southwards through the Cascade Mountains to California. In the north, Douglas fir rises to an altitude of about 1000 m, southward it occupies increasingly higher altitudes reaching max. 2200 m.

**Ecology:** It is a light-demanding species and only in young age, it tolerates lateral shading. It grows in regions with very high precipitation and high snow cover, however, heavy snow damages the species. It does not tolerate drying soils and requires high atmospheric humidity. Parent rock in the species range is created by acid well permeable rocks. Sediments, volcanic material and alluvial soils predominate. It is a typical species of oceanic climate with mild

winters. Polluted environment of large cities and industrial agglomerations is not suitable for the growth of Douglas fir.

**Use:** It is one of the most important commercial species in American forests. Since 1842, it has become an important introduced species in Europe. From the viewpoint of the rate of growth it surpasses other commercial conifers not suffering from insect outbreaks. In landscape architecture, it is used where enough area is available.

**Douglas fir - *Pseudotsuga glauca* Mayr., syn. *Pseudotsuga menziesii* var. *glauca*.**

Grey-green needles. Cones with protruding and markedly backward turned tricuspid supporting scales (Tab. XVI). It tolerates more continental climate, more intense frosts and drier localities as compared with *P. menziesii*. Both species are often mentioned in literature as two variants of the species *P. menziesii*, viz var. *menziesii* and var. *glauca*.

**Hemlock - *Tsuga***

There are about 16 species distributed in the temperate zone of the E Asian and N American region. Usually trees with irregular branching, often with a pendent top. Needles are flat, markedly pedunculate, with two whitish waxy strips of stomata. Cones are usually small, not disintegrating, falling away during the second year. Seeds are winged, resinous. Wood lacks resin.

**Eastern hemlock, Canada hemlock - *Tsuga canadensis* Carr.**

A tree reaching a height of 40 m and stem diameter 1 m. Needles are usually arranged in two rows often covering a twig from above. Cones are small, about 2 cm long, shortly pedunculate. The species shows an intensely developed shallow surface root system (Tab. 17).

A North American species growing in SE Canada and in the NE part of the USA. It is a species well tolerating shading. The species grows on various sites, usually on moist humid acid soils. An important commercial species. Wood is used for building purposes, for the production of cellulose and for boards. In Europe, it was introduced in 1736. It is planted as an ornamental species.

**Western hemlock - *Tsuga heterophylla* (Raf.) Sarg.**

**Description:** A robust tree reaching a height of 70 m (90 m) and stem diameter over 1.5 m. Its crown is pyramidal with a pendent top. Annual shoots are pilose. Needles are equally wide along their length. A bulky root system anchors the species in soil prop roots being rather frequent. Cones without a peduncle are 2 - 2.5 cm long. The species can be propagated by cuttings. It is a fast-growing species.

**Distribution:** Western part of the North American continent, from Alaska to California, in the coastal mountain zone and then separated part of the range in the Rocky Mountains. It grows from the sea level to an altitude of 2000 m.

**Ecology:** It is a shade-tolerating species often creating a lower storey in stands. It prefers localities with high atmospheric humidity and adequate soil moisture. The species grows on various soils from sandy soils through clay soils up to nutrient-poor acid soils of peat bog character. It does not tolerate basic calcareous soils. It is less resistant to low temperatures than *T. canadensis*.

**Use:** An important commercial species of the NW USA. Together with Douglas fir, it creates stands with a growing stock amounting to as many as 2500 m<sup>3</sup>/ha. Its wood is of versatile use, however, it is lighter and less durable than wood of Douglas fir. In horticultural practice, the species is little used.



### **True cedar - *Cedrus***

In North America, the term “cedar” mostly refers to junipers or to the genera of *Thuja* and *Chamaecyparis*. In collections, *C. libani* and *C. atlantica* (Tab. 18) are included. These species are used for the afforestation of limestone localities in the Mediterranean region. The Himalayan species *C. deodara* is known as a production species in plantations in the subtropics and tropics throughout the world.

Cedar of Lebanon - ***Cedrus libani* Loud.** is a tree up to 40 m tall. Needles in a fascicle, 30 - 40 each. Cones are erect disintegrating after maturation. Seeds are winged being similar to fir seeds. Cedar is characterized by durable wood of high quality with finely dispersed resin. The wood was very requested for the construction of ships and temples.

### **Family: - Taxaceae**

Trees with evergreen usually distichous needles. Predominantly dioecious. Male reproductive organs are conelet-shaped, female organs are with a carpel bearing the only ovule. A fruit consists of a seed with nut-shaped skin enveloped by a fleshy or leathery testa (aril). As for European species, only genera *Taxus* and *Torreya* rank among the family.

### **Yew - *Taxus***

There are about 8 similar species distributed in Europe, Asia and America. Merely the only species *T. baccata* grows in the region of the CR. In park management, also a Japanese species *T. cuspidata* is used. The species shows more pointed needles and fine scaly bark. It refers to trees or shrubs of irregular growth with scaly bark. Wood, bark and needles are without resin canals. Fruits consist of small “nut-shaped” seeds in a fleshy testa. Pulp (aril) is sweet, bland, edible.

### **Common yew - *Taxus baccata* L.**

**Description:** A tree with a straight stem, often with a broadly conical or globular crown. Trees are up to 15 m tall reaching over 1 m in diameter at their base. The species can reach 2000 years of age. Branching in young age is noticeably verticillate, later being, however, irregular. Needles are arranged spirally on erect shoots; otherwise they are, however, markedly distichous. They persist for 4 to 8 years. The root system of yew is multilaterally developed. From a heart-shaped basis, roots grow in all directions anchoring the species even on rocky and stony substrates. Yew demonstrates exceptionally good sprouting capacity. The whole plant except aril contains poisonous taxin (Tab. 19).

**Distribution:** Yew is the species of an Eurasian range. Its distribution extends throughout the European subcontinent except cold northern and continental eastern parts. From southern Norway and Sweden to the west, yew grows both in the British Islands and in France and the Pyrenean peninsula; southwards it occurs as far as northern Africa, eastwards it reaches Iran. Throughout its range, the species occurs very sporadically and irregularly. The largest natural habitat of yew occurs in Central Europe in Slovakia in the valley of Harmanec where at least 100,000 older trees occur.

Altitudinal range is considerable being related to latitude. Northwards, yew is also the species of lowlands. Yew reaches the highest locations in the Caucasus or in the Pontic Mts, viz 2300 m alt.

In the Czech Republic, there is a number of isolated localities, eg in the region of Křivoklát, particularly near Týřov (about 5000 trees) and in the Moravian Karst (about 3500 trees). Its occurrence has been markedly reduced through human activities.

**Ecology:** Yew is a species able to tolerate exceptionally intense shading throughout its life. It can grow under heavy shading of other species, mostly of beech and fir. However, it grows also well under conditions of full lighting in the open. Yews growing in the shade adapt badly to sudden insolation, decline and often die. Yew shows marked requirements for moisture. It grows frequently in rock fissures, however, it refers to shady exposures in mountain locations where there are at least sufficient amounts of precipitation and high atmospheric humidity. Yew grows on various soils with the exception of poor and shallow soils. Its optimum occurs often on limestone, cretaceous marl or on well weathering detritus and slope debris of various compositions. It is a species of oceanic climate with moderate winters and considerable relative atmospheric humidity in summer. Yew tolerates well air pollution in cities.

**Use:** At present, yew is without any real forestry importance. Formerly, however, it was appreciated for its exceedingly hard, strong, very durable and resilient wood. It was used as indestructible building timber or for the manufacture of furniture. Until the 16th century, many yews were consumed for the manufacture of bows and crossbows. Yew wood represented an excellent material for turning work and carving. Yew can be rather easily propagated by cuttings. In last decades, shrub cultivars of *T. ×media* (probably a hybrid with *T. cuspidata*) are increasingly used in garden architecture. These cultivars differ in sharply pointed needles and scaly bark.

### **Family : Cupressaceae**

It refers to species with assimilatory organs in the form of needles at least in young age, later mostly scaly foliage either oppositifolious or in whorls of three leaves each. Monoecious or dioecious trees, strobili of separate sex. Behind scales, there is a various number of seeds. Supporting scales are missing. Sometimes, strobili are fleshy even in maturity creating berry-shaped formations. It is a very numerous family, in total about 20 genera. In the CR, it is represented by the only genus: juniper – *Juniperus* (in total 60 species). In horticultural practice and in landscape and shade gardening, members of the genus *Thuja* (5 species), *Platycladus* and *Chamaecyparis* (7 species) are used abundantly in the form of many cultivars. In recent years, a shrubby *Microbiota* is also used. In collections, *Thujopsis* (Tab. 23) and *Calocedrus* (Tab. 23) are also more rarely planted. Some genera of the family *Cupressaceae* are important commercial species of the subtropics. The genus *Cupressus* (15 - 20 species) is distributed in warmer part of the temperate zone of a Northern Hemisphere. The most familiar *C. sempervirens* comes from the Mediterranean. A hybrid *Cupressocyparis leylandii* (*Cupressus macrocarpa* × *Chamaecyparis nootkatensis*) is also used in forestry.

### **Juniper - *Juniperus***

Species with needles or scaly leaves, sometimes the species shows both types of leaves. Junipers are monoecious or dioecios. Thecae occur in strobili. Female strobili show 3 to 8 scales bearing 1 to 2 eggs. Fruits are berry-shaped fleshy strobili ripening in the second or third years. Conelets are intensely aromatically resinous. The genus is distributed throughout the Northern Hemisphere from the Arctic to mountains of the subtropics and tropic (up to Mt Kilimanjaro). In the region of the CR, two subspecies of *J. communis* occur, viz *J. communis* subsp. *communis* and subsp. *alpina*. As for introduced species, North American eastern redcedar (pencil cedar) - *J. virginiana* (Tab. 21) is commonly grown in the form of various cultivars as well as *J. chinensis*. Less abundant species is *J. squamata*. Wood is specially used for

the manufacture of pencils. In horticultural practice, *J. sabina* is also used, particularly its cultivar 'Tamariscifolia' (Tab. 20).

### **Common juniper - *Juniperus communis* L. subsp. *communis***

A shrub or tree of considerably variable shape. Mostly shrubby and multistem, exceptionally only one straight stem reaching a height over 10 m. Pointed needles grow in trimerous whorls showing white waxy stripes on the upper side. It is a dioecious species. Blue-black berry-shaped strobili mature in the second or third years. Its root is of tap type at first. Soon, however, a nodose swelling rich in resin is created near the soil surface. Far-reaching surface roots project from the swelling (Tab. 20). The species shows a large Eurasian range extending from tundra in the north to steppe regions of the Mediterranean, N Africa and central Asia in the south. Juniper is a very light-demanding species being nearly indifferent to soil composition and parent rock showing also broad ecological range to moisture. Juniper berries are a favourite spice in piquant mixtures particularly adjusting the taste of venison. Juniper wood was formerly used in woodcraft.

### ***Juniperus communis* L. subsp. *alpina*, syn. *Juniperus sibirica* Led, *J. nana* Willd.; *J. communis* L. subsp. *nana***

It is a species of only shrubby growth resembling the previous species. A circumpolar species of the Northern Hemisphere. In Europe, it is distributed either in the region of taiga and tundra in the north or above the forest limit in southerly situated mountains.

### **Arbor-vitae, cedar - *Thuja***

Trees with pyramidal crowns. Opposite leaves are scaly, markedly flattened. Monoecious species, female strobili with 4 – 6 pairs of scales bearing 2 – 3 eggs, lignifying. Seeds are winged. Five species are distributed in E Asia and North America. In recent years, *T. koraiensis* is used in horticultural practice as an ornamental species.

### **Eastern arbor-vitae, white cedar - *Thuja occidentalis* L.**

A tree reaching a height of 35 m and stem diameter 1.7 m. Central leaflets are characterized by a markedly protrudent glandule. Its root system is heart-shaped at first, later broadly ramified (Tab. 22). The species is autochthonous in the eastern part of North America particularly in the region of Great Lakes. It is a shade-tolerating species requiring moist soils. Its wood is soft, easily workable and durable. The wood is used for building purposes, for the manufacture of sleepers, hydraulic structures, in joinery etc. In Europe, it is grown since 1536 as an important park species. At present, more than 100 cultivars are known in horticultural practice; it is often used for hedges.

### **Western red cedar, giant arbor-vitae - *Thuja plicata* D. Don**

**Description:** A robust tree reaching a height of 60 (70) m and stem diameter 4 m. Its crown is broadly conical. Maximum age is 800 - 1 000 years. Scaly leaves show whitish spots on the abaxial face. Its root system is well developed although somewhat shallow. The tree resists well to wind gusts.

**Distribution:** A North American species extended particularly along the coast of the Pacific Ocean from Alaska to California. A continental (montane) ecotype extends southwards up to Nevada.

**Ecology:** It demonstrates a broad ecological valence to light. On the one hand, it behaves as a heliophyte, on the other hand it tolerates shade similarly as fir. It requires soil moisture and atmospheric humidity. The species grows well on clayey, deep and moist soils. It does not

show any special requirements for the content of nutrients in soil occupying both acid and basic substrates. Its litter improves the quality of soils. Particularly montane ecotypes are resistant to frosts.

**Use:** The species ranks among the most important commercial species of the American northwest. Its wood is very appreciated being light, resilient, sufficiently hard and durable. It is used for building purposes being also easily workable. The wood contains essential oils giving it characteristic aroma. The species was introduced to Europe in 1853 as an ornamental fast-growing park tree. Later, it was also tested in forest stands.

### **False cypress - *Chamaecyparis***

Trees of pyramidal growth with a nutant top. Opposite scaly leaves are slightly flattened. Strobili are globular. Seven species are distributed in North America and Asia. Less frequently, Sawara cypress - *Ch. pisifera* or *Ch. obtusa* are grown, ie species coming from Japan. An American species *Ch. nootkatensis* is also used as a horticultural species.

### **Lawson false cypress - *Chamaecyparis lawsoniana* (Murr.) Parl.**

A tree reaching a height of 30 - 60 m and stem diameter 2 m. (Tab. 21). It grows in the SW part of the USA on western slopes of mountains. A semisciophyte requiring sufficient soil moisture and atmospheric humidity, however, it can also endure short periods of drought. Its wood is light but hard and strong being markedly aromatic. The wood is resistant to fungi and insect pests. It is used for the construction of buildings, furniture manufacture, for veneers, construction of boats, packing material and in pencil manufacture. It was introduced to Europe in 1854. First as an ornamental park species. Later, it was also used for forestry purposes in western Europe.

Other more familiar species are as follows:

Bald cypress, baldcypress - *Taxodium distichum* (L.) L. C. Rich. (Tab. 24), *Metasequoia glyptostroboides* Hu et Cheng. (Tab. 24), cryptomeria - *Cryptomeria japonica* D. Don (Tab. 25), coastal redwood - *Sequoia sempervirens*, mammoth tree, big tree, redwood - *Sequoiadendron giganteum* (Lindl.) Buchh. (Tab. 26). A North American species growing in the Sierra Nevada Mts in California. Robust trees reaching over 1000 m<sup>3</sup> in volume. The most bulky tree known under name General Sherman reaches a volume of 1467 m<sup>3</sup>. It is a favourite ornamental tree.

### **Family : *Sciadopityaceae***

The genus *Sciadopitys* is represented only by one species - Umbrella Pine - *Sciadopitys verticillata* (Tab. 27). A Japanese species is growing from Honshu in north Japan to Kjusju to south. It is interesting with its needles. They are standing in whorls. It is slow growing tree and it is used as an ornamental species.

### **Family : *Araucariaceae***

It is a family of 3 genera and about 30 exotic species occurring throughout the Southern Hemisphere. A well known species is monkey puzzle - *A. araucana* (Molina) K. Koch (Tab. 27) from Chile and Argentina. Very attractive park trees ranking among the genus *Araucaria*.

The second genus *Agathis* (**Damara**) includes about 20 species in the tropics. The most familiar species used also in Australian forestry is *A. robusta* (height even over 50 m) which is often grown in plantations.

The third genus *Wollemia* is represented only by one species (*W. nobilis*) found in southern Australia in 1994.

Other less known families are *Cephalotaxaceae* with genera *Cephalotaxus* and *Amentotaxus*, eg plum yew *Cephalotaxus* resembles yew with its long needles and further *Podocarpaceae* including about 18 genera with more than 150 species distributed mainly in mountains of the tropics and subtropics predominantly on the Southern Hemisphere. In Europe, the most known genus is *Podocarpus* with about 100 species.

### **Family : *Ginkgoaceae***

It is the only family of the separate section of gymnosperms represented by the only genus and species, viz *Ginkgo biloba* L. The species is a robust tree reaching a height over 30 m and stem diameter more than 2 m. A species with deciduous foliar assimilatory organs. Leaves characterized by a conspicuous fan-shaped nervation growing up on shoots in a spiral, on older shortened shoots in fascicles of 3 - 5 each. A dioecious species. Seeds are similar to a yellow-orange drupe. Ripe flesh smells very unpleasantly, however, the actual seed is edible (Tab. 28).

It is an E Chinese species grown throughout China, Japan and Korea for centuries. It was introduced to Europe in 1730. *Ginkgo* is a light-demanding species tolerating only lateral shading. Its requirements for soil moisture are medium. The species grows best on moist deep soils. For its characteristic foliage, it is particularly used as a park ornamental species with marked yellow autumn coloration. In Asia, it is planted as a sacral species from time immemorial. It ranks among promising species for landscape and shade gardening and for landscape reclamation.

## **Broadleaves**

Broadleaved species are trees, shrubs and woody lianas belonging to angiosperms (ANGIOSPERMAE). Nearly all these species show assimilatory organs consisting markedly of leaves, however, there are also taxa with scale-like leaves (eg *Tamarix*) or with green assimilating shoots virtually without leaves (eg *Spartium*).

All broadleaved species of a temperate and cold zone rank among the class of dicotyledonous plants Magnoliopsida (Dicotyledonae). In the tropics and subtropics, however, there is the class of monocotyledonous plants Liliopsida (Monocotyledonae) the best known of which are palms and ligneous grasses (Poaceae) such as, eg bamboo. Some bamboo plants of smaller growth can survive in our conditions. In our country, palms are known only as house plants. In addition to this, also some plants of the family Liliaceae lignify. Species of the genus *Ruscus* and *Yucca* tolerate our conditions. Species richness of broadleaved species is exceedingly extensive. They include about 300 families with approximately 3800 genera. The number of species reaches tens of thousands. The highest number of the broadleaves comes from the tropics and subtropics particularly from rain forests of the equatorial zone; these species are not utilizable in our country. Conditions of the CR can be tolerated by about 5500 introduced species of angiosperms from roughly 800 genera belonging to about 180 families. About 10 000 species are usable in Europe. Thus, the selection of broadleaved species is very rich; there are several tens of trees of higher growth able to be introduced into our forests.

## **Family : Fagaceae**

There are about 10 species occurring in Europe, eastern Asia and North America. In the CR, the only species grows, viz European beech - *Fagus sylvatica*, the most important forest broadleaved species. A similar E North American species *F. grandifolia* is also a robust tree quite resistant to conditions of our country. Oriental beech - *F. orientalis* from SE Europe, Asia Minor and Caucasian region reaches also considerable dimensions and, therefore, it should be tested. E Asian species of the genus *Fagus* are mostly of smaller growth. They are planted in collections, eg *F. engleriana*, *F. crenata* and *F. japonica*.

It refers to trees with smooth bark. Leaves are deciduous, simple, alternate, sometimes secondarily distichous. Anther catkins are head-shaped, nutant, on long peduncles. Female flowers are individual with two pistils on a cupule. Triangular achenes (beech nuts) are in groups of two surrounded by a fibrous cupule with four valves.

### **Beech - *Fagus sylvatica* L.**

**Description:** A tree of large dimensions with a straight cylindrical stem and markedly smooth thin grey bark. Beech trees with cracked bark occur only exceptionally (so-called stone beeches). In trees growing in the open, crowns are globular whereas in stands broom-shaped. Beech reaches a height of about 35 (50) m and stem diameter 2 m. Its maximum age is 200 - 400 years. The biggest trees reach a volume of 30 m<sup>3</sup>. Stems are straight up to the tree crown and branches protrude in an acute angle. Secondary branching is flat. Leaves are arranged spirally their shade leaf blades being thin; sunlit leaves are tough their blades being risen towards margins. In autumn, beech trees are markedly coloured, at first being yellow then red and lastly dark-brown. In the open, beech begins to bear fruits between 20 and 40 years of age; in forest stands, not sooner than at 60 years of age. Fertile periods occur irregularly in several-year intervals. Beech nuts mature in autumn showing at first excellent germination capacity. Under natural conditions, it is preserved until spring and then sharply decreases. Too dry seeds lose their germination capacity entirely. Beech nuts are of hazel nut taste being edible. Seedlings are striking by exceedingly large kidney-shaped cotyledons. Primary leaves are opposite. The species root system can be considered to be heart-shaped. From a bulky root nodule below the soil surface, roots grow up in all directions into soil. Therefore, the species is very well anchored in soil and only rarely it suffers from windfalls. More likely, wind breakage occurs. On soils rich in nutrients, beech takes roots often rather shallowly and in old trees, there is a conspicuous tangle of large roots around the tree stem on the soil surface.

Sprouting capacity of beech is quite small. It is rather frequent only in young age persisting perhaps till 30 to 60 years particularly in suppressed trees. Stump sprouting is only negligible. Root suckers are not formed. Propagation by cuttings is not commonly used. Grafted plants in beech take roots easily (Tab. 29)

**Distribution:** Beech is the species of a European range with its centre of distribution in the western, central and south-eastern part of the continent. It is totally missing in eastern Europe. A northern limit runs from England to the warmest parts of the Scandinavian Peninsula in the southern coast of Norway and to southern Sweden. Its eastern limit proceeds from the area of western Baltic through Poland to the south-east on the foots of the Carpathians and the Balkan Peninsula. Beech is distributed in mountains throughout the Apennines reaching the range of Sicily. It also occurs in mountains of Corsica while missing, however, in Sardinia. In the Pyrenean peninsula, it is distributed in the eastern and western zone of the Pyrenees affecting also the Cantabrian Mountains. Inside the range, beech is missing particularly in warm regions with the deficit of precipitation (Hungarian lowland, central and SW France) and where a too contrast climate occurs (central and western Poland, the central Alps).

Vertical distribution is dependent on latitude: in the north of the range, beech forests occur from the sea level to an altitude of 200-300 m. A little southwards, beech becomes the species of uplands and in Central Europe, it is the species of lower mountain locations with an optimum between 400 and 1000 m altitude. In the Alps, beech occurs at an altitude of up to 1500 m. Localities of beech in the Pyrenees, Apennines and in the Balkans reach an altitude of 1800 to 2100 m and beech does not occur at lower altitudes than 1000 - 1300 m.

Morphological variability of beech in relation to its range is generally small; provenance trials, however, show considerable ecological differences. As for growth, Nordic ecotypes of lower altitudes rather differ from mountain Central European types. Beech trees from the north show more spreading crowns and shorter stems; mountain beech trees are higher being characterized by slim growth and a straight stem and, therefore, they are more valuable from forestry aspects. Early- and late-flushing varieties are distributed throughout the range and any of them does not predominate in any part. In central parts of the Balkans, we can note transitional types between *F. sylvatica* and *F. orientalis*. In the region of penetration of both species, a transitional species *F. moesiaca* is often mentioned although differences between the initial species are negligible. A beech growing in the Caucasus (*F. taurica*) is also considered to be a transitional type.

The whole area of the CR lies inside the range of beech, however, at present, only remnants of the distribution have been preserved. Beech was replaced in mixed stands of higher locations in favour of Norway spruce; at lower locations, priority was given to oak.

**Ecology:** It is a shade-tolerating species. Leaves of beech inside a closed stand are adapted to the shortage of light through their differing anatomical structure. Considering its potential to tolerate intense shade even pure beech stands can show several storeys because suppressed trees can survive for a long time in undergrowth. Therefore, on more favourable sites, beech supersedes the majority of other species requiring more light which results in the origin of pure beech stands. Sudden exposure of stems growing in shade to full sun results in bark scorch.

Beech demonstrates medium requirements for soil moisture. It avoids extremes missing both on drying out soils and waterlogged soils. Beech does not tolerate floods and, therefore, it does not occur in floodplain forests. The species requires sufficient amounts of precipitation and particularly in summer, sufficient relative air humidity has to be available. In some parts of its range, beech forests occur typically in the zone of abundant fogs. In the region of the optimum distribution of beech, it is rather indifferent to a parent rock. It grows nearly on all types of soils. Where climate and other factors are not optimal, requirements of beech for soil increase markedly. Therefore, soil requirements can be evaluated only in connection with climatic conditions. Otherwise, beech looks for soils rich in nutrients preferring often limestone if there is sufficient amount of precipitation.

Thus, it is evident that mild oceanic climate satisfies requirements of beech. It does not thrive in frost holes and at localities endangered by late frosts. Beech buds early and, thus, new shoots often become the victim of late frosts. Young trees can be totally destroyed by late frosts but also mature trees suffer from the frosts and show crooked burl stems. Due to the susceptibility to late frosts it is sometimes advantageous to use late-flushing beech from mountain locations for the reforestation of large clear-felled areas. Beech is medium-sensitive to air pollution and, thus, it is not suitable for planting in industrial agglomerations.

**Use:** Beech is an important commercial broadleaved species. Valuable wood is usually given by the smooth part of its stem. Its wood is of versatile use. It is used for the manufacture of veneers, plywood, sleepers, parquets, barrels, furniture including bent-wood furniture, handles, toys and other products. It serves for the production of charcoal and some chemical distillation products. It is also used for the manufacture of paper or as fuelwood. Old beech trees

are an usual decoration of manor parks. About 20 cultivars differing in colour or leaf shape and growth are planted.

### **Oak - *Quercus***

Trees or rarely shrubs mostly of crooked growth. Leaves are deciduous or evergreen, simple, frequently lobed, spirally arranged. Anther catkins are placed at ends of twigs being slim and pendent. Pistil flowers are arranged individually or in groups of several flowers in short terminal spikes. Fruits are nut-shaped seeds with a thin skuin (acorn) sitting in a scaly or fibrous cupule. Sometimes, cupule scales grow together into concentric circles. Acorns mature in the first or in the second year.

It is a genus with at least 200 species distributed particularly in warm regions of the Northern Hemisphere. Many species are important from forestry aspects. In E Asia, it is eg *Q. mongolica* and *Q. variabilis*, in North America *Q. alba*, *Q. velutina*, *Q. macrocarpa* or *Q. rubra*. The Mediterranean species *Q. suber* is grown for bark processed for cork. Some species are with edible acorns such as eg the S European species *Q. ilex* var. *rotundifolia*.

In the CR, four species are commonly distributed: pedunculate oak - *Q. robur* (*Q. pedunculata*), sessile oak - *Q. petraea* (*Q. sessilis*), Turkey oak - *Q. cerris* and pubescent oak - *Q. pubescens*. Very rare is *Q. frainetto* (Tab. 35). From the aspect of forestry, the most important species are pedunculate oak and sessile oak.

#### **Pedunculate oak - *Quercus robur* L.** (syn. *Q. pedunculata* Ehrh.)

**Description:** A tree of considerable dimensions with a large-diameter stem and a spreading crown. In stands, the species reaches a height of 40 m and stem diameter 1.5 m. Maximum age is 400 - 500 years. The biggest trees reach a volume of 40 m<sup>3</sup>. In a stand, stems are long and cylindrical with a rather small crown. Branches are crooked, tough large leaves with short petioles are arranged in the tree crown in the form of tufts. In autumn, leaves turn to light brown colour and sometimes dry leaves persist on a tree till winter.

Pedunculate oak begins to fruit rather early, viz in trees growing in the open between 10 and 20 ears of their age, in stands after 40 years of their age. Large elongated acorns with a typical long peduncle mature and fall out in autumn. High germination capacity of acorns rapidly decreases. Germination is hypogeal. Seedlings develop a tap root. Later, the root system is vigorously developed, roots reach deep being characterized by a mighty tap root. Therefore, pedunculate oak is very resistant to wind using moisture in lower soil layers. Root swellings are not anyway markedly developed (Tab. 30).

Stump sprouting is excellent persisting to a considerable age making possible to manage oak stands as a coppice forest. Shoots are easily formed everywhere on stems mainly under condition of increased access of light or in suppressed trees.

**Distribution:** Pedunculate oak is a species of European range distributed nearly throughout the continent with the exception of cold north and north-east. In the north in Scandinavia, it occurs in the warm coastal part of Norway, southern Sweden and grows also in the southernmost Finland. In Norway, it occupies a belt of about 20 km along the coast max. up to 63° N latitude, generally about 150 km more northward than sessile oak. From the region of the Finnish gulf, the range proceeds through the whole European part of Russia eastwards up to the Urals. From there, the boundary of its distribution turns through steppe regions in the south of the European part of Russia to the estuary of the Dnepr to the Black Sea. Southwards, in the region of dry steppes, the species is already missing. It grows in the region of the Caucasus (up to the Caspian Sea) and Asia Minor. In the south, it occupies the whole Balkan Peninsula and the Apennines with the exception of the southernmost part. In the west, it occurs in



the northern half of the Pyrenean peninsula, in France and in the British Islands (except for Ireland). Inside this range, the distribution of pedunculate oak is markedly related to altitude. It grows above all in lowlands along large rivers, in plains and uplands. It is absent in mountains. Remnants of natural stands with pedunculate oak in floodplains are very rare because easily accessible flat landscape was transformed to agricultural land long ago. If forests have remained there then they consist most often of poplar plantations (eg the whole lowland of the Pad River in Italy). The most notable floodplain forest reserve of a central European character with age-old specimens of pedunculate oak lies in the Morava River near Lanžhot.

**Ecology:** Pedunculate oak is a heliophilous species being a little more light-requiring than sessile oak. It is also indicated by the arrangement of leaves. Oak tolerates only light shade and for the purpose of regeneration, heavy opening up is necessary.

As for requirements for moisture we have to differentiate two ecotypes in pedunculate oak. An ecotype which is characterized by a possibility to grow on shallow and in summer heavily drying up soils with groundwater table out of the reach of roots is less distributed being economically insignificant. Such conditions occur at forest-steppe localities. A commonly distributed ecotype which is the subject of forest management particularly in floodplain forests exhibits considerable requirements for moisture. Thus, groundwater table has to be within the reach of roots. Pedunculate oak tolerates spring floods before the flushing period taking maximally 21 days.

It is a species growing best on deep loamy soils occurring in floodplain forests or on loess. It resists to a certain extent also salts in soil which resulted in its increased use in establishing forest shelterbelts in steppe regions. Pedunculate oak is rather indifferent as for climatic conditions which are related to its considerable range. From the viewpoint of phenology, differences in budbreak are most important for growing; early-flushing and late-flushing forms can differ in the beginning of flushing even by 3 weeks. The fact is crucial from the viewpoint of damage caused by late frosts. Such forms can be found in any part of its range. The species is rather resistant to air pollution and thrives passably under conditions of large towns. Some results of experiments also indicate a possibility to use the species in the afforestation of waste dumps, slag heaps and spoil banks.

**Use:** Pedunculate oak occupies very important position in forest management. Its wood is of versatile use in the manufacture of veneers, as building timber, in shipbuilding, in the manufacture of sleepers, parquets, barrels and furniture. For the large content of tannins its wood is durable under water and, therefore, it is used in hydraulic engineering. In the landscape, old pedunculate oaks represent an important element. In Central Europe, the tree was formerly planted on crossroads, squares, dams of ponds and in the vicinity of notable buildings.

### **Sessile oak - *Quercus petraea* (Matt.) Liebl.** (syn. *Q. sessilis* Ehrh.)

**Description:** A tree of medium dimensions with a slightly crooked stem and elongated irregularly formed crown. It is up to 30 m tall and reaches 2 m in stem diameter. It can achieve several hundreds of years. On shallow dry soils typical of the species its dimensions are far smaller. Sessile oak begins to fruit usually earlier than pedunculate oak. Seed years are, however, more sporadic and acorn crop lower than in pedunculate oak. Acorns are in sessile or shortly pedunculated cups. Root system is multilaterally developed and a marked tap root is not present. Main roots are rather short ramifying intensely. On shallow soils, windfalls sometimes occur. Sessile oak exhibits very good stump sprouting, more abundant than pedunculate oak (Tab. 31).

**Distribution:** It is a species of European distribution being absent in the cold north. It does not occur particularly in the whole eastern part of continental Europe. In the north, it occurs in the warmest parts of Scandinavia. In southern Sweden, the boundary of distribution turns

southwards going between islands of Gotland and Öland to Lithuania. The eastern boundary of distribution of sessile oak heads through Byelorussia and the Central Russian Upland to the middle reach of the Volga River. In the south-east, the sessile oak distribution penetrates to the region of the Caucasus and Asia Minor occurring also in Crimea. In the Mediterranean, it occupies the whole Balkans and the Apennines and islands in the Mediterranean Sea. Thus, it reaches farther southwards than pedunculate oak in this region. In the west of Europe, its range is roughly the same as that of pedunculate oak; it occupies the northern part of the Pyrenean peninsula, France and the British Islands (occurring also in Ireland and Scotland). In general, it is possible to say that sessile oak is the species of lowlands in northern Europe whereas in Central Europe, it grows in uplands and in southern Europe, Asia Minor and the Caucasus the species rises to lower mountain locations. Under conditions of Central Europe, sessile oak grows in the extensive region of uplands and mid-mountains most often with hornbeam, in thermophilic communities also with pubescent oak and wild service tree. It creates often mixtures with beech. Its altitude ranges from 200 m to 1600-1800 m (Greece, the Caucasus).

In the region of the CR, sessile oak is distributed in all warm uplands and its limit of occurrence coincides with lower limit of beech.

**Ecology:** Sessile oak is a heliophilous species its requirements for light being a little lower than those of pedunculate oak. It naturally regenerates under a parent stand better than pedunculate oak. As for moisture requirements there are certain differences. Mostly, it is possible to notice that sessile oak grows under conditions of considerable moisture deficit surviving on substrates which become very dry in summer as well as on markedly dry forest-steppe sites on loess or on bedrocks. In addition to this, we can find sessile oak usually with birch on waterlogged sites. In spite of this, it does not tolerate floods.

Requirements for soil are exiguous. It grows on nutrient-poor acid and shallow soils of the crystalline complex or on gravel terraces as well as on andesite or limestone. It tolerates bedrocks. As for climatic factors, sessile oak is particularly endangered by heavy frosts causing cracks in wood and damage heartwood and typical frost ribs are formed. In some places, sessile oak crowns are heavily damaged by the mass occurrence of *Loranthus*. It is a species resistant to air pollution tolerating the urban environment.

**Use:** An important commercial broadleaved species. At present, wood of sessile oak is not distinguished from the wood of pedunculate oak showing the same versatile use (building timber, veneers, sleepers, furniture, barrels etc.). Horticultural cultivars are rare. Sometimes, separate taxa of the species are differentiated such as *Q. polycarpa* and *Q. dalechampii*.

### **Turkey oak - *Quercus cerris* L.**

**Description:** A tree reaching 30 m in height and stem diameter 1 m with a slightly crooked stem and fissured bark with rusty cracks. Its leaves are leathery and bright. The species exhibits striking buds with fibrous perennial bracts. Large acorns are in a sessile strikingly subulate- fibrous cupule maturing in the second year. Root system is multilaterally developed penetrating upper soil layers far of the tree stem. It exhibits good stump sprouting (Tab. 32).

**Distribution:** It is a south-European species occurring in warm locations of western, central and eastern Europe. The centre of its distribution is the Apennines, the Balkans and Asia Minor. Northwards, it reaches central France, warm regions of Switzerland and the CR. In Italy, Balkan countries and Turkey, it often covers (together with sessile oak and pubescent oak) huge areas of degraded grazing forests. In the CR, Turkey oak occurs only in southern Moravia. It is admixed in thermophilous oak stands and forest-steppe shrubs northwards up to Brno (Hády). It is missing in Bohemia.

**Ecology:** Turkey oak is a moderately heliophilous species. It develops well even under conditions of slight shade. The species is thermophilic tolerating moisture deficits and drying up the soil profile in summer months. It grows in regions with low precipitation and does not require special soils. Turkey oak tolerates acid, shallow and nutrient-poor soils. On limestone bedrocks, it is replaced by pubescent oak and other thermophilic species. It is very sensitive to heavy frosts; cracks and occlusions depreciating wood originate easily.

**Use:** Its wood is of lower quality than in sessile oak or pedunculate oak serving often only as fuelwood. Otherwise, it provides large masts and so the species is suitable for game preserves.

**Pubescent oak - *Quercus pubescens* Willd.** (syn. *Q. lanuginosa* Thuill. )

**Description:** A smaller tree with a crooked stem reaching a height of 15 m and stem diameter (exceptionally) 100 cm. Its bark is dark, rough and cube-shaped cracked. Annual shoots and leaves are tomentose-pubescent. Acorns are with a sessile tomentose cupule. The species exhibits a multilaterally developed root system (Tab. 33).

**Distribution:** It is a species distributed particularly in southern Europe, from the Pyrenees to the Balkans. It grows also in Asia Minor and the Caucasus. Northwards, it occurs also in Germany. It grows at lower locations, in uplands. In southern Europe and Asia Minor, it rises to foothills creating, together with *Quercus petraea* and *Fraxinus ornus*, extensive open forests. In the CR, it occurs in the warmest regions of the country where it creates, together with other xerophilous species, characteristic forest-steppe formations.

**Ecology:** Pubescent oak is a highly heliophilous species. It tolerates very dry sites and even bedrocks. The species grows in regions of the lowest precipitation. It prefers soils developing on limestone, basalt, cretaceous marl, andesite or loess. It is a thermophilous species.

**Use:** In forest management, pubescent oak is nearly without any commercial importance. Its sites are mostly represented by protection forests.

**Red oak - *Quercus rubra* L.** (syn. *Q. borealis* Mich.)

**Description:** A tree reaching a height of 50 m and stem diameter over 1.5 m. Bark on its stem remains smooth for a long time. Strong, large and bright leaves turn red in autumn. Acorns sit in quite flat cups and mature in the second year. Its root system is flat reaching far the tree stem anchoring it well in soil (Tab. 34).

**Distribution:** A North American species distributed in the eastern part of the continent. Its range extends from the north of New Scotland in Canada to Alabama in the south. Towards interior, it proceeds up to the basin of the Missouri river in Kansas (USA). The species was introduced in Europe at the beginning of the 18th century. Later, it was also used in forest plantations.

**Ecology:** It is a heliophilous species. In young age, it tolerates only light shade. Its crown shows a tendency to occupy as large as possible area which results in the suppression of neighbouring trees. The species requires sufficient moisture not tolerating stagnant water. It is undemanding for soil. It grows on poor skeletal soils poor in nutrients if they are sufficiently moist. The species tolerates heavy-textured clay-loam soils. It is quite resistant to frost and tolerates air pollution.

**Use:** An important commercial species. Its wood exhibits versatile use similarly as in European species – building timber, veneers, sleepers, parquets, furniture etc. For its considerable porosity it is not suitable for barrels. It is a valuable park tree.

**Chestnut - *Castanea***

There are about ten species distributed in the temperate zone of Europe and North America. The best edible fruits are given by the south-European sweet chestnut *C. sativa*, north-American *C. dentata* and a Japanese species *C. crenata*.

### **Sweet chestnut - *Castanea sativa***

A massive tree reaching a height of 30 m and stem diameter 3 m. Leaves are deciduous, simple, roughly and sharply serrate, with many pairs of parallel nerves. Pistil flowers are usually in groups of three each placed in the lower part of the uppermost anther catkin. Only occasionally, female flowers are on separate catkins. Large edible fruits lie 1 to 3 each in a cupule with sharp setal-shaped thorns in fascicles (Tab. 36).

The species is distributed throughout the Mediterranean region including northern Africa

From the viewpoint of forestry, it is of interest that sweet chestnut of seed origin occurs in forest plantations in some places. Ecological requirements can be compared with sessile oak or Turkey oak. Sweet chestnut provides extremely strong, hard and very durable wood.

### **Family : Corylaceae**

Woody species with deciduous simple leaves. Inflorescences are monoecious, unisexual; male inflorescences are in catkins. Fruits are nuts surrounded by the coat of bracts. The family consists of four genera two of them being native: hornbeam - *Carpinus* and hazel - *Corylus*. Other genera belonging to the family are *Ostrya* and *Ostryopsis* which occur only rarely in our collections.

### **Hornbeam - *Carpinus***

About 26 species of the genus have spread from Europe to E Asia and the Himalayas. Fruits consist of nut-shaped seeds equipped with large supporting leaves.

### **European hornbeam - *Carpinus betulus* L.**

**Description:** A tree of medium dimensions with a slim crown and strikingly smooth bark. It reaches a height of 25 m and stem diameter 1 m. It can achieve 150 years of age and exceptionally even more. Its stem is not usually straight and branches protrude in an acute angle. In a stand, its crown is strikingly broom-shaped. Leaves turn yellow in autumn. Seeds, small heart-shaped nuts with a trimerous supporting bract, retain high germination capacity for several years.

Its root system is heart-shaped or of a “pseudo-leg” type in deep soils; thick roots proceed first near the surface and later they turn downwards into soil. Root swellings are strikingly developed. On shallow soils, roots are developed in upper soil layers only and thus windfalls occur sometimes. Sprouting capacity is very high. Hornbeam is, therefore, grown as coppice with a short rotation (Tab. 37).

**Distribution:** Hornbeam is a European species and the centre of its distribution occurs in western, central and south-eastern Europe. It is missing particularly in the cold north and in the NE part of the continent. It does not grow in the eastern continental part of Europe and in the Pyrenean peninsula. In the Balkan peninsula, the range of hornbeam reaches northern Yugoslavia, southernmost Hungary up to the lower reach of the Danube. Southwards of the limit, it is gradually replaced by a related species *C. orientalis*. European hornbeam occurs also in the Apennine peninsula with the exception of the southernmost part. It does not occur on all islands of the Mediterranean Sea. In western Europe, it reaches southwards up to the Pyrenees, northward to England.

Altitudinal distribution of hornbeam can be best compared to sessile oak. In the CR, hornbeam is part of mixed stands accompanying mainly sessile oak nearly in all uplands.

**Ecology:** It is a species tolerating shade but to a smaller extent than beech. It survives in the second storey of oak stands and thus it can somewhat compete beech. As for requirements for moisture, there are differences. Hornbeam mostly prefers moist sites, nevertheless, it is not absent on dry and sunny soils drying up in summer. In floodplain forests, it occurs even at the border of flooded parts. However, it does not tolerate regular floods. It exhibits medium requirements for soil growing on various rocks. The species avoids nutrient-rich and acid substrates and does not tolerate peat soils. Together with maples and other more demanding broadleaves, it grows even on slope debris. It is resistant to climatic deviations. Hornbeam does not suffer from frosts or drought.

**Use:** Hornbeam is the species of inferior quality. Its wood is strong and hard, however, not durable. It is predominantly used as fuelwood because of its high calorific value. At present, the wood is also used for the manufacture of paper. To a smaller extent, it serves for the manufacture of tools, in pattern making and in wheelwright's workshops. In gardens and parks, it is often possible to find pruned hornbeam hedges.

### **Hazel - *Corylus***

Trees or shrubs with deciduous simple distichous leaves. Anther (male) flowers in long pendent terminal catkins. Pistil (female) flowers either individually or in groups of two each in bud-like formations on older parts of branches. Fruits are nuts surrounded by variously formed bracts.

The genus consists of about 15 species distributed in Eurasia and North America predominantly in warm regions. A common European species *C. avellana* L. (Tab. 38) - grown for edible seeds. A shrub of medium size about 5 m tall with stems up to 30 cm in diameter. In forest management, it is sometimes used as a soil-improving species.

### **Turkish hazel - *Corylus colurna* L.**

A tree reaching a height of 30 m and stem diameter 1.5 m with an egg-shaped crown and straight stem. Nuts are in groups of 6 – 20 each in a wide campanulate open coat. Its root system is richly developed and already in seedlings a tap root is formed. Sprouting capacity of stems is medium (Tab. 39). It is rather a heliophilous species tolerating lateral shade in young age. The species is not too demanding for moisture and survives on soils becoming dry in summer. It grows particularly on nutrient-rich limestone substrates. The species tolerates larger amounts of soil skeleton. It is rather tolerant to air pollution in industrial regions being suitable for the urban environment. Its wood is valued and processed particularly for decorative purposes. Otherwise, it provides large crops of nuts of good taste. It is usually used as an ornamental park species.

### **Hop hornbeam - *Ostrya***

About 7 species of the genus are distributed in Eurasia and North America. In the region of the eastern Alps, south-eastern Europe and Asia Minor, there is *O. carpinifolia* (Tab. X), a smaller tree, seldom grown in stands. It differs from hornbeam particularly by fruits. Its fruit is a small costate nut hidden in coalescent bracts. The whole infructescence resembles a "hop cone".

### **Family : Oleaceae**

Trees and shrubs with opposite leaves; the position of leaves is only exceptionally alternate. Flowers are usually with 4 petals their number being only seldom higher. They are polygamic or unisexual. Fruits are variously formed. There are at least 20 genera and about 400 species.

Olive tree *Olea europaea* is an age-old cultivated plant giving particularly oils. It is a typical species of the subtropics freezing out in cold parts of Europe. Ornamental shrubs *Forsythia* or lilac *Syringa* rank among other genera. Privet - *Ligustrum vulgare* L. is a well-known European species. It is a thermophilic species growing on nutritive soils and occurring in forest-steppe formations.

### **Ash - *Fraxinus***

Deciduous trees, rarely also shrubs with opposite odd-pinnate leaves sometimes reduced to the only terminal leaf. Small flowers are usually arranged in panicles. Fruits consist of winged achenes. About 65 ash species are distributed in Europe, Asia (southwards up to Java) and in North America (southwards up to Mexico). As for known European species it refers to European ash (common ash) *F. excelsior* and narrow-leaved ash *F. angustifolia*. In the warmest regions, manna ash *F. ornus* is planted coming from southern Europe. As for introduced ash trees we can rather often encounter *F. americana* and *F. pennsylvanica*.

#### **European ash, common ash - *Fraxinus excelsior* L.**

**Description:** A tree reaching a height of 40 m and stem diameter 1.5 m living even 250 years. Its branching is regular, opposite. Odd-pinnate leaves are sparsely arranged, predominantly along the crown circumference. In autumn, leaves fall green. Achenes mature in autumn persisting often through winter. Germination capacity is high and lasts 2 - 3 years. Its root system is mostly of a "pseudo-leg" type; thick roots are directed first laterally at the soil surface and then in depth. Tap roots are weakly developed. Roots of European ash penetrate intensely surface layers of soil thus precluding self-seeding of other species. Stump sprouting is excellent (Tab. 40).

**Distribution:** *Fraxinus excelsior* is of European range extending nearly throughout the continent apart from the utmost north and north-east. Northward, it occurs in the warm part of Scandinavia growing also in southern Finland. From the area of Karelian neck, its range continues through the European part of Russia to the southern Urals. Through steppe regions in the south, it proceeds to the Black Sea and occurs in Caucasian and Asia Minor regions. In the area of the Mediterranean Sea, the southernmost boundary line goes through the centre of the Pyrenean and Apennine peninsula and southern half of the Balkan peninsula. In these parts, ranges of *Fraxinus excelsior* and *Fraxinus angustifolia* mingle. In western Europe, the species occupies the whole France and British Islands with the exception of Scotland. Altitudinal distribution within the range is very miscellaneous because it probably refers to three different ecotypes: floodplain, mountain and limestone ash. Floodplain ash shows its centre of distribution in lowlands along courses of large rivers. Mountain ash is particularly distributed in the zone of beech stands and in the south of its range increasingly in mountains. Limestone ash occupies upland locations often characterized by a moisture deficit.

**Ecology:** In young age, ash requires shading whereas in maturity, it is a heliophilous species.

Floodplain and mountain ash require sufficient moisture. It can survive floods only for short time. It needs deep, humous and moist soils. The species grows on various soils if they are sufficiently rich in nutrients particularly enriched by nitrogen.

European ash is sensitive to heavy frosts being medium-sensitive to air pollution.

**Use:** Wood is of very good quality belonging to the best woods for the manufacture of furniture, veneers, sports articles, parquet, musical instruments etc. It is used for the construction of cars and wagons being also searched for in aviation. The wood of mountainash with curly annual rings was formerly highly appreciated and particularly bird's-eye wood of stems and roots was processed. In mountain regions, ash was planted as a road avenue tree. It was also extensively used in establishing shelterbelts and riparian stands.

**Narrow-leaved ash - *Fraxinus angustifolia* Vahl** (syn. *F. oxycarpa* Willd).

**Description:** A tree resembling European ash. It differs particularly in serrate leaves turning red in autumn, brown buds, racemose inflorescence and wedge-shaped basis of achenes. Its root system is of a "pseudo-leg" type and intense sprouting capacity is also a property which is common for both species.

**Distribution:** A species of south-European distribution occurring in all countries around the Mediterranean Sea. Southwards, it reaches N Africa being distributed in the Caucasian- Iranian region and throughout Asia Minor. From there, its range extends up to Syria. Northwards, it is distributed from southern France to the Alps, N Yugoslavia and Hungary. From the Pannonian lowland, its range protrudes to the warmest parts of Slovakia and the CR. Its distribution is very gappy consisting of belts of floodplain forests along watercourses at low locations.

**Ecology:** It agrees with the floodplain ecotype of *Fraxinus excelsior*.

**Use:** Its wood is of high quality and does not differ from wood of European ash being processed together.

## **Family : Ulmaceae**

Species with simple, deciduous, sometimes semi-evergreen leaves, markedly distichous. Inflorescences are monoecious.

About 15 genera with 150 species with the exception of the most cold regions are distributed on the Earth. In Europe, following genera are represented: elm - *Ulmus*, hackberry - *Celtis* and more rarely also zelkova - *Zelkova*. Three monotypic genera, viz *Planera* from North America, *Hemiptelea* and *Pteroceltis* from E. Asia are grown in the warmest collections. An Australian-E Asian genus *Aphananthe* occurs rather rarely.

### **Elm - *Ulmus***

About 18 species are distributed in the temperate zone of the Northern Hemisphere. In Europe, the best known species growing also in the CR are: smooth-leaved elm - *U. minor*, syn. *U. carpiniifolia*, wych elm - *U. glabra*, syn. *U. scabra* and European white elm - *U. laevis*.

Trees often without a straight main stem, leaves deciduous (seldom semi-evergreen), simple, frequently markedly asymmetrical and distichous. Inflorescences bisexual in fascicles or racemes are growing in leaf axils. Fruits are formed by achenes with orbiculate membranous wings. Fruits of species flowering in spring mature immediately after the lose of blossoms simultaneously with the development of leaves.

A number of elm species in their world range is seriously endangered by Dutch elm disease. In Europe, Dutch elm disease gradually destroys all species of *U. minor* and *U. glabra* in forest stands and parks including ornamental cultivars. A west-European elm *U. x hollandica* is very tolerant. The species is also more resistant to air pollution.

**Smooth-leaved elm - *Ulmus minor* Mill.** (syn. *U. carpinifolia* Gled., *U. glabra* Mill., *U. foliacea* Gilib )

**Description:** A tree with a slim stem and a broom-shaped crown. It reaches a height of 25 - 40 m and stem diameter over 1.5 m. In the upper part of a tree, the stem exhibits branches arranged in a plane and distichous leaves. Leaves do not change colour in autumn. Sometimes, we encounter markedly developed corky ribs on twigs (var. *suberosa*).

Fruiting in free-growing trees occurs early, sometimes even in 10 - 12 years. It is in blossom before leaf unfolding. Mature fruits immediately fall and germinate. Its root system shows a tap root in young age later being heart-shaped. Roots grow both near the soil surface and partly penetrate sideways deep. The species is well-anchored in soil not suffering from windfalls. Stump and root sprouting is intense and sprouts develop abundantly (Tab. 42).

**Distribution:** Eurasian species. In Europe, its range reaches the whole continent except for cold north and north-east. It occurs in the warm part of Scandinavia and from there, its range proceeds through the European part of Russia and the Ukraine by steppe regions to the Urals and the Caspian Sea. In the west, it occupies the southern part of the British Islands being extended throughout France and the Pyrenean peninsula. Through islands in the Mediterranean Sea it reaches Africa. The species grows in Asia Minor and the Caucasus-Iran region.

Within this range, elm is differentiated to two ecotypes. One of them extends in floodplain forests along courses of large rivers, the second one occurs at forest-steppe localities. A floodplain ecotype is of forestry importance. This ecotype never creates poor stands but only admixtures of mixed stands.

**Ecology:** The species tolerates shade particularly in young age. In old age, it requires more light being a semi-sciophilous species. The floodplain ecotype requires high groundwater table and tolerates floods. On the other hand, the forest-steppe ecotype survives under conditions of moisture deficit and tolerates drying up shallow soils if they are sufficiently rich in nutrients. In the eastern part of its range, it grows even on saline soils. It does not tolerate changes in the water regime caused by draining or channelization of watercourses. Elm is ranked among demanding broadleaves (similarly as ash or maple). It is a sub-nitrophilous species which does not grow on acid and nutrient-poor soils. It does not survive on peat soils. The species is of medium sensitivity to air pollution.

**Use:** Its wood is of high quality, strong, hard, giving a nice curly-grain veneer. It was formerly used in woodcraft, wheelwright's workshops, in the manufacture of furniture, wagons, gun stocks and in hydraulic structures.

**Wych elm - *Ulmus glabra* Huds.** (syn. *U. scabra* Mill., *U. montana* Stok.)

**Description:** A tree with a straight stem and broom-shaped crown reaching a height of 35 m and stem diameter 1 m. In its crown, the stem ramifies in acute angle. Leaves are rough. It flowers and yields seed similarly as smooth-leaved elm.

Its root system is multilaterally developed being often of a "pseudo-leg" type. Flattened root swellings are markedly developed. The tree is well anchored in soil. Stump sprouting is intense, however, root suckers are not created (Tab. 43).

**Distribution:** Wych elm is a Euroasian species. In contrast to smooth-leaved elm its range is a little shifted towards colder regions. In Scandinavia, it goes along the coast of Norway northward up to 67° N. It also occurs on the southern part of Finland. Through the European part of Russia, it gets to the Urals. In the west, it grows in the British Islands including Scotland. From the Pyrenean peninsula, it occupies only its northern part. It occurs at higher locations of the Apennines and the Balkans except for southern parts. Its range penetrates to Asia Minor and the Caucasus. Altitudinal range within its area is considerable. In the north, it



grows at altitudes 200 - 700 m; in the Hercynian mountains (CR) it rises to an altitude of 900 m and in the Caucasus perhaps up to 1900 m altitude.

**Ecology:** Other species of elms tolerating heavy shade particularly in young age. In maturity, requirements for light increase. The species exhibits considerable requirements for moisture. Typical sites occur on spring areas, waterlogged slope debris and on soils near the groundwater table. At lower locations, it grows on moisture-favourable shadowy slopes and in valleys. It does not tolerate drying up the soil profile in summer. The species is very demanding for soil nutrients. It tolerates considerable amounts of skeleton in the soil profile. Wych elm does not suffer from late frosts and tolerates hard winters providing sufficient moisture. It is sensitive to air pollution.

**Use:** Its wood does not differ from the wood of smooth-leaved elm. It is considered to be very quality showing the same use (veneers, furniture, parts of cars, wagons, building constructions).

**European white elm - *Ulmus laevis* Pall.** (syn. *U. effusa* Willd.)

**Description:** A tree reaching a height of 35 m and stem diameter over 1 m. Its stem is often of bird's-eye character with burls and numerous sprouts. In autumn, leaves turn yellow. It buds later than smooth-leaved elm and wych elm and also blossoms later than smooth-leaved elm and wych elm. Its root system is richly developed. At the stem base, markedly flattened plank root swellings often originate. Stumps sprouting is excellent but root suckers do not occur (Tab. 44).

**Distribution:** European white elm exhibits European range rather unusually distributed. Northwards, it gets to the Baltic Sea and from there, it extends far to the European part of Russia. Then, it heads for steppe regions in the south and to the western coast of the Black Sea. It occupies the northern part of the Balkans and Apennines. Westwards, it occurs in the central France; in the British Islands and in the Pyrenean peninsula, it is missing.

**Ecology:** Requirements for light are similar as those of other species. As for moisture requirements, the range of European white elm is considerable. It grows in floodplain forests with high groundwater table and tolerates floods but it survives also where the table markedly decreases in summer, soil dries up, becomes hard and develops cracks. In this respect it resembles smooth-leaved elm. European white elm is ranked among demanding broadleaves. It tolerates very well saline soils.

**Use:** Its wood is processed similarly as in previous species, however, it is considered to be of lower quality. In addition to wood also bast was formerly processed similarly as that of lime.

**Family : Aceraceae**

Shrubs and trees with opposite leaves. Flowers are mostly in compound inflorescences. Fruits are two-piece winged achenes. In Europe, the family is represented by one genus only, viz *Acer*. The second genus, *Dipteronia*, coming from China and belongs to the most rare species of collections. Sometimes, a genus *Negundo* is distinguished. The genus belongs originally to the genus *Acer*.

**Maple - *Acer***

The genus consists of about 120 species in Eurasia and North America mostly in a temperate zone. In Europe, following three species are most widely known: field maple - *A. campestre*, Norway maple - *A. platanoides*, sycamore maple - *A. pseudoplatanus*. A number of introduced species is also grown, such as silver maple - *A. saccharinum* (*A. dasycarpum*) and sug-

ar maple - *A. saccharum* from the USA and Canada, Japanese maple - *A. palmatum* from E Asia and Japan or a North American species with pinnate leaves – box elder - *A. negundo*. Deciduous trees, rarely of shrubby appearance, sometimes also evergreen. Leaves opposite, simple, often palmate-lobed or odd-pinnate. Polygamous flowers in racemes, panicles or cymes. Fruits are typical two-winged achenes.

#### **Sycamore maple - *Acer pseudoplatanus* L.**

**Description:** A tree reaching a height of 35-40 m and stem diameter 1.5 m. It can achieve about 400 years of age. Scaly bark of old stems is variously formed (small scales, large plates, narrow strips etc. Leaves are usually pentalobated. Phenological forms differing in the beginning of flushing by 1-3 weeks are important. Late-flushing sycamore maples are characterized by faster growth. They produce seed annually. Germination capacity is high but survives only over winter. Seedlings show long ligulate cotyledons. Its root system is of a heart-shaped type well anchoring the species even in a boulder soil. Sprouting capacity of sycamore maple is good only in young age (Tab. 45).

**Distribution:** Sycamore maple is the species of a European range extended particularly in central and southern Europe except for northern and Eastern Europe. In the north, it occurs rarely on Danish islands and perhaps in southern Sweden. In the east, it occurs only in SW Byelorussia (to the Bug River). In the south of the range, it proceeds from the Pyrenees up to Mt. Olympus. The occurrence of sycamore maple within the range is very irregular and gappy. In altitudinal direction, sycamore maple exhibits similar range of the occurrence as beech. In the region of the CR, sycamore maple grows as an intersperse species mostly in groups in all uplands, mid-mountains and mountains. Sporadically, it occurs at altitudes over 1200 m.

**Ecology:** Sycamore maple tolerates shade rather well. Young plants develop well in the lower storey. The species is related to moist sites such as spring areas and alluvia of small rivers; however, it does not tolerate stagnant water and floods. Typical mountain sites of sycamore maple are characterized by high precipitation or high atmospheric humidity from other reasons (deep valleys, northern slopes).

Sycamore maple ranks among demanding broadleaves and tolerates soils with the high content of skeleton.

Sycamore maple is a species of the humid mountain climate of oceanic character and is sensitive to frost. It does not tolerate air pollution and climate of cities.

**Use:** Fine-grained, heavy and strong wood was used in joinery and turnery. Its wood is also used for the manufacture of toothpicks. The species is indispensable in the manufacture of musical instruments particularly if its wood is characterized by wavy annual rings. It was also planted for the manufacture of maple sugar syrup. It is used as an ornamental species.

#### **Norway maple - *Acer platanoides* L.**

**Description:** A tree reaching a height of 20-25 m and stem diameter 1 m. Its age can achieve 150 - 200 years. Foliage is dense and leaves form a perfect mosaic. The foliage shows very nice colour in autumn. Seeds of a diachene type fall after the first frosts and germinating in spring. In young age, it grows very fast. Its root system consists of a short tap root and a number of lateral roots reaching deep near the tree stem. The species is very well anchored in soil. Stump sprouting is excellent persisting about until 60 years (Tab. 46).

**Distribution:** Norway maple is of a European range. In the north, it occurs in the warm part of Scandinavia, from Finland it proceeds southeastward up to the Urals. It occurs in the northern part of the Balkan and Apennine peninsulas being extended up to the Pyrenees. It is missing in the British Islands.

In the north and east of its range, Norway maple is a species of uplands and lower altitudes (the Alps up to 1000-1200 m, Bulgaria 1400 m). In the CR, Norway maple is a sparsely distributed species growing particularly in lowlands, valleys and uplands occurring on average about 200 m below the upper limit of distribution.

**Ecology:** Norway maple is a species markedly tolerating shade particularly in young age. Requirements for soil moisture and air humidity are similar as in sycamore maple. It tolerates stagnant water and, therefore, its occurrence in floodplain forests is higher. However, it is rather sensitive to changes in groundwater table. The species requires deep and moist soils rich in nutrients and particularly nitrogen which can show the high content of soil skeleton. It tolerates air pollution and thrives even in the urban environment. However, the species heavily suffers from road salting.

**Use:** Its wood can be used similarly as that of sycamore maple although it is considered to be of lower quality. Norway maple gives good bee pasture. It suits for landscape and shade gardening being planted in avenues and a number of ornamental cultivars is used.

### **Field maple - *Acer campestre* L.**

**Description:** A tree reaching a height of 15-25 m and stem diameter 0.75 m. In forest-steppe areas, it demonstrates low and crooked growth showing several stems. Often it occurs nearly in the form of a shrub. Its leaves turn yellow in autumn. It is a very variable species. Its pilose form (f. *hebecarpum*) is markedly differed from glabrous form (f. *leiocarpon*) according to diachenes. A form *suberosa* with corky ribs on twigs appears to be a rarity. Roots are multi-laterally developed ramifying intensely (Tab. 47).

**Distribution:** The species is missing in the north and north-east of Europe. It penetrates only marginally to the warmest parts of Scandinavia, southwards it proceeds through forest-steppe regions to the east up to the Volga river basin. It grows in the Caucasus and Asia Minor regions. The species occurs on the British Islands except for Scotland. It is also original in the Pyrenean peninsula and isles of its occurrence appear also in Africa. Its range in southern and south-eastern Europe is rather problematic because of the possibility of replacement with similar species (*A. opalus*, *A. hyrcanum*). In the CR, it grows throughout the country both in floodplain forests and in warm uplands.

**Ecology:** Field maple is a species tolerating shade. Even in maturity, it is a typical species of the second storey. Requirements for soil moisture are not unambiguous and it is possible to notice two optima: on the one hand, it is a floodplain forest with high groundwater table ("floodplain" field maple), on the other hand, dry types of oak stands with wild service tree or pubescent oak characterized by moisture deficit in summer ("forest-steppe" field maple). It grows on nutrient-rich bedrocks, often on limestone or even on debris slopes. The species also occurs on saline soils. It is resistant to frost and tolerates summer heats and droughts. It is resistant to air pollution and other unfavourable impacts of the urban environment.

**Use:** Wood of field maple was used only rarely. Bird's-eye stems were formerly processed to veneers. Field maple brushwood was used as feed for cattle. Field maple is valued as a melliferous species. It is used in establishing shelterbelts and game refuges. It is suitable as an avenue tree in towns.

### **Box elder - *Acer negundo* L. (syn. *Negundo aceroides*)**

The species reaches a height of 25 m and stem diameter about 0.75 m. It is a short-age species. Compound leaves turn yellow in autumn. Its root system is predominantly superficial extending far from the tree stem. The species easily sprouts from roots. A North American species with an extensive range west of the main Rocky Mountains range.

*Acer negundo* was introduced in Europe as early as 1688. It exhibits considerable ecological range as for moisture requirements. It survives floods even on drying up soils. From forestry aspects, it is a negligible species. It suits for revegetation of non-forest land, spoil banks, waste dumps etc. The species is resistant to the urban environment being suitable as an avenue tree.

### **Family : Tiliaceae**

Shrubs, trees but also herbs often with ramified trichomes. Leaves are simple, sometimes lobed, often asymmetrical. Regular flowers show mostly 5 petals. Fruits are of various appearance. The family comprises at least 35 genera and about 300 species, mainly in the tropics and subtropics; only two genera occur in the temperate zone. In Europe, particularly a genus lime Tilia is known which is also represented by native species.

### **Lime, linden - Tilia**

Deciduous trees mostly with heart-shaped leaves, distichous and secondarily alternate. Flowers white or yellowish of honey odour, in inflorescences with a marked supporting bract. Fruits consist of nuts with 1 to 3 seeds. Cotyledons are typically fingerlike-lobed.

At least 30 species are distributed mainly in the temperate N Hemisphere zone except for W parts of North America. Two species are autochthonous in the CR, viz small-leaved linden (*T. cordata*) and large-leaved linden (*T. platyphyllos*). Rarely, we can encounter their hybrid *T. × vulgaris = T. × europaea* planted as a park species. From introduces species of limes, a Balkan-Asia Minor species silver linden *T. tomentosa (T. argentea)* is abundantly planted.

### **Large-leaved linden – *Tilia platyphyllos* Scop. (syn. *Tilia grandifolia* Ehrh.)**

**Description:** A tree reaching a height over 35 m in canopy, stem diameter 1.5 m and age 200 years. Solitary trees can occur 1000 years old. The species unfolds leaves and blossoms earlier than small-leaved linden; in autumn, it remains green for a long time. Hard ribbed nuts (larger than those of small-leaved linden) persist on trees over winter and usually delay one year before they germinate. Its bulky root system is multilaterally developed and reaches deep. Sprouting capacity is excellent, viz both stump sprouting and sprouting induced by trimming (Tab. 48).

**Distribution:** The species is of a European range occurring mainly in the centre and south of the continent. It is missing in northern and eastern Europe which is a significant difference as compared with small-leaved linden. The northern limit of its range runs from the Netherlands through Germany and Poland to the Ukraine. From there, it heads along the border of steppes to the western coast of the Black Sea. Then, it runs through Europe westwards up to the northern part of the Pyrenean peninsula. Everywhere, it occurs more southwards than small-leaved linden.

**Ecology:** Large-leaved linden tolerates shade quite well and thus it can persist in the lower storey. It comes up to the moisture deficit but only if it grows on rocks rich in nutrients. It is medium-demanding for soil (exhibiting, however, higher requirements than small-leaved linden). It thrives best on sediments of slope bases of smaller valleys and upland ravines. Also its localities on slope debris and in the vicinity of rocks refer mainly to nutrient-rich bedrocks. It survives in the urban environment being resistant to industrial pollutants. The species does not tolerate saline soils.

**Use:** Its soft and light wood was valued in woodcraft and pattern making. It was used for the manufacture of boxes and pencils. Lime charcoal was used in drawing and for the production

of gunpowder. It is an excellent melliferous species used in pharmacy. Also its bast was used and seeds served for pressing lamp oil. Large-leaved linden is used as an ornamental and soil-improving species.

**Small-leaved linden – *Tilia cordata* Mill.** (syn. *Tilia parvifolia* Ehrh.)

**Description:** A tree of medium dimensions reaching a height of 20 - 30 m in a canopy, stem diameter over 1 m and age 150 (400) years. In autumn, its leaves turn yellow and soon fall down. Small thin-wall nuts fall in autumn and at the beginning of winter. Its root system is multilaterally developed being often with marked bumpy roots at the soil surface. The species shows excellent sprouting capacity and particularly its stump sprouting is good. It tolerates even heavy pruning, eg in hedges (Tab. 49).

**Distribution:** It is the species of an Eurasian range reaching from Europe eastwards through the Ural to western Siberia. Its northern limit reaches about 63°N in Scandinavia. Eastwards, it heads the southern Urals. It occurs in the northern part of the Apennines and from the Pyrenees it reaches mountain ranges of NE Spain. In the British Islands, its natural range is uncertain and several relict localities is noticed.

**Ecology:** The species ranks among the most marked shade-tolerating trees. In eastern parts of its range, it grows even under spruce. It occurs on moisture-favourable sites, in floodplain forests (with high atmospheric humidity, shaded slope orientation or higher amounts of precipitation).

The species exhibits smaller requirements for soil than large-leaved linden. In a Siberian coniferous taiga, the species, however, grows on nutrient-poor swampy soils along streams. It tolerates air pollution in towns and industrial regions and thus it belongs to tolerant species.

**Use:** The species is well exploitable as a soil-improving and reinforcing tree. Its wood is a little harder and heavier than that of large-leaved linden, however, in practice it is not distinguished. It is the first-class melliferous species. Its tea is of the same quality as that of the second species. Loppings of the species were formerly used as feed. In the urban greenery, it is used for its large resistance to transplanting, pruning and thoughtless treatment. It tolerates overburden, made-up ground, excavations around tree stems. It is, however, sensitive to road salting. Ornamental cultivars are rare.

**Family : Betulaceae**

Species with deciduous, simple and alternate leaves. Inflorescences are monoecious, unisexual. Anther flowers are in pendent catkins. Seeds are small winged achenes. The family consists of two genera: birch – *Betula* and alder – *Alnus*. Sometimes, genera *Alnaster* or *Duschkia* are distinguished.

**Alder - *Alnus***

Trees and shrubs with pedunculate buds. Leaves are simple, deciduous, arranged in spirals. Anther flowers in long catkins created already in autumn. Pistil flowers are crowded in short strobiles. Fruits are ligneous non-splitting strobiles persisting some time after maturation. Seeds are winged.

About 30 species of alder are distributed on the Northern Hemisphere predominantly in cold regions. In America, one species reaches southwards up to Peru. The best known species are: black alder - *A. glutinosa* and speckled alder - *A. incana*, South European *A. cordata* and a species of shrubby appearance European green alder - *A. viridis*.

### **Black alder - *Alnus glutinosa* Gaertn.**

**Description:** A tree of a straight stem reaching a height of 35 m and stem diameter 1.5 m. It is a short-living species (200 years). In autumn, leaves fall green turning black on the soil surface. Ligneous non-splitting strobiles survive on trees for one or two seasons. Small achenes with a narrow membranous rim fall during winter.

Its root system is dependent on the groundwater table and soil. Shallow soil and stagnant water near the soil surface result in roots developed in a plane; otherwise the root system is heart-shaped. On small lateral roots, typical bacterial nodules are formed making possible to take atmospheric nitrogen. If water stagnates near the soil surface, roots project above the surface (aerial roots). Roots reinforce river banks and through their sprouting and regeneration capacity resist damage, eg by ice blocks. The species exhibits excellent stump sprouting capacity; root swelling sprouts are abundant. Sprouting capacity of higher parts of the tree stem is low (Tab. 50).

**Distribution:** An Euro-Siberian species. Its range includes nearly the whole Europe, reaches N Africa and eastwards, it occurs in the westernmost Siberia. In the north, its borderline runs through central Norway, Sweden and Finland and in the east, it crosses the Ural. Then, the borderline of distribution runs through the zone of forest-steppes in Russia to the western coast of the Black Sea. The species occurs from lowlands to mountain locations (the Pyrenees 1700 m alt.)

**Ecology:** Black alder is a species which is rather demanding for light and only in young age, it can tolerate shade. The species exhibits maximum requirements for soil moisture and occurs even on sites where the water table is permanently on the soil surface. However, it grows better on sufficiently aerated soils. The species does not tolerate markedly acid soils and thus, it only suffers on peat bogs and high bogs being easily pushed out eg by pubescent birch. It resist to air pollution in towns and industrial agglomerations.

**Use:** Light and soft wood staining orange on a new cut. Formerly, it was used in hydraulic structures, in the manufacture of plywood, frames and lathes. In furniture industry, coloured alder was used for the imitation of rare woods such as jacaranda and mahogany. Because the species blossoms very early it represents valuable bee pasture. It is used for bank protection and other reclamation operations. Locally, it has proved good in the afforestation of spoil banks and heaps.

### **Speckled alder - *Alnus incana* Moench.**

**Description:** A tree reaching usually a height of 10 to 15 m and stem diameter 30 cm. Sometimes, it grows as a shrub. Grey-green leaves fall in autumn without any colouring. Strobiles persist on trees until the other season. The species root system is flat, richly ramified, with long lateral roots. Sprouting capacity is excellent both of stumps and mainly of roots. Under shading conditions, sprouting capacity decreases (Tab. 51).

**Distribution:** The species is of a Euro-Siberian range splitting to two parts: northern lowland region and Central-European mountain region. The northern region extends from the Scandinavian Peninsula up to the basin of the Irtysh River in W Siberia. The Central-European region includes the Alps, Sudeten, Carpathians, Dinaric Mts. and mountains of Bulgaria. From mountains, it descends along courses of large rivers. It also reaches the Caucasus.

**Ecology:** It is a light-requiring species. As for water requirements, it is very adaptive (often grows on waterlogged soils and tolerates floods). The species does not require any special soils. It prefers continental climate. A very short growing season is sufficient for the species (in the north 6 weeks only). It tolerates frost hollows and other climatically adverse locations.

**Use:** Its wood is processed only exceptionally. Bark was used for the manufacture of tannins and for dyeing leathers. It is an important soil-improving species, a pioneer species used in forestation. The species is important as early bee pasture.

**European green alder - *Alnus viridis* DC.** (syn. *Alnaster viridis* Spach., *Duschekia alnobetula* (Ehrh.) Pouzar)

A shrub up to 3 m in height with arched branches. Its buds are sessile. Female strobiles are (in contrast to arborescent alders) hidden in buds similarly as in birch; therefore, the species is sometimes classified as a separate genus (*Alnaster*, *Duschekia*). Its root system is mainly superficial and root suckers are not formed (Tab. 52). It is a Eurasian species the range of which consists of two parts: (a) Siberian, including lowlands and forest-tundra in the north and (b) Central-European. The Central-European range is of a mountain type showing a number of separated areas in the Alps, in the Carpathians and rarely also in the Dinaric mountains; it grows usually above the upper forest limit similarly as dwarf pine. In the CR, the species is perhaps autochthonous in the Novohradské hory Mts. *Alnus viridis* a light-demanding species. It prefers moist soils and high precipitation. It grows particularly on acid rocks and avoids limestone. The species tolerates extreme climatic conditions. A short growing season is sufficient for it. The species is successfully used for the reinforcement of landslide areas in mountains and planted along banks of watercourses in torrent training and also tested for the revegetation of avalanche slopes.

### **Birch - *Betula***

About 50 species are distributed in colder regions of the Northern Hemisphere. Trees and shrubs, mostly with white bark. Simple leaves are deciduous with long petioles. Male (anther) catkins are established already in autumn and persist until the early spring when blossom. Female (pistil) catkins are hidden in buds. The catkins disintegrate. Seeds consist of small achenes with membranous transparent wings. Supporting scales of achenes provide significant differentiation features. European birch (silver birch) - *B. pendula* (*B. verrucosa*) and pubescent birch - *B. pubescens* are larger arborescent species. *B. carpatica* (sometimes classified as a subspecies of pubescent birch) belongs to mountain species. Dwarf birch - *B. nana* comes from the north of Europe. As for American species, paper birch - *B. papyrifera* (*B. latifolia*) (Tab. 55) with markedly continuous white smooth bark is most frequent in collections.

**European birch - *Betula pendula* Roth** (syn. *Betula verrucosa* Ehrh., *B. alba* L.p.p.)

**Description:** A tree reaching a height of 30 m and stem diameter over 80 cm. A short-living species. Its stem is not straight, branches are waved with thin long slightly pendent ends. Exceptionally, trees with dark bark can occur.

Its root system is shallow but intensely ramified and far-reaching. Roots adapt themselves to various bedrock conditions and anchor the species even on rocks similarly as in pine. On shallow soils, thicker roots are partly visible on the soil surface. Sprouting capacity on stems is average and on stumps rather small. The species tolerates pruning in the crown. Root suckers are not formed (Tab. 53).

**Distribution:** The species exhibits an extensive Eurasian range the limit of which can be determined with difficulties only because confusions occur with very similar taxa. The range includes the major part of Europe. Northwards, it runs to the Arctic Circle and reaches the basin of the North Dvina river near the Barents Sea. In the east, it crosses the Ural and proceeds through taiga up to eastern Siberia. In the south, it is extended in the northern half of the Balkan Peninsula and occurs throughout the mountain system of the Apennines and in mountains of Sicily and even in Spain. We can find it in Corsica. It is an indigenous species

throughout Western Europe including the British Islands. As compared with pubescent birch it reaches less northwards running far southwards in the Mediterranean. The proportion of birch markedly increased with activities of man and forest management. Extensive areas were reforested in pollution-damage zones.

**Ecology:** Intensely heliophilous species not tolerating shade. It results in the gradual elimination of the species from all young-growth stands of shade tolerating species. From the aspect of moisture requirements the species occurs naturally only on extreme sites where it cannot be endangered by other species. It refers to sites with an extreme deficit of soil moisture as well as sites with excessive moisture. The species does not tolerate changes in the groundwater table. It is not demanding for soil and can adapt to various bedrocks. It occurs predominantly on acid rocks but does not tolerate peat bogs. It grows on sandy soils with the high content of skeleton and can also occur on rocks. The species can thrive on saline soils. Its characteristic property is a potential to colonize raw and undeveloped soils manifesting thus its pioneer character. It is medium-sensitive to air pollution and tolerant to some types of pollution.

**Use:** It is a medium-hard wood, rather strong and tough and formerly was indispensable in carving, manufacture of tools and small products. It is suitable for the manufacture of plywood. So-called bird's-eye birch is very valued. "Karelian birch" is known from the North. Its wicker is traditionally used for the manufacture of brooms. Flushing birch sheds sweet juice suitable for the production of syrup. Birch water is always used in cosmetics. Dried birch leaves are used in pharmaceutical industry for their considerable content of vitamin A.

In horticultural practice, birch represents an attractive architectonic element. It is very popular in urban greenery.

#### **Pubescent birch - *Betula pubescens* Ehrh.**

**Description:** A tree reaching a height of 20 m and stem diameter over 0.5 m. Branches head up even at their ends. Its root system is distributed near the soil surface being richly ramified and reaches far of the tree. Sprouting capacity is medium both on its stump and stem. Root suckers do not occur (Tab. 54).

**Distribution:** The species exhibits a large Eurasian range. As compared with European birch the range reaches far northwards showing smaller occurrence in the south. It grows from forest-steppe to tundra. The species is absent in the Pyrenees, does not reach the Apennines and occurs only in the north of the Balkans. In Central Europe, it grows together with other species of birch or with dwarf pine, at lower locations together with willow and alder.

**Ecology:** It is a light-requiring plant species, a little less demanding for light than European birch. It requires groundwater table near the soil surface and tolerates even stagnant water. The species grows rather well on drier sites. It predominates on soils poor in nutrients, mainly on acid and peat soils and tolerates continental climate. The species tolerates air pollution a little worse.

**Use:** In the north and east of its range, it is used similarly as European birch.

#### **Dwarf birch - *Betula nana* L.**

A low shrub (1 m in height) with ascending broom-like branches. Vegetative propagation is quite common. Small round leaves turn yellow and red in autumn. Its root system is dense, surface, with many adventitious roots (Tab. 55). A circumpolar species extended in the Eurasia and North America tundra. It grows in Greenland and Island. Isolated localities shifted southwards reach Central Europe (the Alps and some Hercynian mountain ranges). It is a markedly heliophilous species tolerating even pure peat soils and waterlogged sites. It is grown on rock gardens as an ornamental species.



## **Family : Salicaceae**

Trees and shrubs (even very small) with soft wood. Leaves deciduous, simple, alternate (several exceptions). Inflorescences dioecious, in catkins. Individual flowers without coats. Fruits are capsules splitting through valves. Its seed is a small achene equipped with pappus. The family consists of 3 genera: willow - *Salix*, poplar - *Populus* and an E Asian monotypic genus *Chosenia*.

### **Poplar - *Populus***

About 35 species are distributed in the Northern Hemisphere. Trees with soft wood. The genus often creates root suckers. Leaves are deciduous, simple, pedunculated, alternate. Catkins blossom before leaf unfolding being pendent and with pedunculate flowers. Anther (male) flowers are with 4 or more stamens. Pistil (female) flowers consist of 2 – 4 carpels. Bases of flowers are furnished with discs. Finely pilose achenes are in capsules. The majority of species grows well from cuttings.

The best known European species are as follows: white poplar - *P. alba*, black poplar - *P. nigra* and European aspen - *P. tremula*. From the viewpoint of wood production cultivars of a hybrid (*P. × canadensis* = *P. × euramericana*) or *P. nigra* × *P. maximowiczii* are of interest. In some countries, they belong to main sources of wood raw material.

### **Black poplar - *Populus nigra* L.**

**Description:** A tree of large dimensions reaching a height of 30 - 40 m, stem diameter 1.5 – 2 m and age about 150 years. Sprouts often occur on stems. Leaves turn yellow in autumn. Black poplar is a fast-growing species.

Its root system is of two types: (a) it goes deep down to ground water table particularly in aerated soil, (b) it is distributed near the soil surface reaching far beyond the crown perimeter. Root swellings are intensely developed. After depositing new soil layers, accessory roots are created in spite of thick bark on the tree stem. Sprouting capacity is intense both on the stem and at the tree stump persisting until the tree high age (Tab. 56).

**Distribution:** An Eurasian species with a large range in warm regions round the Mediterranean Sea. From there northwards, it reaches the North Sea and the European part of Russia. It is not present in Scandinavia and the whole cold north-east of the continent. It occurs throughout W Europe and grows also in the British Islands (except for Scotland and Ireland). It reaches the African continent. The Asian part of its range reaches the Yenisei River. Southwards, it reaches the region of the Pamir – Altai Mts. It occurs virtually only in floodplain forests along large rivers.

**Ecology:** Black poplar is a heliophilous species not tolerating shade even in young age. In dense stands of the species, some pests can reproduce rapidly. The poplar requires considerable amounts of available soil moisture. It is important the water to be running not stagnant. It tolerates the occurrence of water table above the soil surface during floods. During the growing season, it can survive in water as many as 50 days.

Typical sites are characterized by sandy or gravel soils poor in humus and by changes in upper layers of alluvial or slushy soils. Self-seeding in black poplar can occur even on heaps of waste rock. It tolerates even drier loamy soils, however, it suffers on podzol and peat soils. Black poplar and the majority of its hybrids resist to air pollution of the urban environment and industrial regions. However, differences between individual clones are considerable.

**Use:** Its wood is a very valuable raw material particularly for the manufacture of veneers and plywood. Its use is extended for the production of cellulose and particleboards. At present,

wood formed by temperature and ammonia (“lignamon”) is used. Its use as fuelwood increases – energy chips etc. Poplar bark shows similar properties as cork. A cultivar *P. n. var. italica*, a clone with a narrow crown, is frequently used in landscape gardening.

### **Populus x canadensis Moench** (syn. *P. x euramericana* (Dode) Guinier)

A large group of cultivars originating by the spontaneous and intentional hybridization of very related species: *P. nigra* and North American *P. deltoides*. Cultivars differ in growth rate, stem form, branching, site requirements etc., ie features which are important for forestry and other practical applications.

In the CR, we can mostly encounter cultivars ‘Marylandica’ and ‘Virginiana de Frignicourt’. Also hybridization between balsam and black poplars has given a number of prospective cultivars, such as Japanese clones ‘J 101’ – ‘J 105’ (*P. maximowiczii* x *P. nigra*) at present used in energy plantations.

### **White poplar - Populus alba L.**

**Description:** A tree reaching a height of 30 – 40 m, stem diameter 1.5 - 2 m and age 250 years. Its stem has smooth bark. As for foliage, we can notice heterophylly; leaves are orbiculate and dentated leaves change to palmated leaves on long shoots.

Its root system is multilaterally developed reaching deep. In trees coming from seed, a tap root is created with lateral roots reaching far of the tree stem (40 m). Root swellings are only slightly developed. Sprouting ability of stems and stumps is rather small, however, root suckers are very abundant (Tab. 57).

**Distribution:** An Eurasian range extending similarly as that of black poplar in warmer regions. As compared with the latter species it reaches less northwards being absent in W Europe. On the other hand, it extends more to Asia up to western parts of the Himalayas. It grows particularly in floodplain forests. Eastwards, however, the species occurs more frequently also out of watercourses on sands of steppe regions reaching semideserts where it grows in climatically more favourable depressions. In the European part of its range, slightly pilose forms predominate in the north; in the south, white tomentose forms mostly occur (*P. alba* var. *nivea*). Intensely white tomentose *Populus alba* occurs also in the central-Asian region together with pyramidal forms (*P. alba* var. *bolleana*).

**Ecology:** Although white poplar is a heliophilous species it tolerates slight shading in young age. The floodplain forest ecotype requires easily available soil water whereas a steppe ecotype survives under conditions of an extreme moisture deficit. It also tolerates rather saline soils. It resists to winds which proves good mainly in forest shelterbelts and settlements in steppes. It is resistant in regions affected by air pollution.

**Use:** The quality of wood is generally poorer than that of aspen and black poplars. It is suitable for planting in windbreaks, for the reinforcement of sands etc. Pyramidal poplar *P. alba* var. *bolleana* grows well in the dry urban environment.

### **European aspen - Populus tremula L.**

**Description:** A tree with a slim stem reaching a height of 20-25 m, stem diameter about 0.75 m and age 150 years. Leaves are of two forms. On short shoots, leaf blades are round, dentate and petioles are flattened (leaves tremble easily); on sprouts, leaves are cordate. Its foliage colours pastel yellow or red in autumn. The root system of aspen is developed near the soil surface. Long thin roots near the surface reaching 20 to 30 m of the stem and serving naturally for the vegetative regeneration are typical of the species. Aspen uses only little deeper soil layers. Stump sprouting is small and older trees already do not sprout on stumps. Sprouts on stems occur only rarely, however, root suckers are abundant (Tab. 58).

**Distribution:** Aspen exhibits extremely large range extending nearly throughout Europe and the majority of the temperate and cold zone of Asia. It is distributed from Spain up to Scandinavia. Then the range progresses eastwards up to Kamchatka. The southern border in Asia is created by mountain regions and a dividing line between the forest-steppe and steppe. Aspen grows even in the Caucasus. It reaches also Africa in the Atlas Mts. It is of great economic importance in Russia.

**Ecology:** Aspen is a very heliophilous species. Dense thickets coming from root suckers become quickly open. Aspen exhibits wide ecological amplitude in relation to water, tolerates dry soils but floods do not thrive the species. It is not demanding for soil and grows from chernozems to peat soils. Aspen can cope with the short growing season and frosts in the north as well as with the long growing season and considerable heats in the south. It tolerates air pollution of cities and industrial regions.

**Use:** It is considered to be a prospective species for special purposes such as safety match manufacture, wrappage, chips etc. Its wood is suitable for the manufacture of veneers and wooden products as well as paper-making.

### **Willow - *Salix***

About 400 - 600 species distributed throughout the Northern Hemisphere occurring also in the Southern Hemisphere. Trees and shrubs including very small prostrate shrublets. Buds with the only one scale. Leaves are nearly always deciduous, simple, alternate (exceptionally opposite). Catkins are erect with sessile flowers. Pistils are formed by two carpels. Flowers are furnished with nectar glandules. Capsules consist of two valves. Achenes are glabrous and coated with fluff. In the region of the CR, there are 21 naturally growing willow species.

#### **White willow - *Salix alba* L.**

**Description:** A tree reaching a height of more than 30 m, stem diameter 1.5 m and age 80 - 100 years. Shoots are markedly coloured, leaves elliptical, pilose. Its root system is shallow. White willow easily creates adventitious roots. The species is good at sprouting capacity anywhere on its stem and stump (Tab. 59).

**Distribution:** Eurasian species reaching central Asia through steppe regions in the east. In Europe, white willow is missing in the cold northern part. On the other hand, it is extended in the Mediterranean from where it reaches NW Africa. At present, white willow is extended far outside its natural range.

**Ecology:** Intensely heliophilous species tolerating only weak lateral shading. It can cope with very fluctuating amounts of water in soil. It tolerates long-term floods. The species does not thrive on shallow, nutrient-poor and too acid soils but survives moderate salination. It is rather tolerant to air pollution in the urban environment.

**Use:** A fast-growing species reaching a height of 25 m at an age of 30 years. Its wood is of the same quality or even better than poplar wood for the manufacture of veneers, fibreboards and for paper industry. It is also used for the production of wicker or as an ornamental species.

#### **Crack willow (syn. brittle willow) - *Salix fragilis* L.**

**Description:** A tree reaching a height of 20 m and stem diameter 0.75 m. Shoots are brown-green, narrow leaves are glabrous. Shoots in points of branching can be easily broken off. Autumn colour is yellow. Its root system is mainly superficial, irregularly developed. Short lateral roots head deep anchoring the species and preventing scouring. Sprouting capacity on a stem and stump is excellent (Tab. 60).

**Distribution:** A European species extended also in Asia Minor and Caucasian regions. Its natural limits can be determined only with difficulties due to often confusions of the species with a hybrid *S. × rubens*. It occupies spontaneously probably only the continental part of Europe and reaches mountain regions along watercourses.

**Ecology:** A markedly heliophilous species. Under conditions of unilateral shading, its stem turns aside obliquely towards light. It tolerates short-term floods during the growing season. It can cope with a fluctuating groundwater table without any serious damage and survives even permanent decrease in water table after reclamation or other measures. It is undemanding as for requirements for soil and grows even on alluvia containing the high content of soil skeleton.

**Use:** Its wood is suitable only as fuelwood. In submontane streams, it is an important species for bank protection producing also fairly good stemwood. *S. × rubens*, an abundantly occurring hybrid with white willow combines features of both species being, however, climatically much more resistant than *S. alba*.

### **Goat willow - *Salix caprea* L.**

A shrub or tree of lower growth reaching a height of 12 m and stem diameter 0.5 m. By its branching it resembles apple tree. Laves turn yellow in autumn (Tab. 61). An Eurasian species extended in Europe throughout the continent with the exception of the southern part of the Pyrenean and Balkan peninsula. Eastwards, it is extended through the whole Asia up to China. It is a markedly heliophilous species growing on relatively dry sites and thus, in this respect, it differs most from other species of willow.

It is rather undemanding for soil composition and thus it can occur both on acid rocks and limestone. In forests, it is considered to be an undesirable weed. Goat willow is highly appreciated by bee-keepers because it provides rich bee food already in early spring. **Bay-leaf willow - *Salix pentandra* L.** or **violet willow - *Salix daphnoides* Vill.** and ***Salix elaeagnos* Scop.** (syn. *S. incana* Schrank) rank among smaller arborescent species with narrow leaves usually growing in mountain regions.

Common shrubby European willows with narrow leaves are species which are particularly used for the production of wicker, viz **purple willow - *Salix purpurea* L.** sometimes with opposite leaves (Tab. 63), **osier - *Salix viminalis* L.** with markedly long and narrow tomentose leaves (Tab. 62) and **almond-leaved willow - *Salix triandra* L.** (syn. *S. amygdalina* L.), a robust shrub with a patulous richly ramified crown and striking bark peeling in scales.

A well-known shrubby species with broader leaves is eg **grey-leaved willow - *Salix cinerea* L.** A medium-tall shrub of a loaf-shaped crown growing at lower locations along watercourses. On wood free of bark marked ribs can be noticed (Tab. 64). Another species with broader leaves is ***Salix aurita* L.**, a small shrub with a globular densely branched crown and rugose leaves. It grows on acid moist meadows and glades in moist forests from the lowest locations up to the forest limit. Marked ribs occur also on its wood (Tab. 64).

### **Family : Rosaceae**

Herbs and woody species sometimes with root suckers. Leaves are nearly always alternate. Flowers mostly with 5 petals. One of large families amounting to at least 100 genera and about 3000 species extending throughout the world. Taxonomically, we can distinguish four subfamilies characterized particularly by the kind of fruits (subfamilies are occasionally considered as separate families – see names in parenthesis).

### **Subfamily: Prunoideae (Amygdalaceae)**

Trees and shrubs sometimes occurring with thorns. Leaves are simple, flowers only white or pink. Fruits are mostly fleshy and edible drupes.

#### **Cherry - *Cerasus*(*Prunus*)**

Trees or shrubs without thorns. Flowers markedly pedunculate, individual drupes are glabrous and smooth, stones at the most only with a slight tubercle drawing, much arched. Several tens of species are extended in Eurasia and North America. Conditions of the CR are tolerated by about 30 species. Three species are native: mazzard cherry - *C. (P.) avium*, Mahaleb cherry - *C. (P.) mahaleb* and frutescent cherry - *C. (P.) fruticosa*. A decorative Asian species *C. (P.) serrulata* called “Japanese cherry” is also grown.

#### **Mazzard cherry (syn. wild cherry, crab cherry) - *Cerasus avium* (L.) Moench. (syn. *Prunus avium* L.)**

**Description:** A medium-tall tree reaching a height of 25 m and stem diameter 1 m. Its branching is at first rather regular, verticillate, later thick lateral branches are formed. Its root system is of a tap root type in young age, later of a bunch type. Windbreaks do not occur. Sprouting capacity is good, on stumps, however, poor. Root suckers of mazzard cherry are formed only rarely (Tab. 65).

**Distribution:** An Eurasian species distributed nearly throughout Europe except for cold north and north-east. In the Mediterranean, it reaches N Africa. In the east, it occurs in the warmer part of W Siberia being extended up to Central Asia.

**Ecology:** It is a heliophilous species tolerating only slight shading. In forest stands, it is necessary to keep the species as a co-dominant tree. It is rather demanding for soil moisture not tolerating soils drying in summer; on the other hand, it does not survive waterlogging or floods. It grows naturally on deep and nutrient-rich soils though skeletal. The species occurs rather abundantly on limestone bedrocks and does not tolerate very acid or peat soils.

**Use:** Its wood is valued exhibiting excellent strength, nice colour and texture. It is processed for veneers being used in wood-carving, joinery and in the manufacture of various tools. Nevertheless, its main use is in fruit growing; for its fruits it is grown in many varieties in the temperate zone of the Northern and Southern Hemisphere.

#### **Mahaleb cherry - *Cerasus mahaleb* (L.) Mill. (syn. *Prunus mahaleb* L., *Padellus mahaleb* (L.) Vassilcz.**

A medium-tall shrub or tree with a crooked stem and a patulous crown. It reaches a height of 15 m and stem diameter 1 m. Its root system is multilaterally developed, root suckers are not formed. The centre of distribution occurs in S Europe and near Asia. It reaches even NW Africa. Northwards, it reaches up to the Rhineland. It is often the species of forest-steppes and steppes. It is a heliophilous species tolerating drying soils. *Cerasus mahaleb* is the species of soils rich in nutrients growing mainly on limestone. It tolerates well air pollution. The importance of Mahaleb cherry as a decorative species has not been appreciated yet.

#### **Plum - *Prunus***

Trees and shrubs often with thorns. Fruits are fleshy drupes with a lateral line which are sometimes glaucous or tomentose. Their stone is mostly flattened, elongated and rugged. Nearly all species of the genus are important fruit species grown in various parts of the world.

### **Sloe (syn. blackthorn) - *Prunus spinosa* L.**

A medium-tall shrub, densely branched, with numerous thorns. It is characterized by sour blue fruits. The species propagates by root suckers (Tab. 66).

It grows throughout W Europe with the exception of cold north and north-east being extended eastwards to the near part of Asia. In Mediterranean regions, it reaches N Africa and grows even in Syria. It is a heliophilous species tolerating the lack of soil moisture and various soils. Its fruits are tasty only after frost exposure; formerly, they were processed for plum jam.

### **Garden plum - *Prunus domestica* L.**

Usually a tree with a dense crown reaching a height of 10 m and stem diameter 0.50 m. Flowers are greenish-white in groups of two each. Fruits are elongated drupes of a deep blue or blue-black colour with a marked lengthwise line.

From the viewpoint of forestry, the species is unimportant although its wood is very decorative showing a markedly coloured even red-violet heartwood. It is used in the manufacture of small objects, for wainscoting, in the manufacture of furniture (inlay, marquetry). The production of its very tasty fruits is important.

### **Almond - *Amygdalus***

Shrubs or trees without thorns. Lateral buds are in groups of three each. Leaves are sometimes lobed. Flowers are nearly sessile. Drupes with a leathery pulp and rugged stone.

About 10 species distributed mostly from SE Europe to E Asia. Perhaps the only species comes from the west of North America. The only wild-growing species reaches our country, viz dwarf almond - *A. nana*. In the warmest regions of our country, an age-old cultivated plant is grown in various sorts for almonds, namely bitter almond - *A. Communis*

### **Bird cherry - *Padus***

Trees, often only of smaller growth, without thorns. Its wood is of bitter smell. Small flowers are arranged in racemes. Drupes are small, often bitter, uneatable. Stones are small, nearly round. In Europe, a species *Padus racemosa* (L.) Gillib. (syn. *Prunus padus* L., *Padus avium* Mill.) is rather abundant. It is a smaller tree with large simple leaves reproducing through root suckers (Tab. 65). It occurs as an admixture particularly in floodplain forests. In forestry, it is considered to be an unimportant species. In landscape gardening, it is valued as a decorative species. It exhibits the high content of phytoncides characterized by bactericidal and repellent effects.

### **Cherry laurel - *Laurocerasus***

Evergreen trees or shrubs. Small flowers arranged in racemes, fruits are small black drupes. Two species are distributed in the E and W Mediterranean. Our conditions are tolerated by some cultivars of common laurel cherry - *L. Officinalis* (*Prunus laurocerasus*) from SE Europe and Asia Minor.

### **Subfamily: *Pomoideae* (*Malaceae*)**

Trees and shrubs, sometimes with thorns. Leaves simple, pinnate-lobed and pinnate. Flowers with a lower ovary. Fruits are pomes, sometimes quite petty.

There are about 20 genera. Native species are represented by 5 genera. Only the genus *Sorbus* is of forestry importance. Genera apple *Malus* and pear *Pyrus* occur rather as fruit trees. Two other genera of shrubby species are used also in landscape gardening: hawthorn- *Crataegus* and cotoneaster - *Cotoneaster*. Members of genera quince - *Cydonia*, medlar - *Mespilus* and *Aronia* are cultivated fruit species planted since long ago. Genera *Amelanchier*, *Chaenomeles* and *Pyracantha* are used as decorative species.

### **Rowan (syn. ash) - *Sorbus***

Trees with deciduous leaves. Small flowers are crowded in multiflower cymes. The genus consists of at least 80 species in Eurasia (up to the Himalayas) and North America (up to N Mexico). In the region of the CR, there are 7 native species. Species of arborescent growth are as follows: mountain ash (European mountain ash) - *S. aucuparia* and wild service tree - *S. torminalis*; whitebeam - *S. aria* and *S. eximia* are species of lower growth; *S. danubialis* and *S. bohemica* are shrubs of larger growth, however, their taxonomy is rather uncertain. *S. sudetica* is a low shrub. Service tree - *S. domestica* was formerly planted in warm regions for its large edible pomes. It is a tree reaching a height of 20 m (Tab. 67) coming from the Mediterranean region and near Asia.

### **Mountain ash - *Sorbus aucuparia* L.**

**Description:** A tree of smaller growth reaching a height of 10 - 15 m (exceptionally even more), stem diameter up to 0.5 m and age 100 - 150 years. In autumn, compound leaves colour red. Fruits are also red.

Its root system reaches deep only in young age. Later, the system is predominantly superficial. Sprouting capacity both of stems and stumps is good. Suckers from root swellings are particularly abundant (Tab. 67).

**Distribution:** Mountain ash is the species of a huge Eurasian range. In Europe, it grows from the warm Mediterranean region up to cold north being absent only in the SW part of the Iberian Peninsula. In the east, it colonizes large areas of taiga up to the Sea of Okhotsk. Rowan grows from the lowest altitudes through uplands and mountain locations up to the forest limit. Within this altitudinal range, it is possible to distinguish a lowland (thermophilic, xerophilous) variety with piliferous leaves and a mountain (cryophilic, hydrophilic) variety with glabrous leaves.

**Ecology:** It is a heliophilous species tolerating shading in young age. Therefore, it can successfully grow even inside stands where it survives in an understorey for a number of years. The species exhibits considerable ecological range as for the consumption of water. It survives on drying soils and grows even on rocks. On the other hand, it tolerates excess of soil moisture and can grow even on swamps. It does not tolerate floods. Mountain ash grows on various kinds of soils, however, acid soils are preferred.

**Use:** Its wood can be specially used in making meat-blocks. Otherwise, it is a pioneer species able to cover very quickly devastated and weed-infested soils. Rowan proved good as an avenue tree at mountain locations. Rowanberries are an important source of food for birds and game. They are bought for pharmaceutical industry. The species provides good bee pasture.

### **Wild service tree - *Sorbus torminalis* Crantz**

**Description:** A tree reaching a height of 25 m and stem diameter 1 m. Scaly dark bark of its stem resembling pear tree is striking. It peels sometimes in larger sheets. In autumn, leaves colour yellow-red. Its root system is mainly of a tap root type anchoring well the species in

soil. Sprouting capacity on stems and stumps is poor. Wild service tree shows a tendency to create layers, however, root suckers are not developed (Tab. 69).

**Distribution:** It grows in warm parts of Europe, in Asia Minor and in the Caucasus. In the north, it reaches central England and the coast of the North Sea and the Baltic Sea. However, it does not reach Scandinavia and E Europe. Southwards, it extends throughout the Mediterranean and N Africa.

**Ecology:** It is a shade-tolerating species able to survive in an understorey for a long time. In old age, requirements for light are increased. The species grows on soils drying during summer months. It prefers soils rich in nutrients. It is a species of warm locations and sunny slopes.

**Use:** Strong and fine-textured wood was formerly highly valued in wood-carving. The species is used as a decorative tree. It is suitable for pheasantries and as a food for birds. It provides good bee pasture.

### **Whitebeam - *Sorbus aria* Crantz**

A robust shrub or tree with a crooked stem and sparse crown. It reaches a height of 6 - 12 m and stem diameter 0.25 m. Its leaves are large and white-tomentose on the abaxial face (Tab. 68). It is a species growing in warmer regions from Scandinavia to N Africa. Whitebeam tolerates drought and shallow soils. It grows usually on limestone but tolerates acid rocks.

The species can be used for forestation purposes in warm and dry regions. It provides good bee pasture and food for birds. It is used as a decorative species.

### **Apple - *Malus***

Usually deciduous trees and shrubs. Fruits are globular pomes with pulp without sclerenchymatous cells. The basic species of apple trees grown for fruit is *M. pumila* indigenous from SE Europe to central Asia. Apple trees rank among the most widespread fruit species of the world.

About 25 species are distributed mainly in the temperate zone of Eurasia and North America. In our country, there is the only wild-growing species, viz crab apple - *Malus sylvestris* Mill.

It is a tree with a short stem and patulous crown reaching a height of about 10 m and stem diameter 0.5 m. Small leaves are usually glabrous, flowers are white in poor corymbs, fruits are small globular pomes. Crab apple grows nearly throughout Europe reaching Asia Minor and W Siberia.

It is a heliophilous species tolerating slight shading and showing medium requirements for soil moisture. It can even cope with rather dry soils. The species usually grows on soils rather rich in nutrients showing the sufficient content of humus. It is not demanding for climate and is resistant to frost. Wood of crab apple was formerly used in joinery and wood-carving for its hardness and strength. Crab apple is indispensable as a rootstock in grafting. Varieties of apple trees are ranked among the species *Malus domestica*.

### **Pear - *Pyrus***

Trees and rarely also shrubs, deciduous, sometimes with thorns. Fruits are pomes of various size mostly of pear-shaped form or globular, with grainy pulp. About 20 species are distributed from Europe to central Asia and southwards to the Himalayas. In the region of the CR, there is the only indigenous species, viz wild pear - *Pyrus pyraster*, a basis of the inexhaustible number of various sorts of pears grown for fruit from time immemorial.



**Wild pear - *Pyrus pyraeaster* Burgsd. (syn. *Pyrus communis* L. var. *pyraeaster*)**

A tree exceptionally 20 m in height, stem diameter 1 m. Leaves are orbiculate or broadly elliptical, pomes are globular (Tab. 70).

Its range reaches from central and S Europe through Asia Minor to central Asia. It is a heliophilous species tolerating drought and growing on soils which are sufficiently rich in nutrients. Its wood is strong, durable and warping only slightly. It is popular in wood-carving and furniture manufacture. Wild pear is essential as a rootstock in grafting various sorts of fruit trees. These sorts are ranked among the species *P. communis* L. (*P. communis* L. var. *sativa*).

**Hawthorn - *Crataegus***

Shrubs or trees often thorny. Fruits are small pomes with 1-5 hard seeds. One of the richest genera with several hundreds of species distributed in the temperate zone of the Northern Hemisphere.

In the region of the CR, three species are rather abundant: hawthorn - *C. monogyna*, whitethorn - *C. laevigata* syn. *C. oxyacantha* L. p.p. (Tab. 69) and *C. calycina*.

Hawthorn wood is very hard, heavy and durable. It was formerly used in carving for small decorative objects. Leaves, flowers and fruits are collected for pharmaceutical purposes. It is sometimes planted in quickset hedges.

**Subfamily: *Rosoideae* (*Rosaceae*)**

Herbs, semi-shrubs and shrubs, rarely trees, sometimes with thorns. Seeds are achenes or drupes, sometimes on a variously formed fleshy testa.

About 15 genera takes into account for the CR, however, the only genus is represented, viz rose - *Rosa*. Other two genera, viz bramble - *Rubus* and *Dryas* are rather subshrubs. As for introduced tree species, following genera are grown: kerria - *Kerria*, jetbead - *Rhodotypos* and five finger - *Potentilla*.

**Rose - *Rosa***

About 200 species growing in the temperate and subtropical regions of the Northern Hemisphere. Shrubs and sometimes also climbers or trailers, usually with epidermis thorns. Leaves are mostly odd-pinnate. Achenes are surrounded by a fleshy receptacle, the whole fruit is called hip (rose-hip).

Roses provide valuable oil. Here and there, hips are also processed for puree or dried for the preparation of tea.

In the region of the CR, about 15 species of wild-growing roses occur. The best known is dog rose - *R. canina*; many other species are similar. A marked forest species is *R. pendulina*. Striking forest-steppe species are *R. pimpinellifolia* and *R. gallica*. Other species are rare and grow mostly in warm regions.

**Subfamily: *Spiraeoideae* (*Spiraeaceae*)**

Shrubs without thorns. Flowers usually small composing rich inflorescences. Fruits are mostly follicles or capsules with petty seeds. Species of the genus *Spiraea* are frequently grown shrubs. Species of the genus *Physocarpus* and *Sorbaria* are also rather frequently planted. Species of the genus *Exochorda* or *Sibiraea* rarely occur in collections.

## **Family : Fabaceae**

Herbs and trees as well as lianas, deciduous and evergreen. Leaves alternate, pinnate, seldom simple. Five petals are characteristic by their papilionaceous arrangement. Only exceptionally, the papilionaceous arrangement is indistinct and petals are reduced. Fruits are legumes.

A very extensive family amounting to at least 480 genera with about 12 000 species extended throughout the world particularly in the tropics.

As for woody species, about 30 genera appear to be suitable for our conditions, however, hardly a half of them occurs in cultures. Native larger-growth tree species of the family do not occur in our country. Only N American black locust - *Robinia pseudoacacia* is of forestry importance. Other species of arborescent character are *Sophora japonica* and in collections also *Cladrastis lutea* and *Maackia amurensis*. In landscape gardening, some shrubby species have proved good, eg species of genera laburnum - *Laburnum*, pea tree - *Caragana*, bladder senna - *Colutea*, bastard indigo - *Amorpha*, milk trefoil - *Sarothamnus* and scorpion senna - *Coronilla*. Blue-flowering lianas of the genus *Wisteria* are grown less commonly.

### **Locust - *Robinia***

About 20 species distributed in North America southwards up to Mexico. Deciduous trees and shrubs often with stipular thorns. Leaves odd-pinnate with entire leaflets. Flowers white or red in pendent racemes. Pods flat, shrinking, brown, with few seeds.

#### **Black locust - *Robinia pseudoacacia* L.**

**Description:** Trees reaching a height of 20 - 25 m and stem diameter over 1 m. Their root system is first of a tap root type, later multilaterally developed reaching deep and far of the tree stem. As for the intensity of the root development in soil, black locust is number one in this respect its roots reaching even 20 m far of the stem and over 10 m deep. Sprouting capacity of stems and stumps is excellent and the species exhibits also root suckers (Tab. 71).

**Distribution:** This North American species was originally extended in the eastern part of the continent along the Appalachians westwards to the Mississippi River basin. At the beginning of the 17th century, black locust was introduced in Europe. Its growing was soon extended throughout Europe and the species became a trendy tree being later well-known throughout the Earth.

**Ecology:** It is a markedly heliophilous species. Black locust stands are open and their capacity to shade soil is poor. It does not survive in undergrowth and virtually does not form mixtures with other species. However, the species survives moisture deficits and due to this property, it is particularly used. It grows on various soils except for extreme acid and peat ones. The species enriches soil by nitrogen from bacterial nodules on its roots; it tolerates soils lacking humus. It is resistant to the urban environment as a street tree.

**Use:** Black locust provides very valuable wood which is strong, flexible and durable being resistant to insect and fungi and suitable for sleepers, mine timber, furniture etc. It is calorific fuelwood. The species is highly valued as bee food. Its dried flowers are bought for pharmaceutical industry. Black locust is used as a decorative species.

### **Sophora, pagoda tree - *Sophora***

In Europe, the only species coming from China and Korea is often planted, viz **Japanese pagoda tree** - *S. japonica* (Tab. 72). It is a thermophilic robust species a little resembling black

locust (however, without thorns) coming into blossom by large sparse panicles of yellow-white flowers in late summer. Pods are fleshy, strangulated, with several seeds. It has proved good in street avenues being also important as late food for bees.

### **Golden chain - *Laburnum***

Deciduous shrubs without thorns and with trimerous leaves. Yellow flowers in terminal pendent racemes. Two south-European species are commonly grown, viz **golden rain** - *L. anagyroides* (Tab. 73) (earlier coming into blossom) with finely pilose shoots and leaves and **Scotch laburnum** - *L. alpinum*, glabrous. Through their content of alkaloids they are very toxic. Their wood is of high quality.

### **Family : Juglandaceae**

Woody species of aromatic odour. Leaves deciduous, odd-pinnate. Inflorescences monoecious, unisexual, in catkins. Fruits are nuts, sometimes with fleshy skin (drupes). Genera walnut - *Juglans* and hickory - *Carya* are of greater importance (Tab. 98).

### **Walnut - *Juglans***

About 15 species growing in Eurasia and North America in the temperate zone regions. Pith in twigs is interrupted by transverse compartments. Leaves are deciduous, odd-pinnate, aromatic. Fruits are large nuts with leathery skin and hard rugged nutshell. A North American species **black walnut** - *J. nigra* L. is of forestry importance in our country. It is a robust tree reaching a height of 45 m and stem diameter 1.5 m. At first, it creates a bulky tap root; therefore, young plants can be badly transplanted and stands are mostly established by seeding (Tab. 97).

A North American species growing from the Mississippi River basin to the Atlantic Ocean and from the border of Canada to the south of the USA. It is a heliophilous species requiring sufficient soil moisture. It also requires a longer growing season. Stems are sometimes felled together with their basal parts which provide very nice curly-grain wood. The species wood is suitable for veneers, furniture and music instruments, ship and aircraft building etc. It was used as a substitute for mahogany wood.

Another species grown for its valuable fruits in Europe from time immemorial is **English walnut (syn. European walnut)** - *J. regia* (Tab. 96). It comes from SE Europe and Asia Minor. It is a heliophilous species demanding for soil and sensitive to late frosts. Its quality wood is strong, workable, with nice curly grain. It is used for the manufacture of veneers, in furniture making, for gun stocks etc.

### **Hickory - *Carya***

About 20 species are distributed mainly in North America. Trees with very hard wood. Pith in twigs is uninterrupted. Fruits consist of nuts with four protruded ribs surrounded by skin. Some American species are important forest trees with quality wood. Other species, such as *C. pecan* give very tasty nuts.

### **Family : Caprifoliaceae**

Mostly shrubs, sometimes climbers but also trees and herbs. Leaves are usually simple, opposite. Androgynous flowers show often a tubular crown. Fruits are variously formed.

Fourteen genera with 400 species are extended mainly in the temperate zone of the Northern Hemisphere. Only some of them reach mountain ranges in the tropics and Southern Hemisphere. Three genera are represented by native species in the CR: honeysuckle - *Lonicera*, viburnum - *Viburnum* and elder - *Sambucus*. Introduced species of the genera are also grown. The best known genera are snowberry - *Symphoricarpos* (Tab. 80) and old-fashioned weigela - *Weigelia*. In the CR, other genera occur only in collections although they include very resistant and decorative species, such as *Kolkwitzia* or *Diervilla*.

### **Honeysuckle - *Lonicera***

Nearly 200 species are extended throughout Northern Hemisphere, in North America southwards up to Mexico, in Asia up to Java and the Philippines. Flowers are on a common peduncle in groups of two each or crowded near leaves around an axis. Fruits are berries.

In the CR, three wild-growing species of honeysuckle occur, viz two shrubby species fly honeysuckle - *L. xylosteum* and black-barried honeysuckle - *L. nigra* (in cold locations) and the only liana perfoliate honeysuckle - *L. caprifolium* (Tab. 75). A species *L. tatarica* from eastern Europe is planted as a decorative species.

### **Fly honeysuckle - *Lonicera xylosteum* L.**

Small or medium-tall shrubs with dense crooked branches and thin shoots. It is striking by its red berries placed in groups of two each on one peduncle. It exhibits good sprouting capacity and can propagate by layers (Tab. 74). It is an Eurasian shrub. In Europe, it is missing in the warm Mediterranean and in the cold north-east. Eastwards, it reaches through SW Siberia up to the Altai Mts. It tolerates even heavy shading. It adapts to locations with a temporary moisture deficit. The species grows mainly on nutrient-rich soils, often on limestone.

### **Viburnum, arrowwood - *Viburnum***

About 120 species are extended throughout the Northern Hemisphere. Deciduous and evergreen shrubs and trees. Leaves opposite, simple, often palmate-lobed. Flowers small, white or pink in composed cyme or panicle inflorescences. Fruits are drupes with flat stones.

In the region of the CR, two species grow naturally, viz guelder rose - *V. opulus* (Tab. 76) with lobed leaves and red fruits and wayfaring tree - *V. lantana* (Tab. 77) with entire leaves and red fruits. Both species are also planted for decorative purposes.

### **Elder - *Sambucus***

About 20 species extended in the temperate and subtropical zones of both hemispheres. Shoots have thick pith. Odd-pinnate leaves are opposite. Fruits are berries.

### **European elder - *Sambucus nigra* L.**

A robust shrub or small tree reaching a height of 8 m and stem diameter 40 cm. Large white inflorescence, fruits black. Its root system is quite flat-distributed. The species creates intensively coppice shoots and stem sprouts but particularly shoots on root collars (Tab. 78). Its range includes the whole Europe with the exception of north-eastern part reaching W Siberia. It tolerates intense shading particularly in young age. Elder tolerates excessive moisture, however, does not tolerate extremely dry sites. In forest stands, it is considered to be a troublesome weed. Red elder *Sambucus racemosa* L. is a similar species. It is a shrub of broom

growth with red fruits (Tab. 79). Its Eurasian range includes the substantial part of Europe reaching eastwards up to Siberia. It is a shade-tolerating species requiring sufficient soil moisture and atmospheric humidity. It grows mainly on acid soils, particularly humous soils.

### **Family : Rhamnaceae**

About 45 genera with more than 550 species distributed nearly throughout the world. In the CR, only species of genera *Frangula* and *Rhamnus* are indigenous.

#### **Buckthorn - *Rhamnus cathartica* L.**

A medium-tall shrub or small tree with fork-shaped branching and thorns. Crenate leaves with bow-shaped venation show opposite arrangement. Seeds are with a line (Tab. 81). A species distributed nearly throughout Europe except for cold north and reaching Asia Minor and W Siberia. *R. cathartica* is a heliophilous species. It tolerates drying soils and grows particularly on limestones and other rocks rich in nutrients. Its wood is ring-porous, hard, with red heartwood and nice texture.

#### **Alder buckthorn - *Frangula***

***F. alnus* Mill., (*Rhamnus frangula* L.)** A medium-tall shrub without thorns with alternate leaves and naked buds. Fruits are drupes with seeds without a line. The species exhibits large Eurasian range reaching central Asia. It is a shade-tolerating species occurring on moist sites. It can survive even stagnant water. Alder buckthorn grows usually on acid soils. Its wood is of reddish colour. The species is highly valued as bee pasture.

### **Family : Celastraceae**

About 50 genera with nearly 800 species are extended on both hemispheres. Particularly a genus **spindle tree - *Euonymus*** is known.

The genus comprises 120 species. Deciduous and evergreen shrubs and trees with simple opposite leaves. It has tetramerous flowers, fruits are capsules with seeds in a fleshy aril. In Europe, three species are common: **cat tree - *E. europaeus* L.** A medium-tall shrub or small tree with stem diameter up to 20 cm. Sometimes striking corky ribs on branches. In autumn, leaves turn red (Tab. 82). Its range comprises the substantial part of Europe reaching Asia Minor and Caucasus. It tolerates shade and avoids drying soils. The species thrives mainly on rich humous soils on bases of slope debris.

Its dense and strong wood of yellow colour was used for small carvings products – pipes, toothpicks and components of music instruments.

**Warty-backed spindle tree - *Euonymus verrucosus* Scop.** A smaller shrub with twigs covered with corky lenticels (Tab. 83). A thermophilic species surviving at drying sites of lighter soils developed on various bedrocks. *E. latifolius* is a less frequent species.

### **Family : Cornaceae**

Ten genera amounting to about 90 species are extended in the temperate and subtropical zones predominantly in the Northern Hemisphere.

#### **Dogwood - *Cornus***

Deciduous shrubs and trees, rarely herbs. Opposite and only exceptionally alternate leaves are simple and entire. Flowers are small, tetramerous, often with striking bracts. Fruits are drupes with a two-capsule stone. About 40 species are distributed in the temperate zone of the Northern Hemisphere. In addition to the native species cornelian cherry - *C. mas* and red dogwood - *C. sanguinea* also an Asian species Tatarian dogwood - *C. alba* with dark red flowers and white fruits is rather frequently planted. A similar North American species osier dogwood - *C. stolonifera* (*sericea*) is also rather used.

#### **Cornelian cherry - *Cornus mas* L.**

A robust shrub or small tree (8 m). It flowers strikingly early before leaf unfolding. The species exhibits excellent sprouting capacity and tolerates pruning (Tab. 84). It is extended from central Europe to Caucasus. *Cornus mas* is a heliophilous species. It can grow on sites heavily drying during the growing season. The species prefers soils rich in nutrients and can be found particularly on limestones. Its wood is very hard, strong and fine-grained formerly being used in carving and the manufacture of tools. Red fruits are edible and tasty.

#### **Red dogwood - *Cornus sanguinea* L., syn. *Thelycrania sanguinea* Fourr., *Swida sanguinea* (L.) Opiz.**

A medium-tall shrub with black fruits (Tab. 85). It is a Euro-Siberian species growing both on soils with sufficient soil moisture and on drying soils. Its heavy, hard and strong wood was used in the manufacture of small tools.

### **Family : *Staphyleaceae***

Five genera with 25 species extended in the temperate zone of the Northern Hemisphere. For our country, only the genus *Staphylea* comes into question.

#### **Bladdernut - *Staphylea pinnata* L.**

A medium-tall shrub with sparsely fork-shaped branching. Its white flowers are very nice and also membranous capsules can attract the attention of an observer (Tab. 86). It grows in central and SE Europe and reaches Asia Minor. The species thrives under conditions of weak shade on nutrient-rich humous soils, often under rocks on slope debris. From time immemorial, its seeds were used for the manufacture of rosaries and other decorations. Flowers provide bee pasture. Hard and fine-grained wood was formerly used in carving.

### **Family : *Berberidaceae***

Herbs and woody species with alternate leaves. Flowers are androgynous. Fruits are berries. About 10 genera with about 450 species are extended throughout the Northern Hemisphere. Only the genus *Berberis* reaches South America up to Terra del Fuego. Some species of the genus *Mahonia*, eg a North American species *M. aquifolium* with yellow flowers are rather frequently planted. The species reaching a height of 2 m is characteristic by its compound leathery leaves and striking yellow phloem. An intergenus hybrid  $\times$ *Mahoberberis* is also known.

#### **Barberry - *Berberis***

A very rich genus with about 180 species. A European species piperidges - *B. vulgaris* L. ranks among the best-known of them. A small shrub with bow-shaped thorny branches, yel-

low flowers and red fruits (Tab. 87). Its bark was used to dye yellow. Berries were used to tinge jams and beverages. Barberry provides good bee pasture.

### **Family: Saxifragaceae**

A large family consisting of about 80 genera with about 1200 species extended mainly in the temperate zone of both hemispheres. The only genus, currant - Ribes is indigenous. As for introduced species, following genera are used rather frequently: mockorange - Philadelphus, hydrangea - Hydrangea and deutzia - Deutzia. The genera mentioned above are sometimes ranked among more families: Grossulariaceae (Ribes), Hydrangeaceae (Hydrangea) and Philadelphaceae (other genera).

### **Currant, ribes - Ribes**

A rich genus with about 150 species. Shrubs with androgynous flowers and juicy fruits - berries. A subgenus or even separate genus Grossularia (R. grossularia, Grossularia uva-crispa) is usually distinguished. It is characterized by thorny branches, small number of flowers in inflorescences (sometimes only one flower each) and often setaceous fruits. Most common are following species: rock red currant - R. petraeum, mountain currant - R. alpinum and black currant - R. nigrum (Tab. 88).

### **Family : Ranunculaceae**

Herbs and woody species distributed in 50 genera and 1300 species mainly in temperate regions of the Northern Hemisphere. Woody species of genera peony - Paeonia and Virgin's bower - Clematis come into question for our country.

### **Virgin's bower - Clematis**

Herbs, subshrubs and shrubs, often climbers. Leaves opposite, usually composed. Climbers attach by means of leaf tendrils. A well-known Clematis vitalba L. is a climber (Tab. 89). The centre of its distribution is in the Mediterranean. The species exhibits medium requirements for moisture; it grows even in regions with low atmospheric precipitation. It requires deep, nutrient-rich and humous soils.

### **Family : Anacardiaceae**

About 60 genera with roughly 400 species growing mainly in the tropics and subtropics of both hemispheres. Fruits are nuts or achenes. Two genera reach the temperate zone, Cotinus and Rhus. So-called "pistachio nuts" of the subtropical genus Pistacia are also sold. In the region of the CR, an E North American species R. typhina is grown rather frequently. Its wood is of an attractive yellow-green colour (Tab. 90).

### **Family : Araliaceae**

About 50 genera with 500 species. A common species of the genus Hedera is an evergreen ivy - Hedera helix L. It climbs to a height of 10 - 20 m. Heterophylly has developed in the species: lobed leaves are on flowerless shoots, leaves without lobes occur on flowering shoots (Tab. 91).

### **Family : Tamaricaceae**

The family consists only of 4 genera and about 100 species. Its fruit is a capsule with seeds often equipped with egret (down). Only two genera come into question for our country: myricaria - *Myricaria* represented by a native species *Myricaria germanica* Desv. A shrub reaching a height of 2 m with scaly leaves (Tab. 92). The second genus is tamarisk - *Tamarix* with several species from warmer regions where it tolerates saline soils (Tab. 93).

### **Family : Ericaceae**

Shrubs and small trees, very often only subshrubs. Leaves are usually evergreen. Fruits are capsules, more rarely berries or drupes. Conditions of Central Europe can tolerate members of more than 30 genera. Members of the following genera are usual: heather - *Calluna*, bell-heather - *Erica*, crowberry - *Empetrum*, blueberry - *Vaccinium* (at present also separate genera fen-berry - *Oxycoccus* and cranberry - *Rhodococcum*), dogberry - *Arctostaphylos* and Dutch myrtle - *Andromeda*, of large growth is only Labrador tea - *Ledum*. Mostly only small shrubs and subshrubs. Members of the genus *Arbutus* are arborescent. *Rhododendron* - *Rhododendron* (azalea - *Azalea*) is the most important genus grown for decorative purposes in many species and cultivars in gardens and parks nearly throughout the world.

### **Family : Vitaceae**

Shrubs, often climbers attaching through tendrils but also straight-growing shrubs and small trees. Flowers are small, in compound inflorescences placed opposite a leaf. Fruits are berries with small seeds. Two genera are well known: vine – *Vitis* represented perhaps also by an indigenous wild-growing species *V. vinifera* var. *silvestris* and woodbine – *Parthenocissus* (Tab. 94).

### **Family : Loranthaceae**

Woody species and herbs mostly parasitizing in crowns of trees. Leaves largely opposite. Fruits are berries. The family consists of 21 genera with at least 600 species. Main regions of its distribution are the tropics and subtropics. In Europe, species of genera mistletoe - *Viscum* and loranthus - *Loranthus* are typical. A S European genus *Arceuthobium* growing often on junipers is less known.

### **Family : Hippocastanaceae**

Four genera with about 25 species. Trees and shrubs with opposite palmate compound leaves. Symmetrical flowers with 4 - 5 petals arranged in terminal panicles. Fruits are three-part splitting capsules with large seeds. Members of the genus *Aesculus* are grown as decorative species. It refers to **horse chestnut - *Aesculus hippocastanum* L.** A medium-tall tree with a patulous crown reaching a height of 25 m and stem diameter over 1 m. Old trees occurring often with burls and winding stems. The species comes from the Balkan Peninsula. Horse chestnut tolerates shading in young age. It grows on deep, moist, permeable soils but tolerates also dry sites. Its wood is not of good quality (Tab. 95).

### **Family : Platanaceae**

A monotypic family with a range in North America and Eurasia extending from the boundary of a temperate and cold zone up to the subtropics.

**Plane tree, sycamore - *Platanus***



About 6 species growing in North America and Eurasia. Large trees with alternate palmate-lobed leaves. Smooth bark peels in strips and so the stem is light-spotted. Buds are with one scale. Globular infructescences from small achenes hang on long pedicles. The most common species is London plane - *Platanus × acerifolia* (Ait.) Willd. (*P. hispanica*) (Tab. 99).

### **Family : Simarubaceae**

Trees and shrubs with bitter bark. Leaves are variously formed and arranged. Small flowers in racemes or panicles. Fruits are drupes, berries or winged achenes. About 28 genera amounting to about 150 species are distributed in the tropics; only some of them reach the temperate zone. In the CR, only a Chinese tree of heaven - *Ailanthus glandulosa* (Mill.) Swingle occurs. A fast-growing species with large leaves (Tab. 100). Its wood is light and of short duration. It is a decorative species for towns in warmer regions.

### **Family : Moraceae**

Woody species and herbs often producing latex. Leaves are simple. The family consists of at least 55 genera with about 1000 species extended mainly in the tropics. For our country, only genera mulberry *Morus* or *Maclura* come into question. The genus *Ficus* is also well known. White mulberry - *M. alba* coming from China is rather abundantly planted. It reaches a height of 20 m and its fruits are tasty. Its wood is also of interest.

### **Family: Magnoliaceae**

Woody species with simple alternate leaves. About 10 genera with about 80 species are distributed in the temperate zone and in the subtropics of America and Asia. In the region of our country, members are known of the genus magnolia – *Magnolia* and tuliptree - *Liriodendron*. As a botanical curiosity, climbers of the genus shizandra - *Schisandra* are sometimes grown.

#### **Tuliptree - *Liriodendron***

Trees with pedunculate buds. Leaves deciduous, alternate. Flowers individual, of tulip shape. Fruits are splitting cones consisting of achenes with long wings. A species common in parks is an E American tulip tree - *L. tulipifera* L. (Tab. 101). It reaches a height of 50 m and stem diameter 2 m. The species provides soft wood similar to poplar wood. Tulip tree does not tolerate drought and calcareous soils. It is a decorative species.

#### **Magnolia, cucumber tree -*Magnolia***

Trees and shrubs with striking terminal buds with one scale. Leaves simple, large, alternate. Flowers individual, terminal, exceedingly large and decorative (eg *M. × soulangeana*.)

### **Family : Caesalpinaceae**

Shrubs, trees and also lianas. Leaves simple or double-pinnate, alternate. Fruits are variously formed pods. The family exhibits a number of common features with a family *Fabaceae*. There are about 200 genera with roughly species. For example, the following members are known: Judas tree - *Cercis*, honey locust – *Gleditsia triacanthos* (Tab. 102). It is a tree of robust growth reaching a height of 30 m. It is characteristic by large thorns and long bow-shaped pods. Leaves are 1-2 × paripinnate. It comes from the east of North America. It provides high-quality reddish wood. A similar species is coffee tree - *Gymnocladus dioica*, a

decorative tree. A subtropical S European species *Ceratonia siliqua* named “carob /carob-tree/” is known according to edible pods.

### **Family : *Buxaceae***

Evergreen subshrubs or small trees with sessile leaves. Flowers monoecious, unisexual, small, usually without petals. Fruits are capsules or berries. Six genera with 40 species are distributed mainly in the tropics and subtropics. Only some of them reach the temperate zone. In our country, however, common boxwood *Buxus sempervirens* is planted very frequently. A decorative species with very hard wood.

### **Family : *Elaeagnaceae***

Shrubs or small trees often with scales or stellated hairs. Leaves simple, entire, deciduous and evergreen. Small flowers without petals. Fruits are drupes. In parks, species of the genus oleaster - *Elaeagnus* and sea buckthorn - *Hippophaë* occur rather frequently.

Russian olive - *Elaeagnus angustifolia* L. Usually shrubs reaching a height of 9 m and stem diameter 0.5 m. By its silver leaves it resembles white willow, however, it has thorny branches, intensely odorous yellow flowers and edible elongated drupes. Its quality wood is ring-porous. The species is extended from SE Europe to Asia.

Common seabuckthorn - *Hippophaë rhamnoides* L. It is a dioecious shrub or small tree reaching a height of 10 m, often with thorns, intensively propagating by root suckers. Leaves are linear-lanceolate, silver-tomentose, buds are bronze (Tab. 103). In some countries, red fruits are collected and processed for juice rich in vitamin C.

### **Family : *Scrophulariaceae***

Shrubs and trees with simple leaves. Flowers are variously formed, often with sepals creating two labia. Fruits are capsules or berries. About 180 genera with roughly 3000 species are distributed throughout the world. A very rich genus *Hebe* is grown in our country. **Royal paulownia - *Paulownia tomentosa* (Thunb.) Steud.** is planted as a decorative species.

### **Family : *Bignoniaceae***

Shrubs, trees and also herbs, often climbers. Leaves mostly opposite. Nice flowers with a large funnel-shaped corolla occurring in racemes or panicles. Fruits are capsules with many small winged seeds. The family consists of 100 genera with about 600 species. Members of the genus *Catalpa* are grown rather frequently. Deciduous and evergreen trees with large simple leaves arranged predominantly in whorls of 3 each. Fruits are long narrow capsules with winged seeds. *C. bignonioides* of warped growth and *C. speciosa* with a straight stem of higher growth have been introduced from North America. A North American liana *Campsis radicans* is less planted in our country.

### **Family : *Rutaceae***

About 120 genera with roughly 1000 species growing mainly in the tropics; some genera reach the temperate zone of the Northern Hemisphere. Trees, shrubs and herbs with variously formed and arranged leaves, often with spots of volatile oils. Conditions of our country can tolerate woody species of hardly 10 genera two of them being planted more frequently, cork tree - *Phellodendron* and shrubby trefoil - *Ptelea*.

### **Family : *Aquifoliaceae***

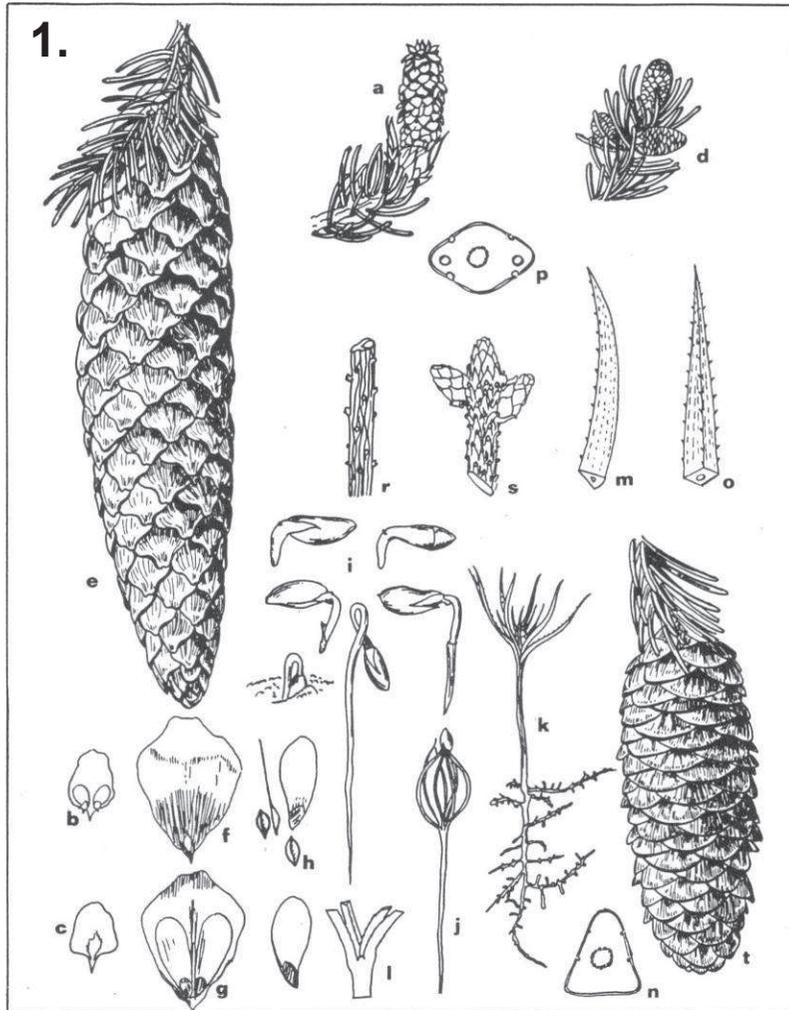
In the region of our country, holly - Ilex is particularly grown, predominantly an evergreen Eurasian species I. aquifolium with white flowers and red fruits (Tab. 104).

**Family : Myrtaceae**

Evergreen, intensely aromatic trees and shrubs. Regular flowers are with 4 - 5 petals. A well-known genus is eucalypt - Eucalyptus. About 400 species of Eucalyptus are indigenous in Australia and only some of them reach Malaya. In southern regions of Europe, E. camaldulensis, E. globulus and E. botryoides are often planted. The genus Myrtus is also well known. It is an iconic plant of old civilizations in SE Europe and Asia Minor.

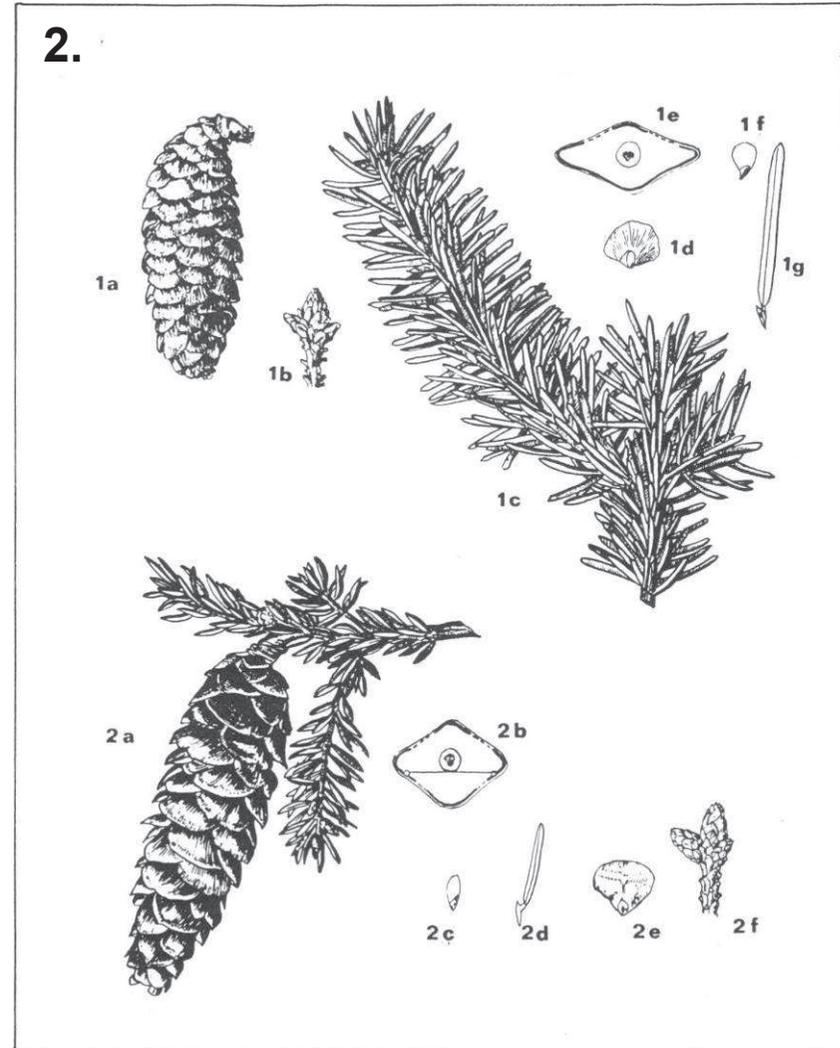
**Family: Lauraceae**

Aromatic woody species with simple, alternate leaves. Fruits are drupes or berries with a thickened pedicle. A large family with about 45 genera and 1000 species extended particularly in the subtropics and tropics. For example, the genus Laurus (spice) is well-known. In antiquity, laurel wreaths were used to decorate winners of races, famous warriors and rulers.



***Picea abies***: a) branch with female cone-like inflorescence, b) fertile scale with seeds, c) fertile scale with small bract scale, d) shoot with male catkins, e) cone, f-g) fruit scales, h) winged seeds, i) germination, j) seedling, k) one year old plant, l) top of sapling - longitudinal section, m) end of cotyledon, n) cotyledon - cross section, o) ending of primary needle, p) needle - cross section, r) shoot, s) buds

***Picea obovata***: t) cone

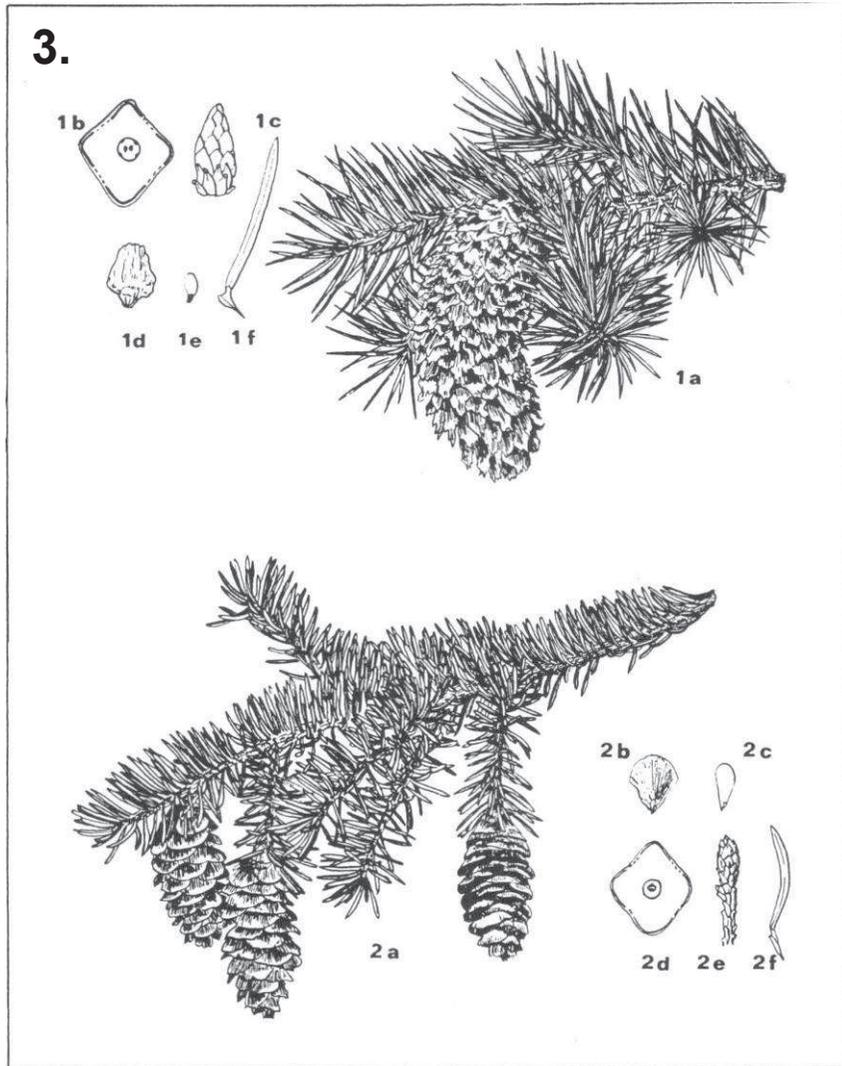


***Picea omorika***: a) cone, b) winter buds (3x), c) shoot, d) fertile scale,

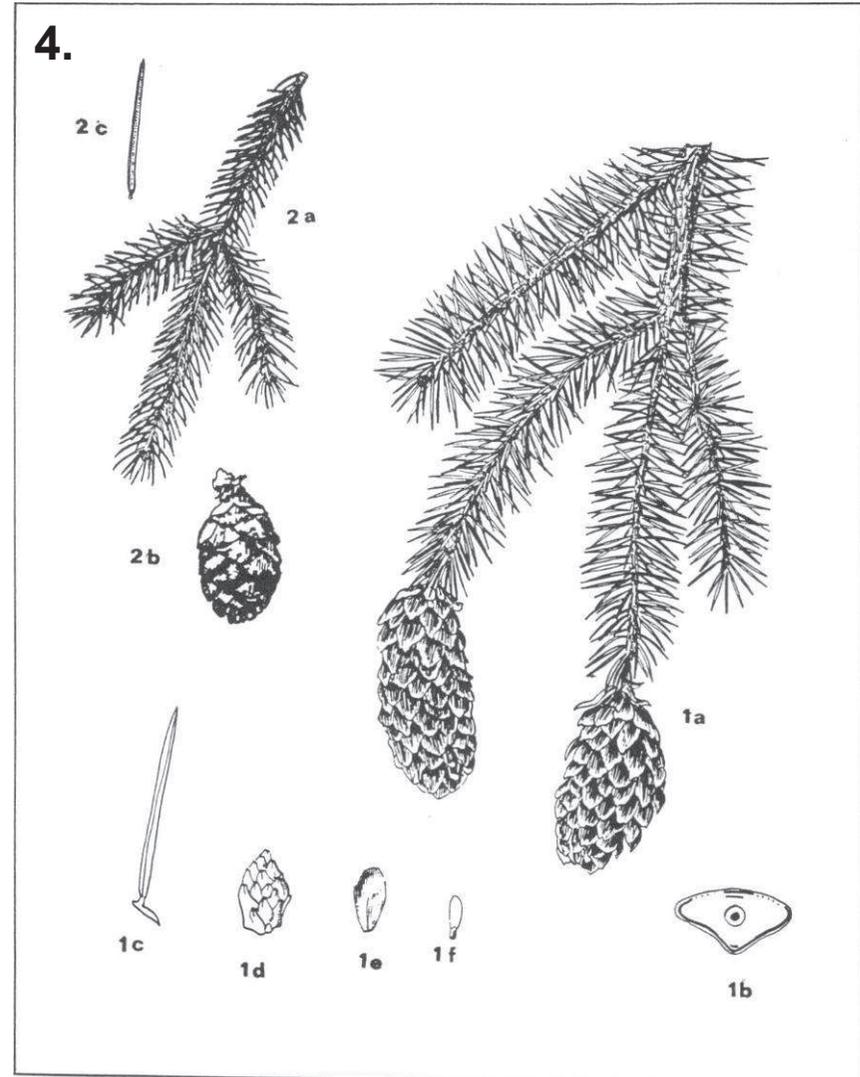
e) needle - cross section (20x), f) seed, g) needle (4x)

***Picea orientalis***: a) shoot with cone, b) needle - cross section (20x), c) seed,

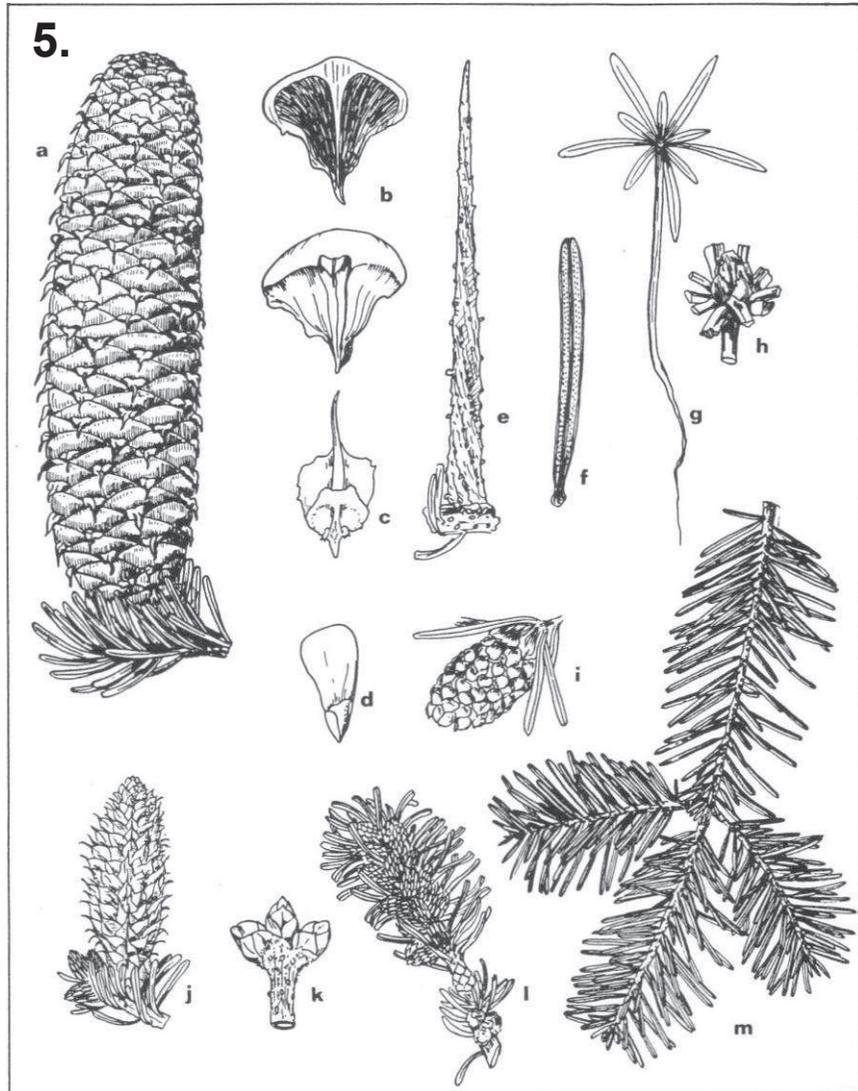
e) needle (4x), e) fertile scale, f) winter buds (3x)



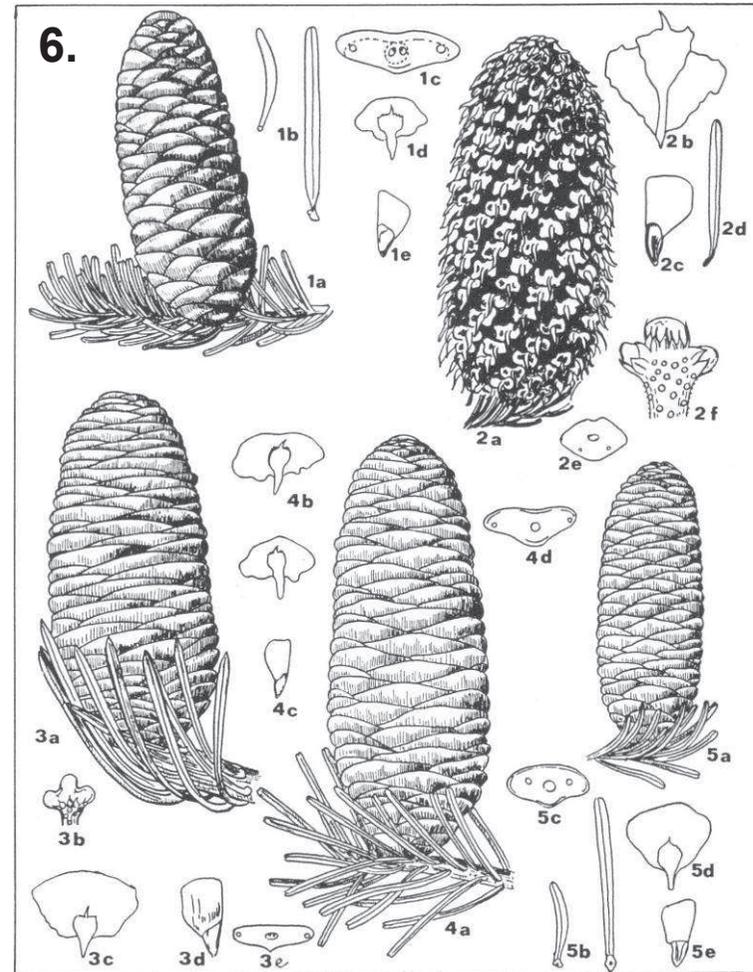
*Picea pungens*: a) shoot with cone, b) needle - cross section (20x), c) winter bud (3x), d) fertile scale, e) seed, f) needle  
*Picea glauca*: a) shoot with cones, b) fertile scale, c) seed, d) needle - cross section (20x), e) winter bud (2x), f) needle



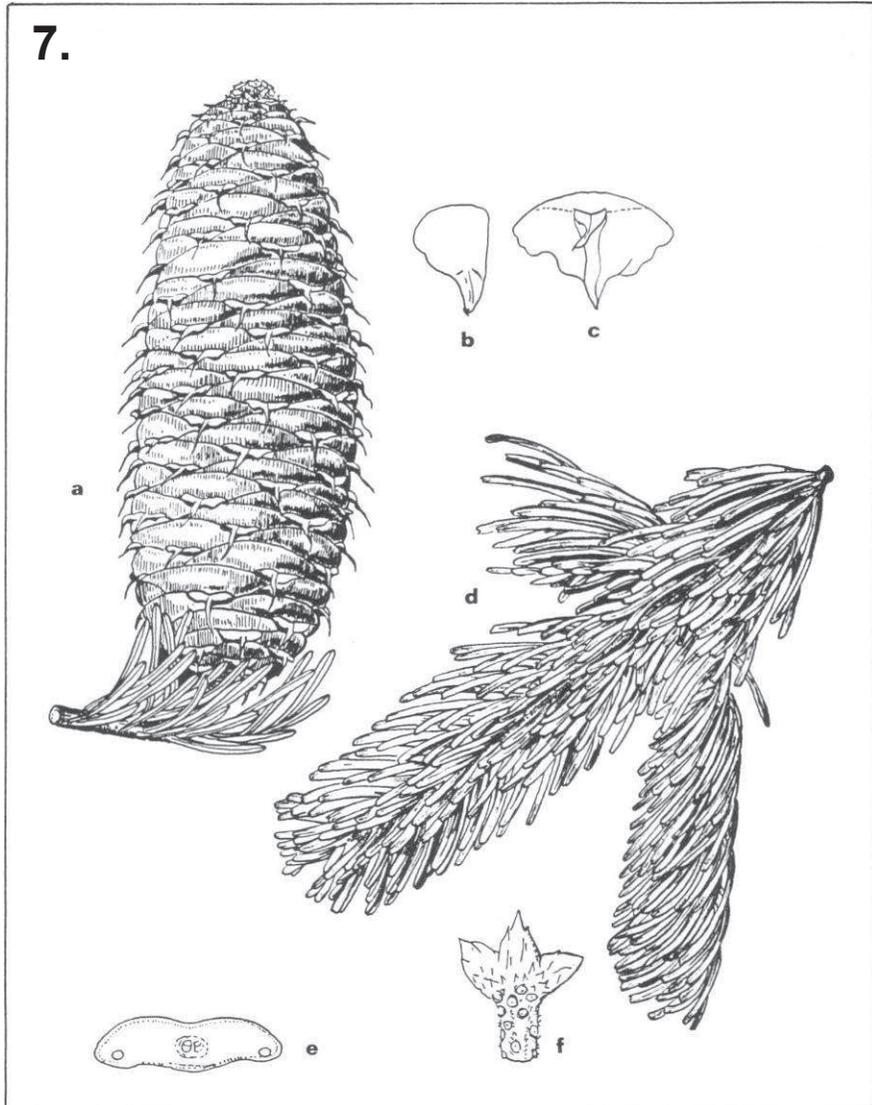
*Picea sitchensis*: a) shoot with cones, b) needle - cross section (20x), c) needle (3x), d) winter bud (4x), e) fertile scale, f) seed  
*Picea mariana*: a) shoot, b) cone, c) needle (3x)



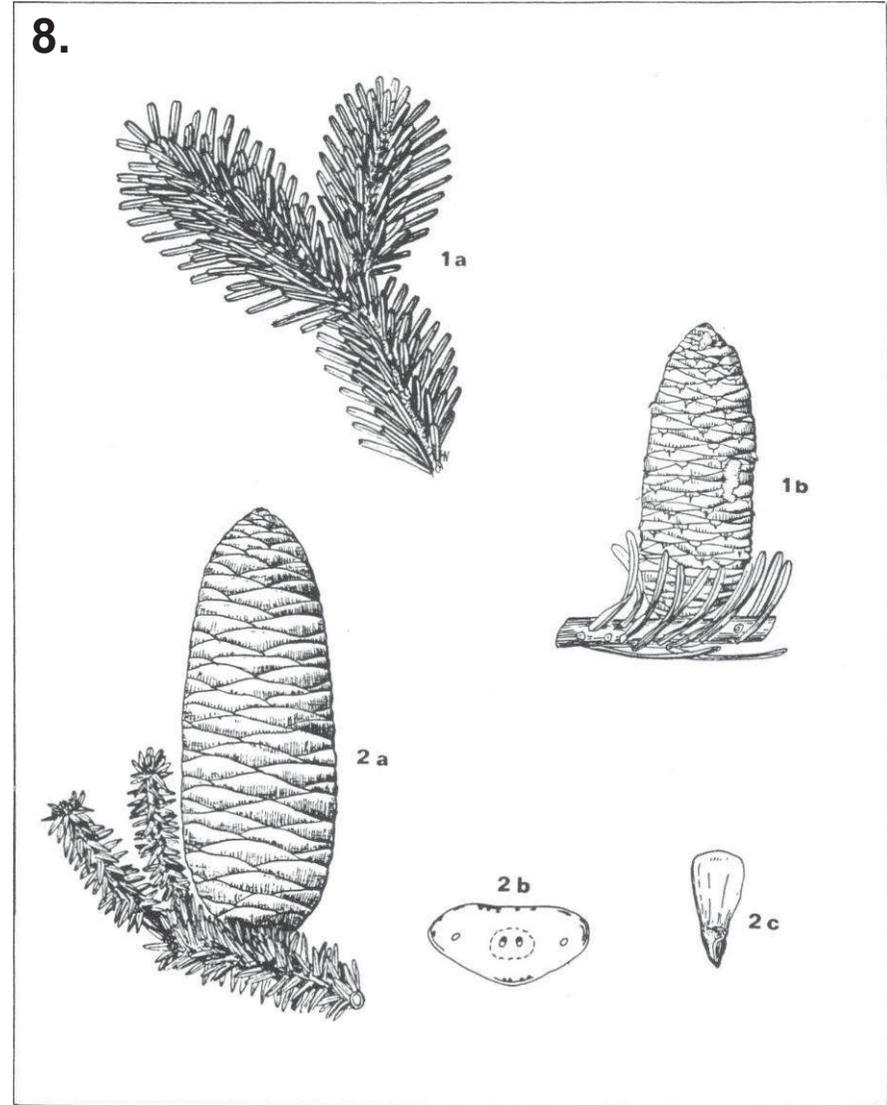
**5. *Abies alba*:** a) cone, b) fertile scales, c) bract scale, d) seed, e) cone rachis, f) needle (2x), g) seedling, h) unfolding bud, i) male inflorescence, j) female inflorescence, k) winter buds, l) shoot with male inflorescences, m) twig



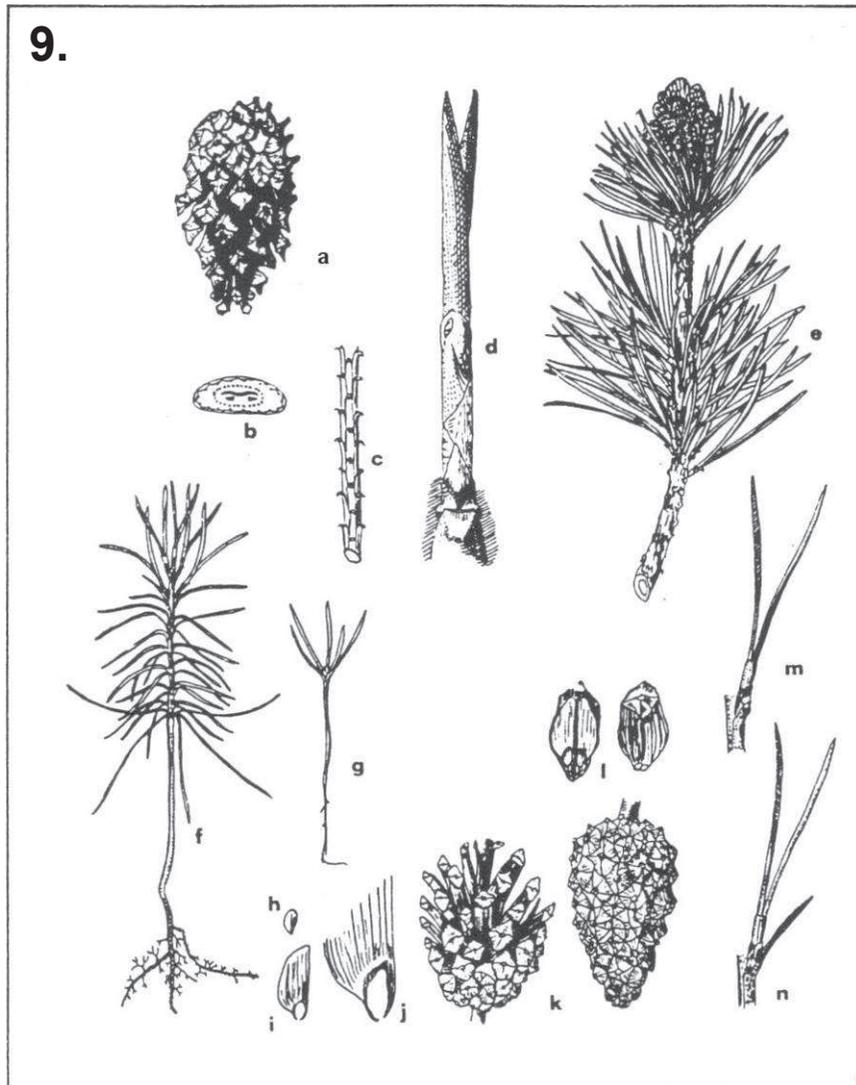
**1. *Abies balsamea*:** a) cone, b) needle, c) needle - cross section (20x), d) fertile scale with bract scale, e) seed  
**2. *Abies procera*:** a) cone (2x reduced), b) fertile scale with bract scale, c) seed, d) needle, e) needle - cross section (10x), f) winter buds  
**3. *Abies concolor*:** a) cone, b) winter buds c) fertile scale with bract scale, d) seed, e) needle - cross section (15x)  
**4. *Abies grandis*:** a) cone, b) fertile scales with bract scales, c) seed, d) needle - cross section (15x)  
**5. *Abies sibirica*:** a) cone, b) needle, c) needle - cross section (15x), d) fertile scale with bract scale, e) seed



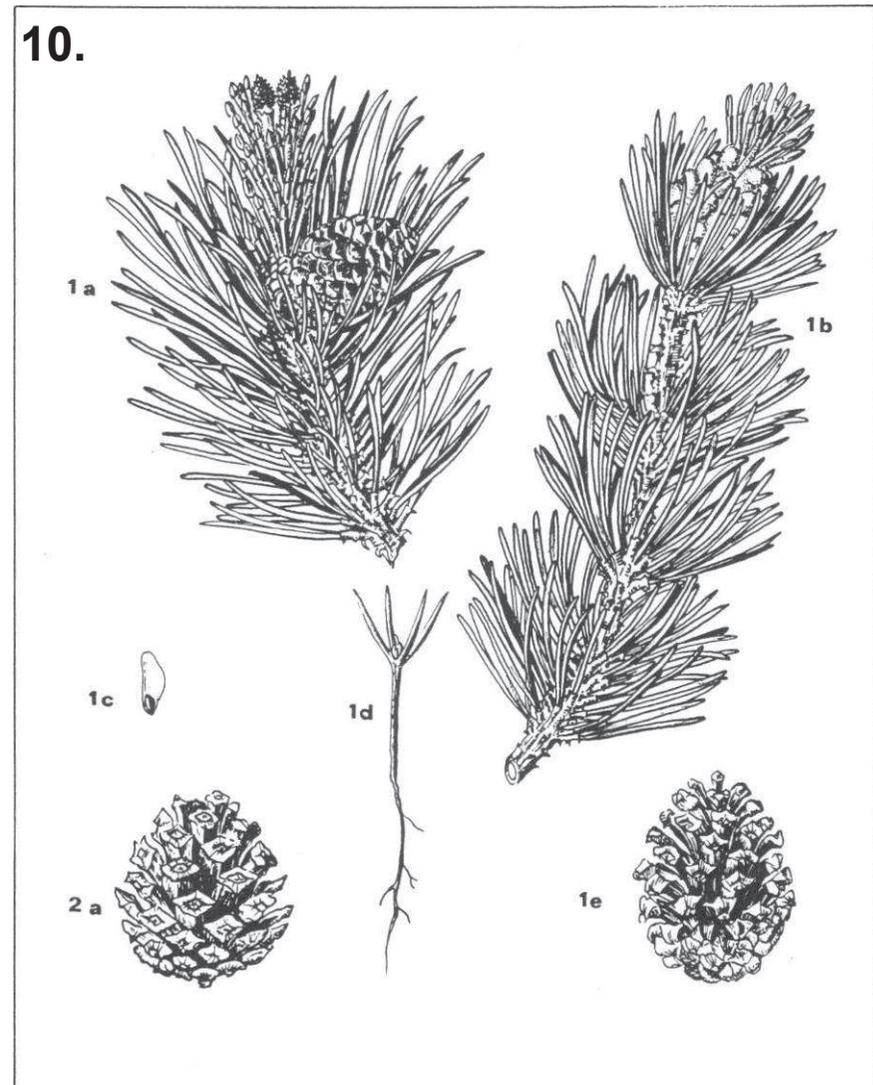
*Abies nordmanniana*: a) cone b) seed, c) fertile scale, d) shoot, e) needle - cross section (20x), f) winter buds (2x)



*Abies veitchii*: a) shoot, b) cone  
*Abies pinsapo*: a) shoot with cone (2x reduced), b) needle - cross section (20x), c) seed



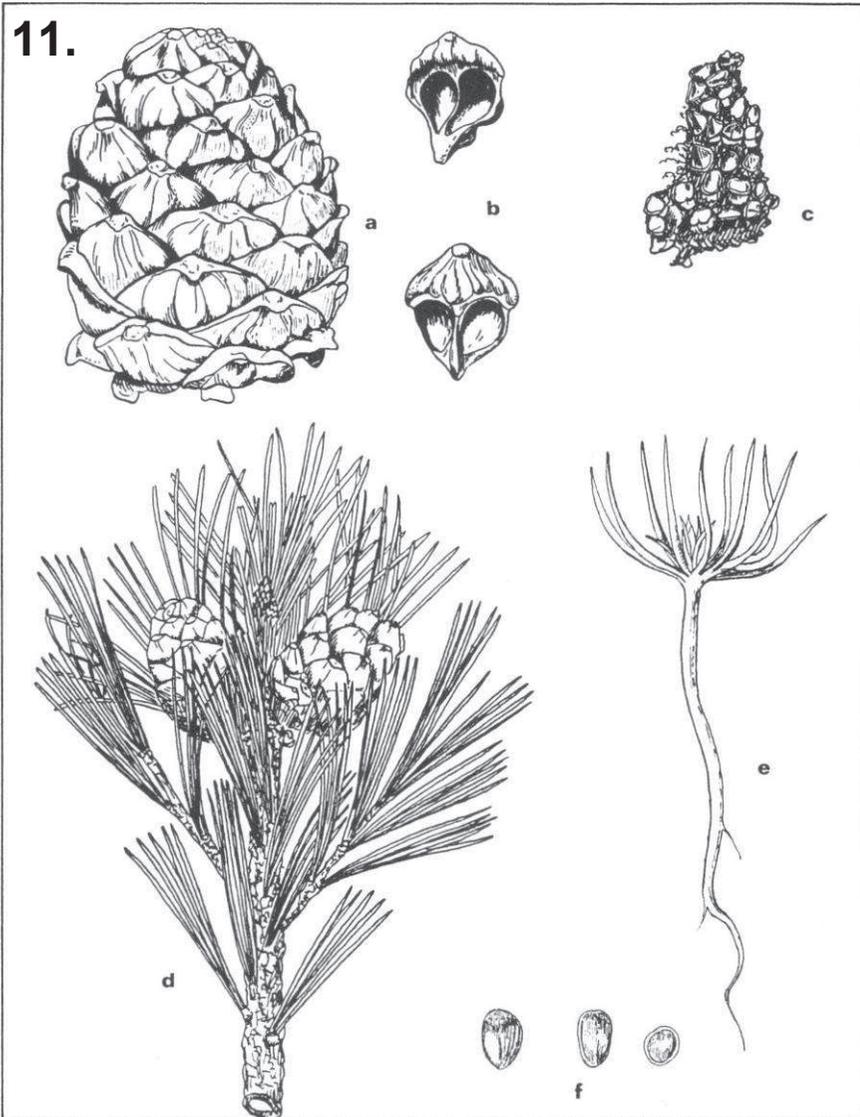
*Pinus sylvestris*: a) cone, b) needle - cross section, c) detail of twig, d) unfolding needles, e) shoot with male inflorescence, f) 2 years plant, g) seedling, h) winged seed, i) wing, j) detail of wing, k) cones, l) fertile scales with seeds, n), m) needles



1. *Pinus uncinata* ssp. *uliginosa*: a) shoot with female inflorescences and immature cone, b) male inflorescences, c) seed, d) seedling, e) cone  
2. *Pinus mugo*: cone

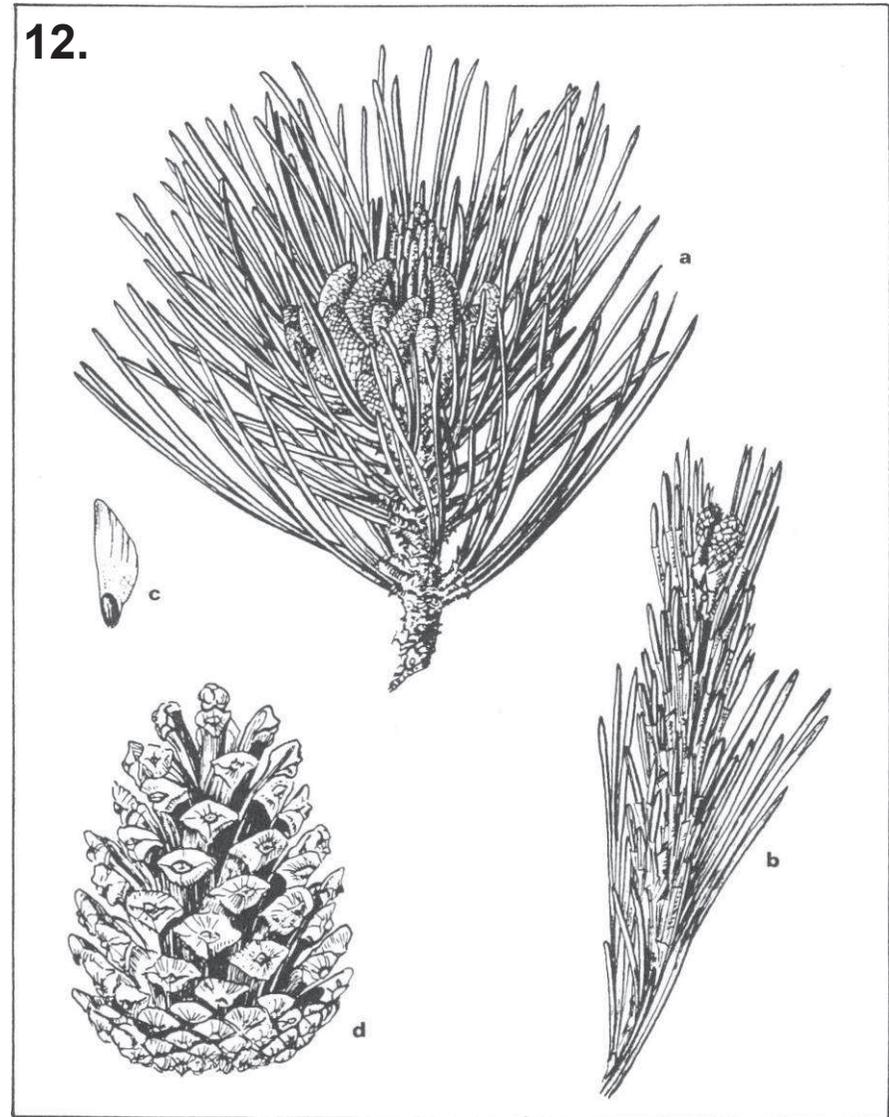


11.

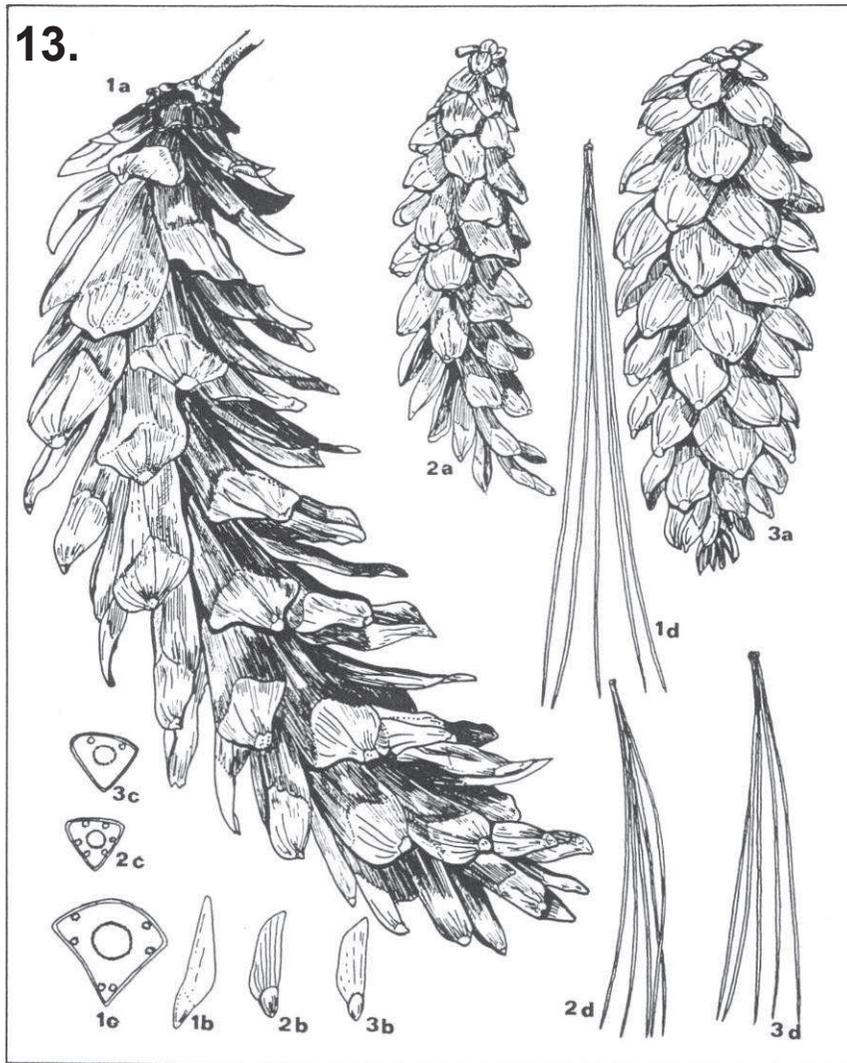


*Pinus cembra*: a) cone, b) fertile scales, c) rest of cone, d) shoot with immature cones, e) seedling, f) seeds.

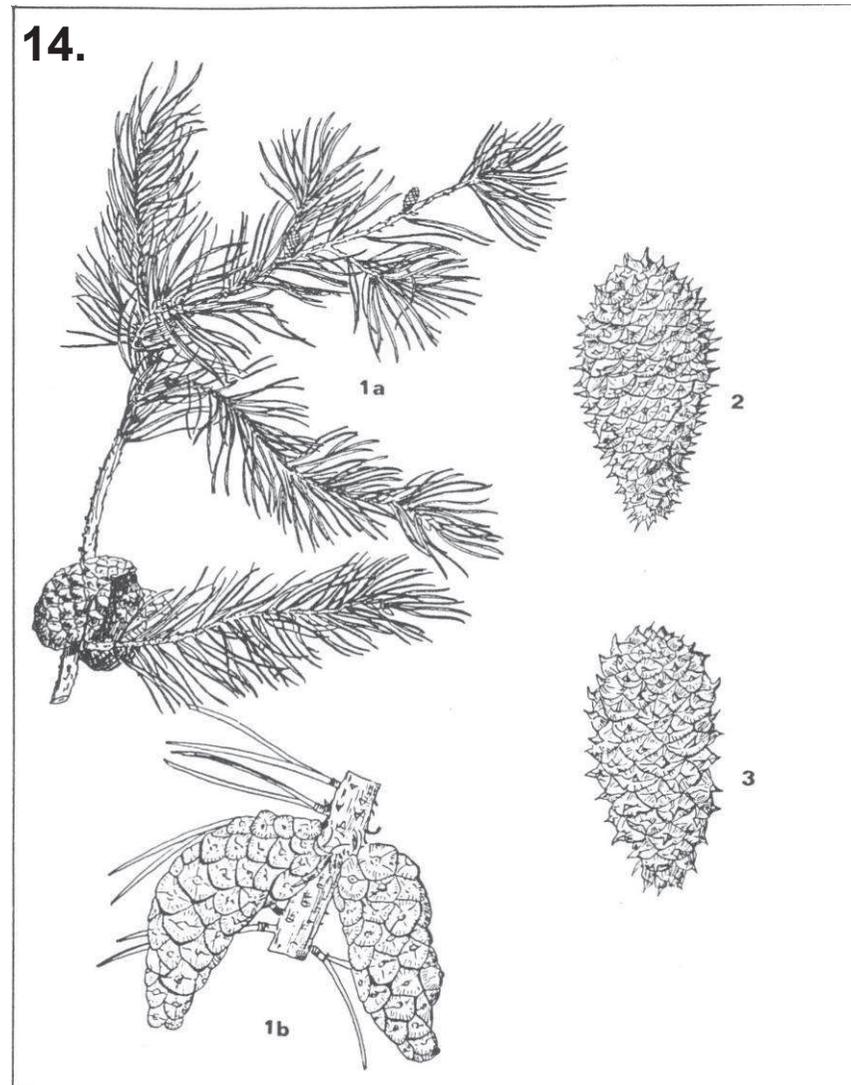
12.



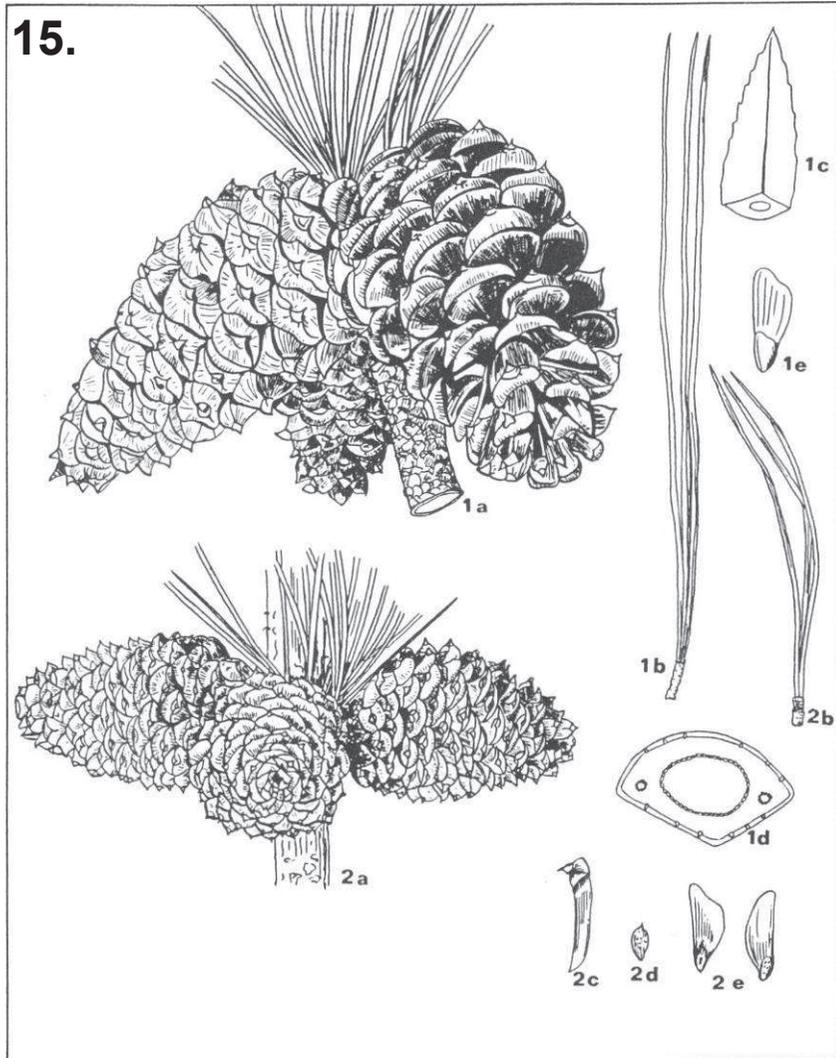
*Pinus nigra*: a) shoot with male inflorescences, b) female inflorescences, c) seed, d) cone



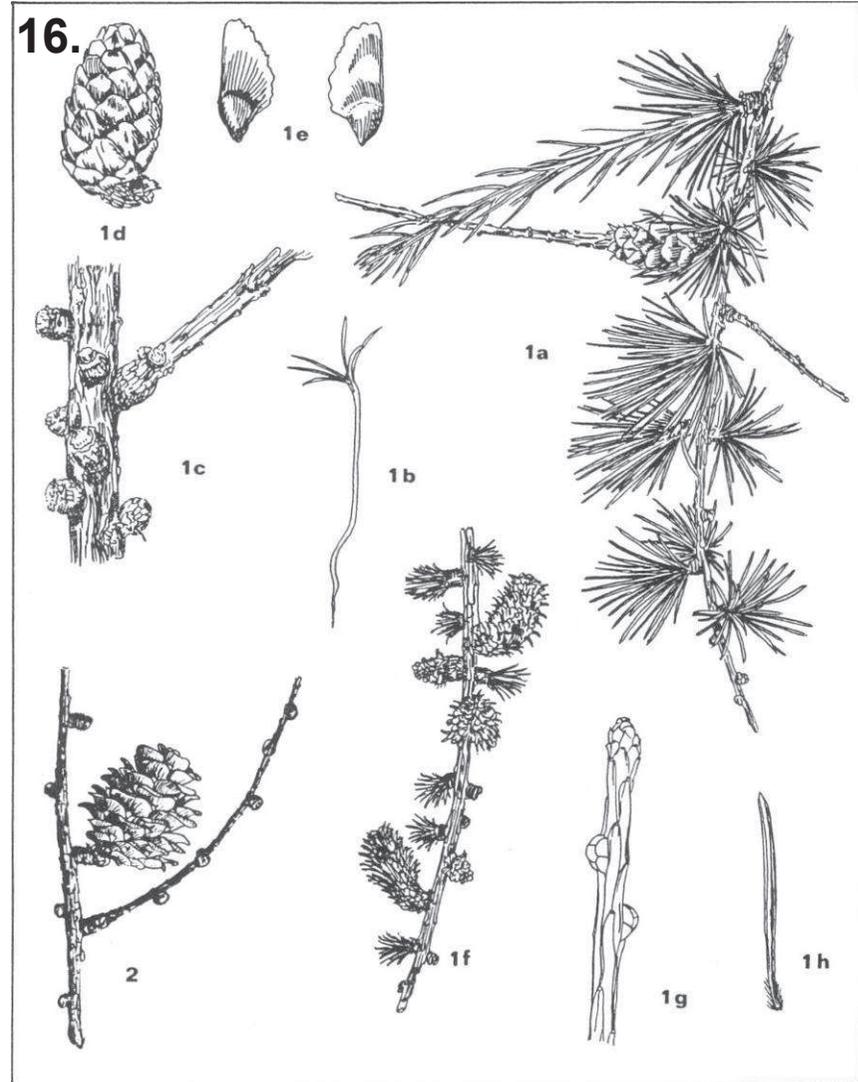
1. *Pinus wallichiana*: a) cone, b) seed, c) needle - cross section (15x),  
 d) brachyblast with needles  
 2. *Pinus strobus*: a) cone, b) seed, c) needle - cross section (10x), d) brachyblast with needles  
 3. *Pinus peuce*: a) cone, b) seed, c) needle - cross section (10x), d) brachyblast with needles



1. *Pinus banksiana*: a) shoot with female inflorescences and ripen cones, b) cones  
 2. *Pinus contorta*: cone  
 3. *Pinus murrayana*: cone

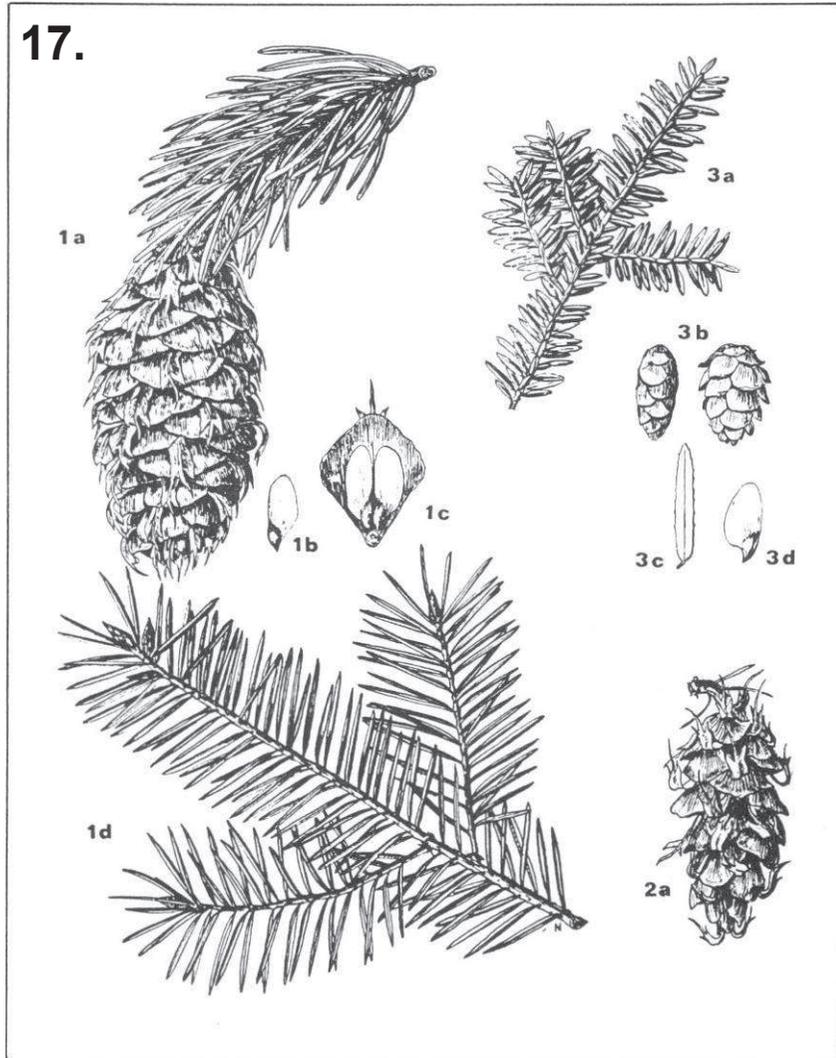


1. *Pinus ponderosa*: a) shoot with cones, b) brachyblast with needles, c) needles top, d) needle - cross section (35x)  
 2. *Pinus rigida*: a) shoot with cones, b) brachyblast with needles, c) fertile scale, d) seed, e) winged seed



1. *Larix decidua*: shoot, b) seedling, c) unfolding buds, d) cone, e) seeds, f) shoot with female inflorescences, g) winter buds, h) needle  
 2. *Larix kaempferi*: twig with cone

17.

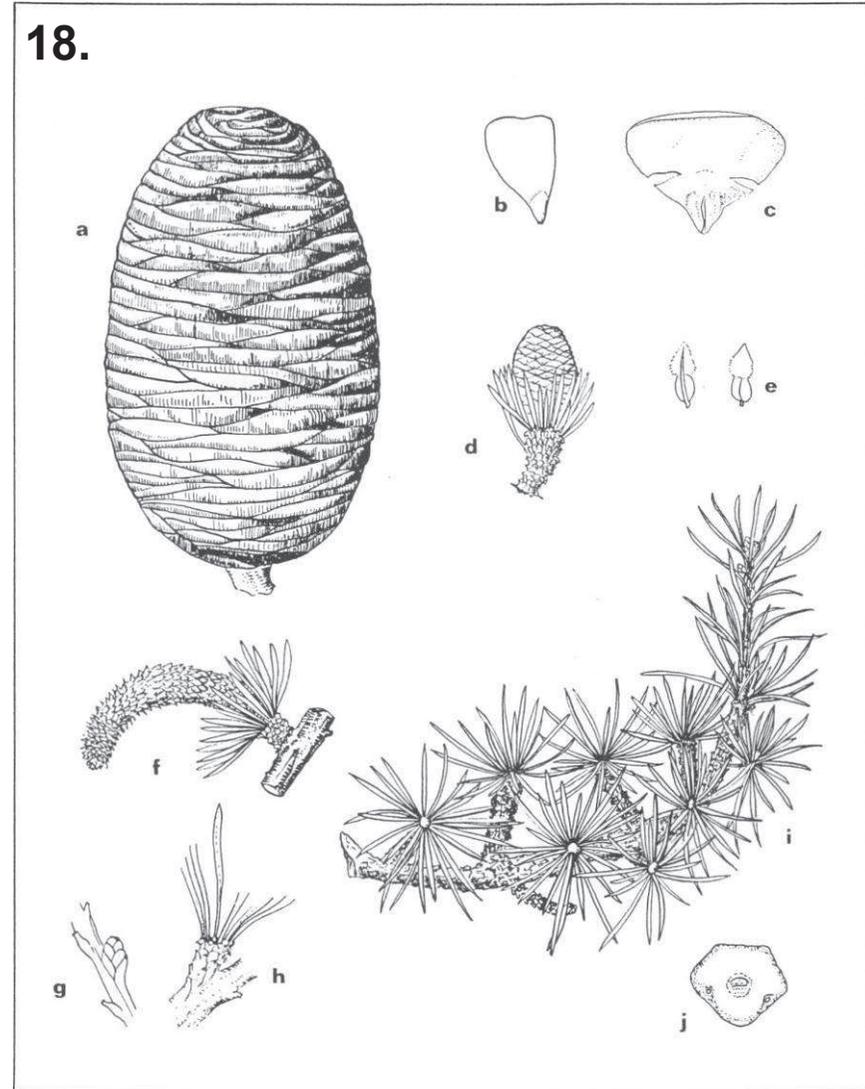


1. *Pseudotsuga menziesii*: a) shoot with cone, b) seed, c) fertile scale with seeds, d) shoot with winter buds

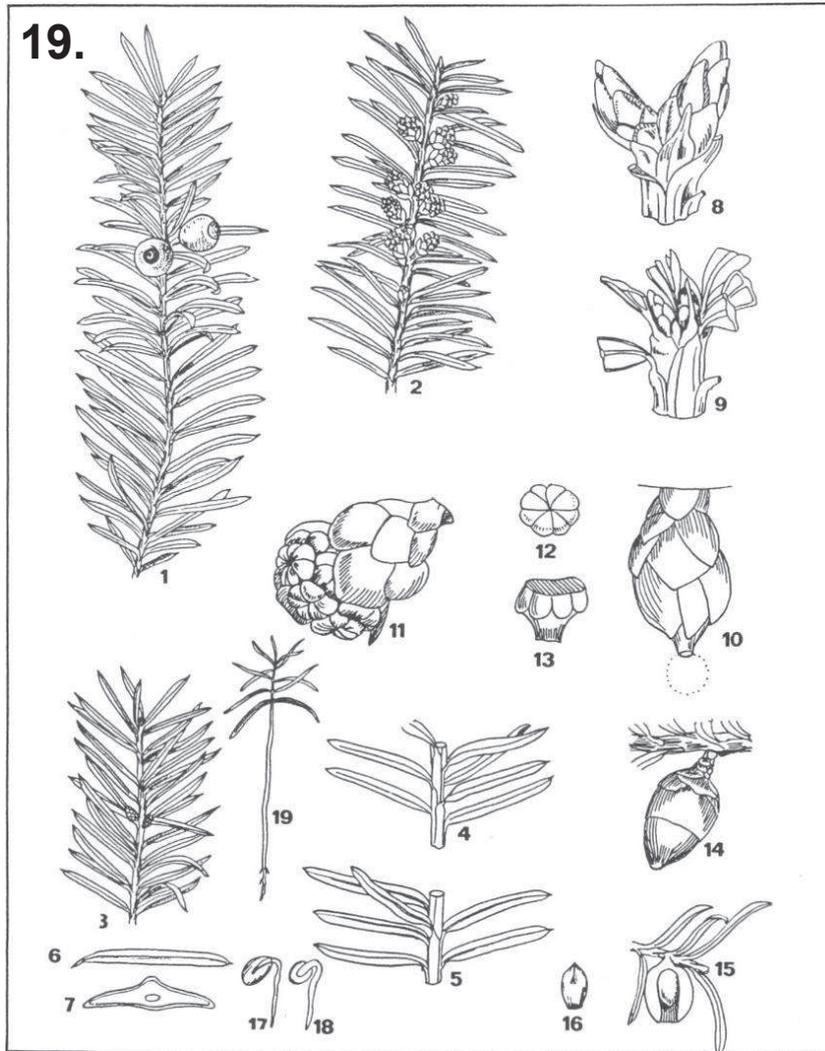
2. *Pseudotsuga glauca*: a) cone

3. *Tsuga canadensis*: a) shoot, b) cones, c) needle (2x), seed (2x)

18.



*Cedrus libani*: a) immature cone, b) seed, c) fertile scale, d) female inflorescences, e) anthers, f) male inflorescences, g) winter bud (3x), h) brachyblast with needles, i) shoot, j) needle - cross section (15x)

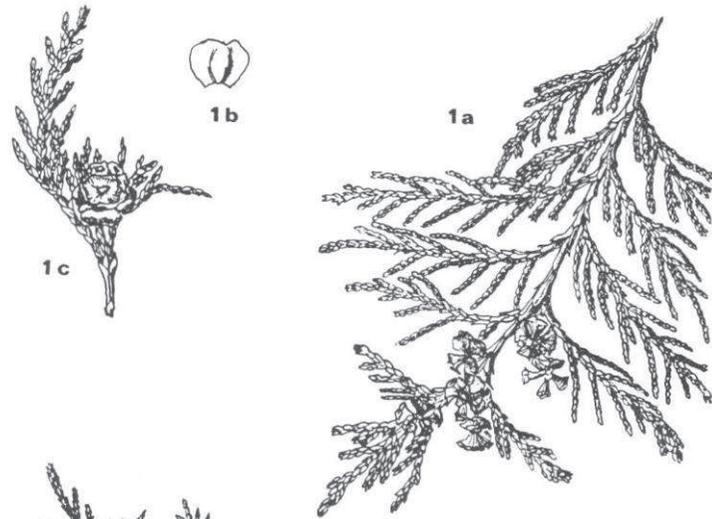


**Taxus baccata:** 1) shoot with fruits, 2) shoot with male inflorescences, 3) female flower, 4), 5) needles, 6) needle, 7) needle - cross section (15x), 8) top of the shoot (4x), 9) terminal bud (4x), 10) female flower (15x), 11) male inflorescence (15x), 12), 13) stamens (20x), 14) immature seed, 15) seed with aril, 16) seed, 17), 18) germinated seed, 19) seedling



**1. Juniperus communis:** a) shoot with male inflorescences, b) seeds, c) shoot with fruits, d) needles - detail  
**2. Juniperus sabina:** shoot with fruits, b) shoot, c) seeds

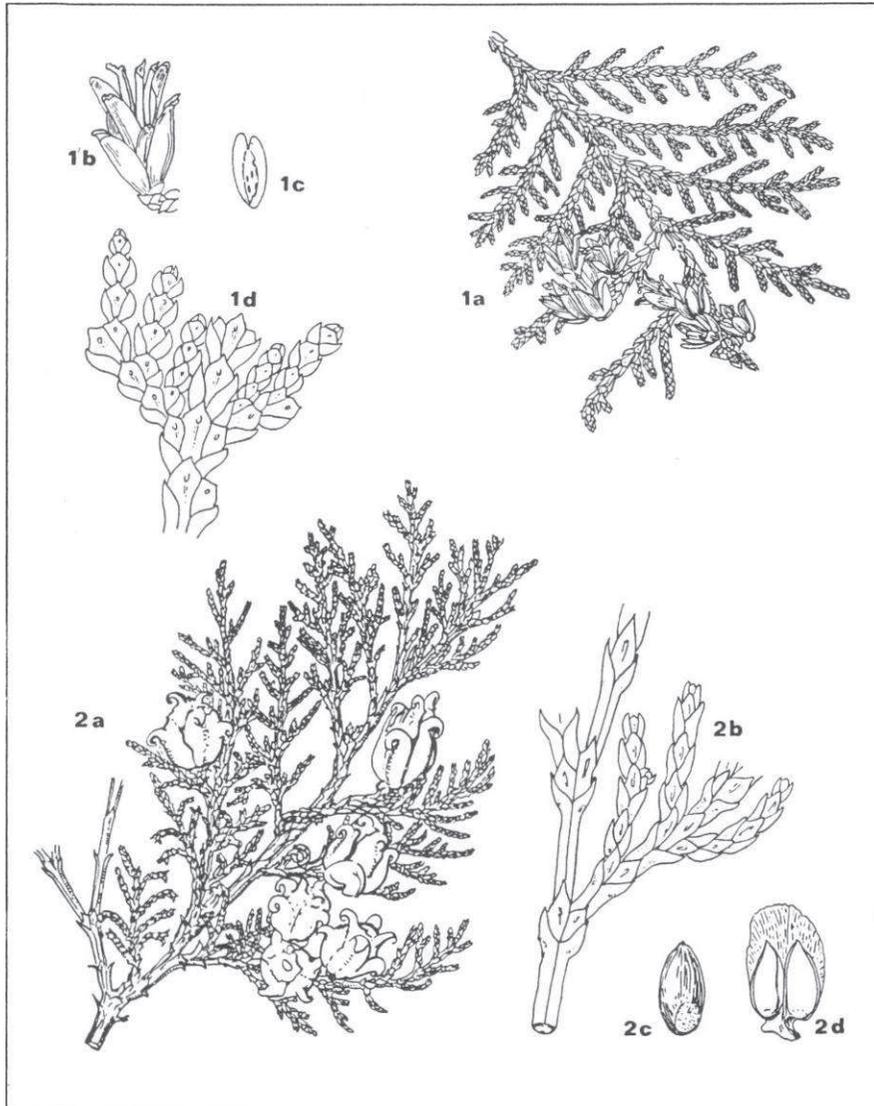
21.



1. *amaecypris lawsoniana*: a) shoot with cones, b) seed, c) cone

2. *Juniperus virginiana*: a) shoot with fruits, b) scale like leaves, c) needles

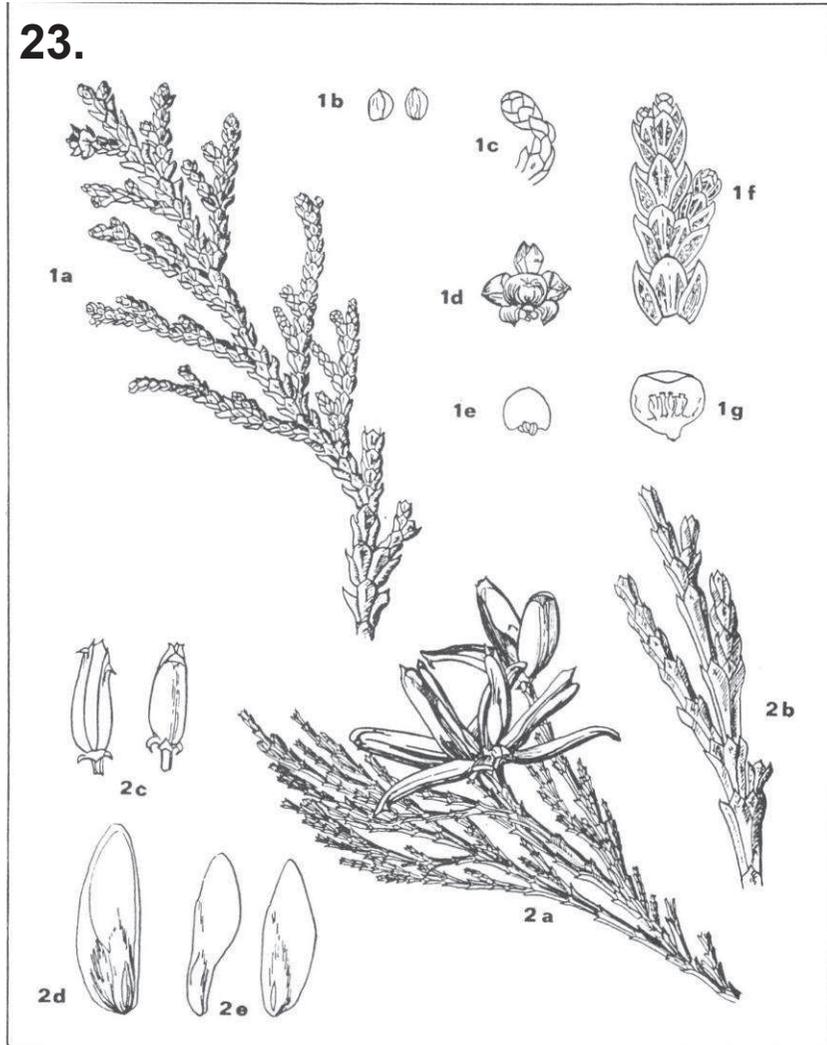




1. *Thuja occidentalis*: a) shoot with cones, b) cone (2x), c) seed, d) branchlet (shoot) (3x)

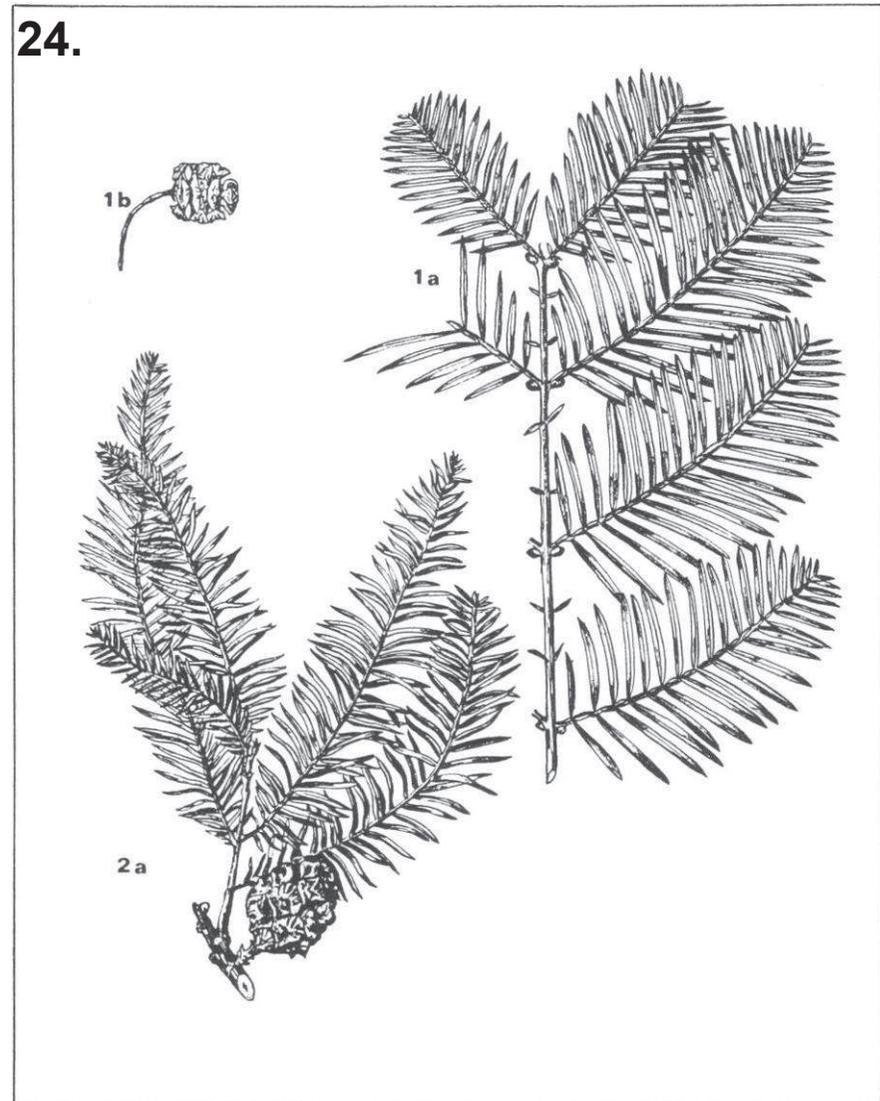
2. *Platycladus orientalis*: a) shoot with immature cones, b) shoot (3x), c) seed, d) fertile scale

23.



1. *Thujopsis dolabrata*: a) shoot with cone, b) seed (2x), c) male inflorescence, d) open cone, e) anther (5x), f) shoot from below, g) fertile scale with 4 ovules (5x)  
 2. *Calocedrus decurrens*: a) shoot with cones, b) shoot (3x), c) immature cones, d) fertile scale with seed (2x), e) seeds (2x)

24.



1. *Metasequoia glyptostroboides*: a) shoot, b) cone  
 2. *Taxodium distichum*: a) shoot with cone

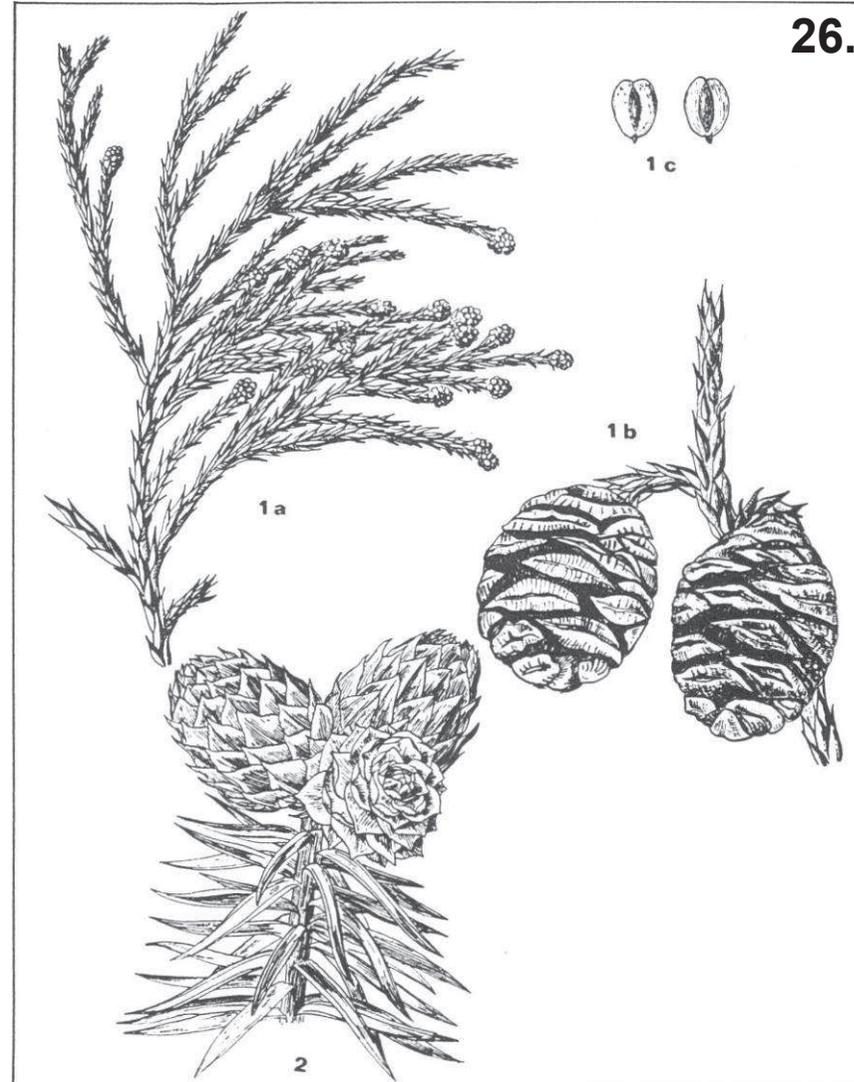


25.

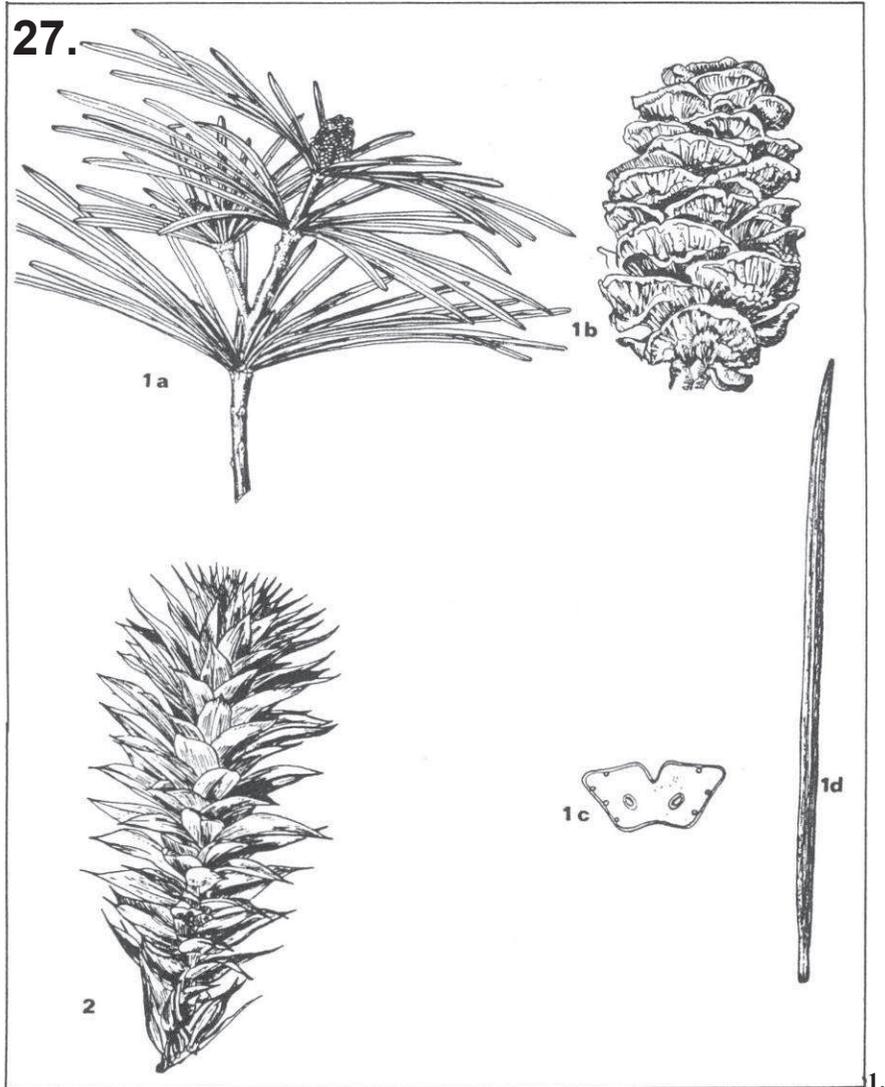


*Cryptomeria japonica*: a) shoot with female inflorescences, b) seed (2x), c) shoot with cones, d) shoot with male inflorescences

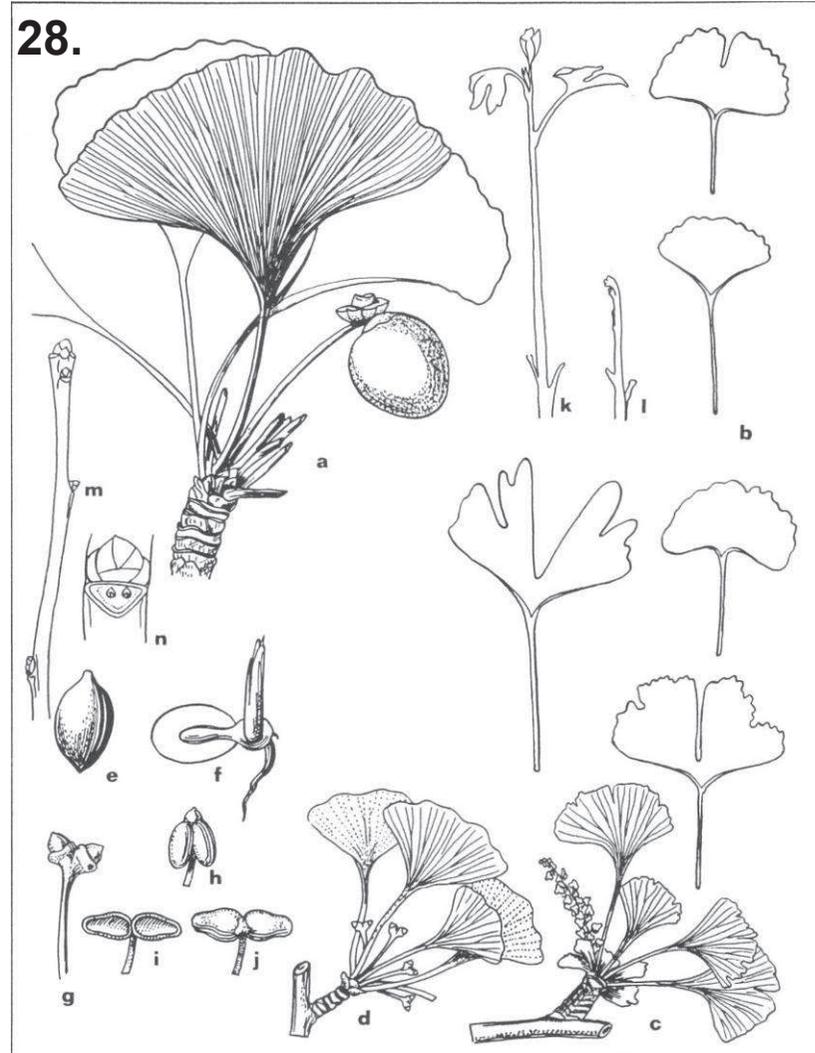
26.



1. *Sequoiadendron giganteum*: a) shoot with male inflorescences, b) shoot with cones, c) seeds (2x)  
 2. *Cunninghamia lanceolata*: shoot with cones



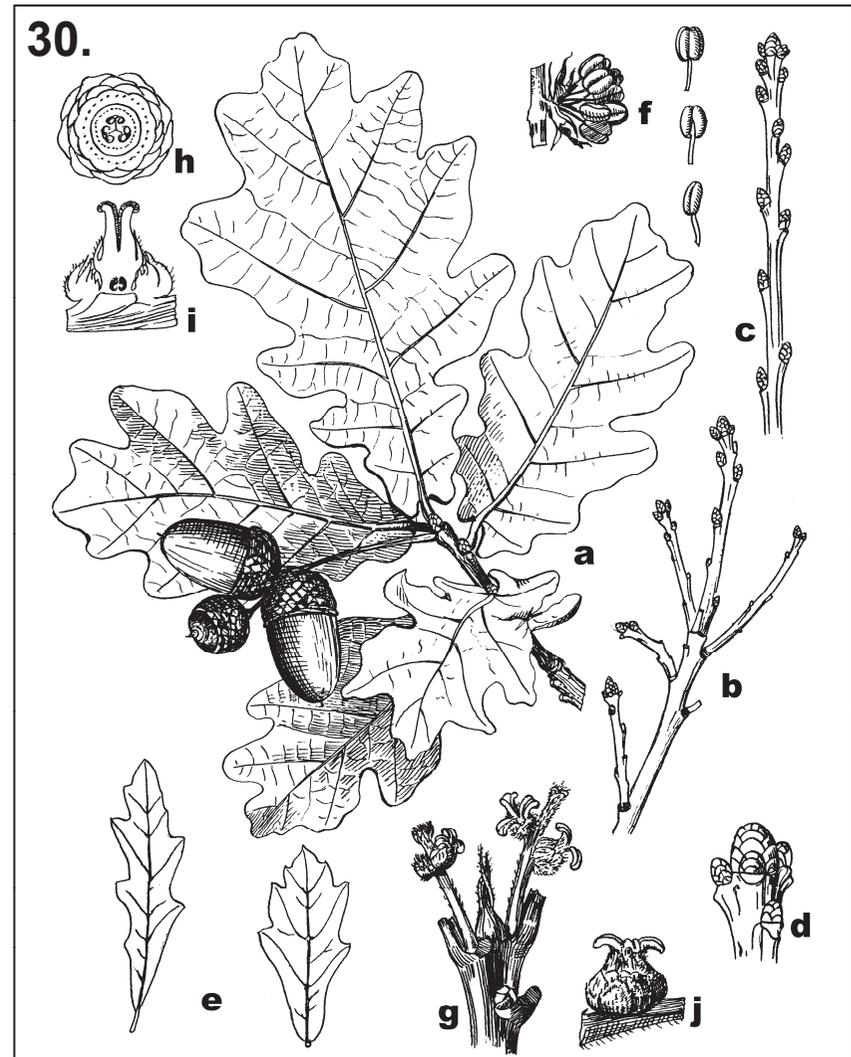
27. *Sciadopitys verticillata*: a) shoot with male inflorescences, b) cone, c) needle - cross section (6x)  
 2. *Araucaria araucana*: shoot and leaves



28. *Ginkgo biloba*: a) brachyblast with leaves and fruit, b) leaves blades, c) brachyblast with male inflorescences - reduced, d) brachyblast with flowers, e) seed obal, f) germinated seed, g) female flower - sporangiofor (2x), h-j) stamens (6x), k) one year old plant, l) seedling, m) shoot, n) winter bud

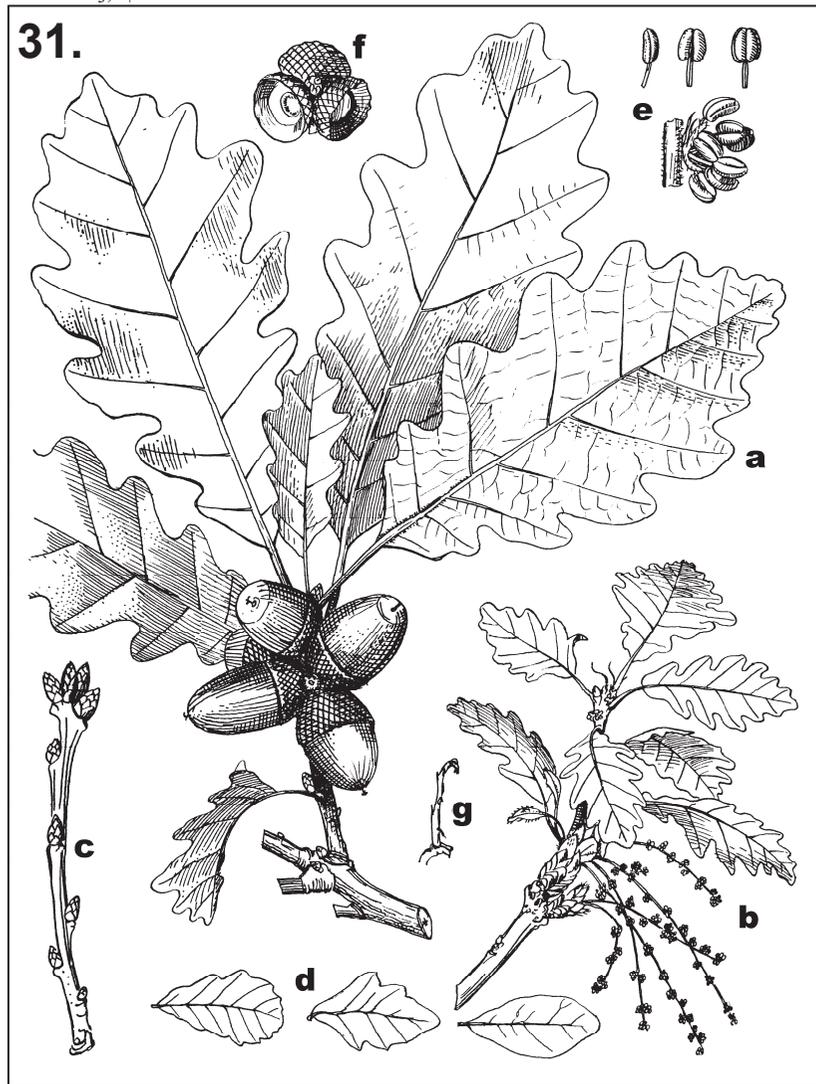


*Fagus sylvatica*: a) fructing twig, b) shoot,  
 c) short shoot, d) bud, e) shoot cross-section, f) leaf scar,  
 g) ♂ flower, h) ♀ flower, i) beechnut, j) nut cross-section, k) seedling

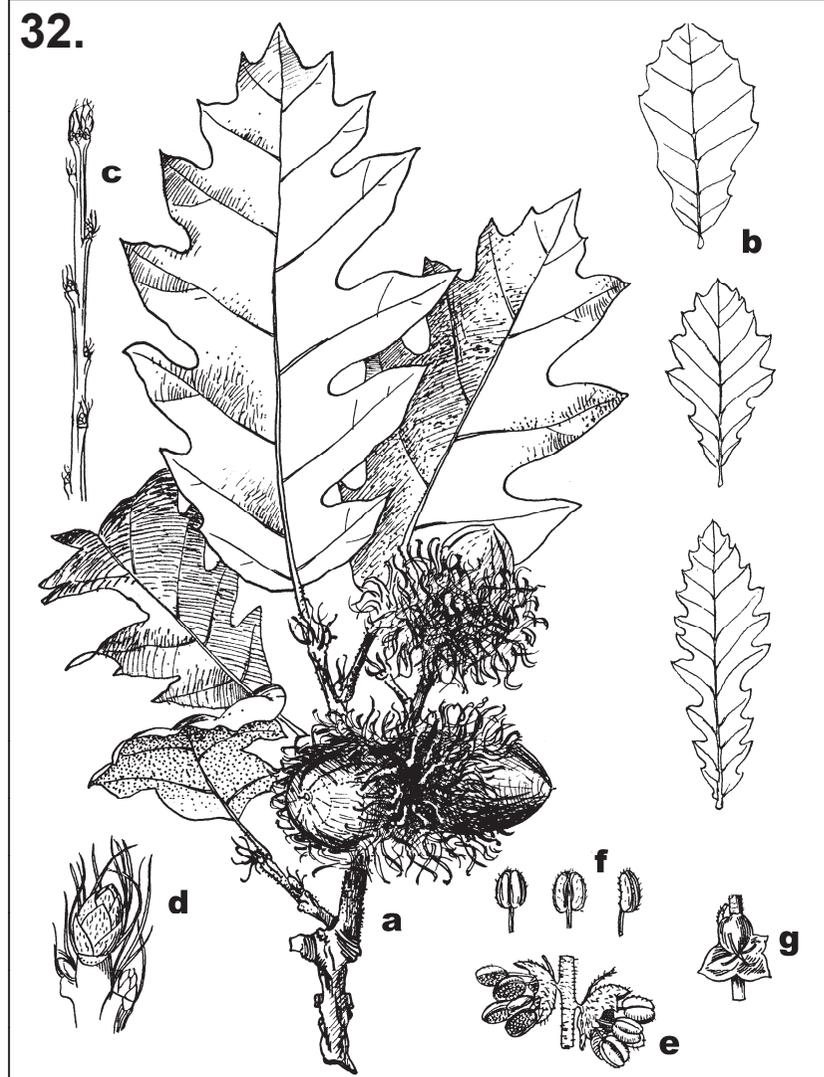


*Quercus robur*: a) fructing twig, b) branchlet with short shoots,  
 c) shoot, d) terminal buds, e) leaves, f) ♂ flower and anthers,  
 g) ♀ flowers, h) ♀ flower cross-section, i) ♀ flower, longitudinal section,  
 j) ♀ flower cross-section

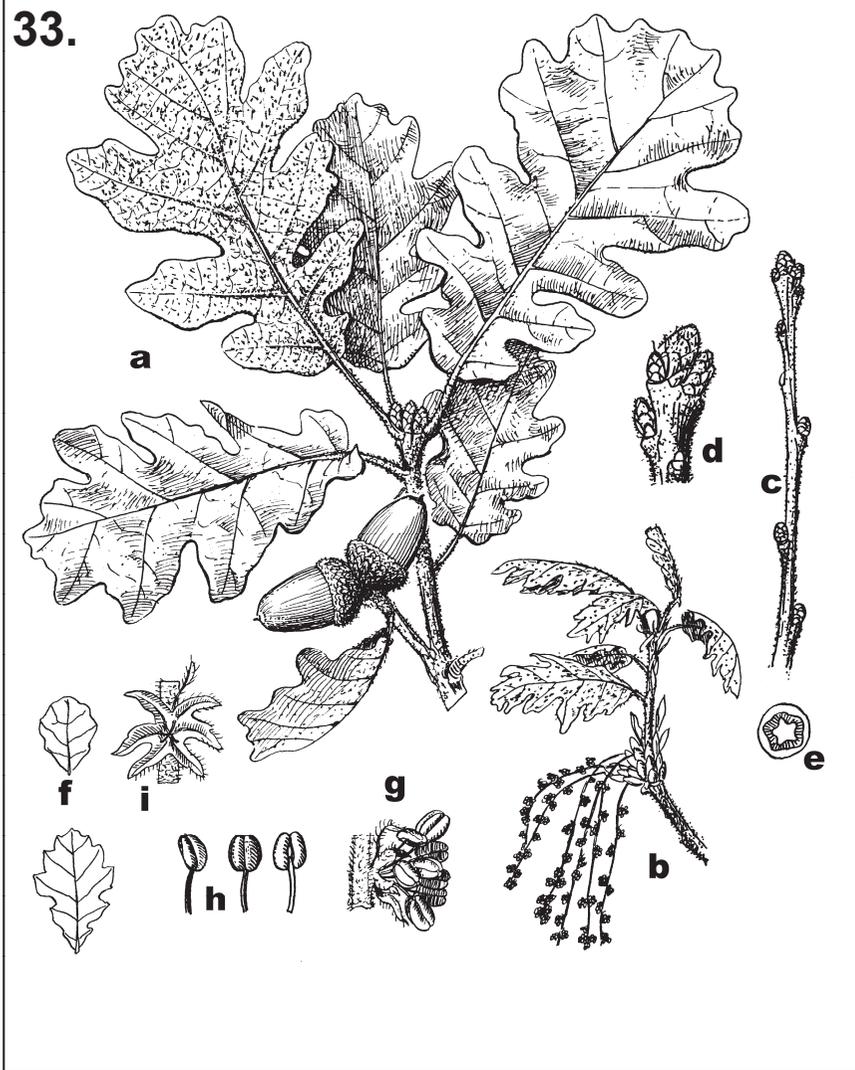
j) ♀ flower



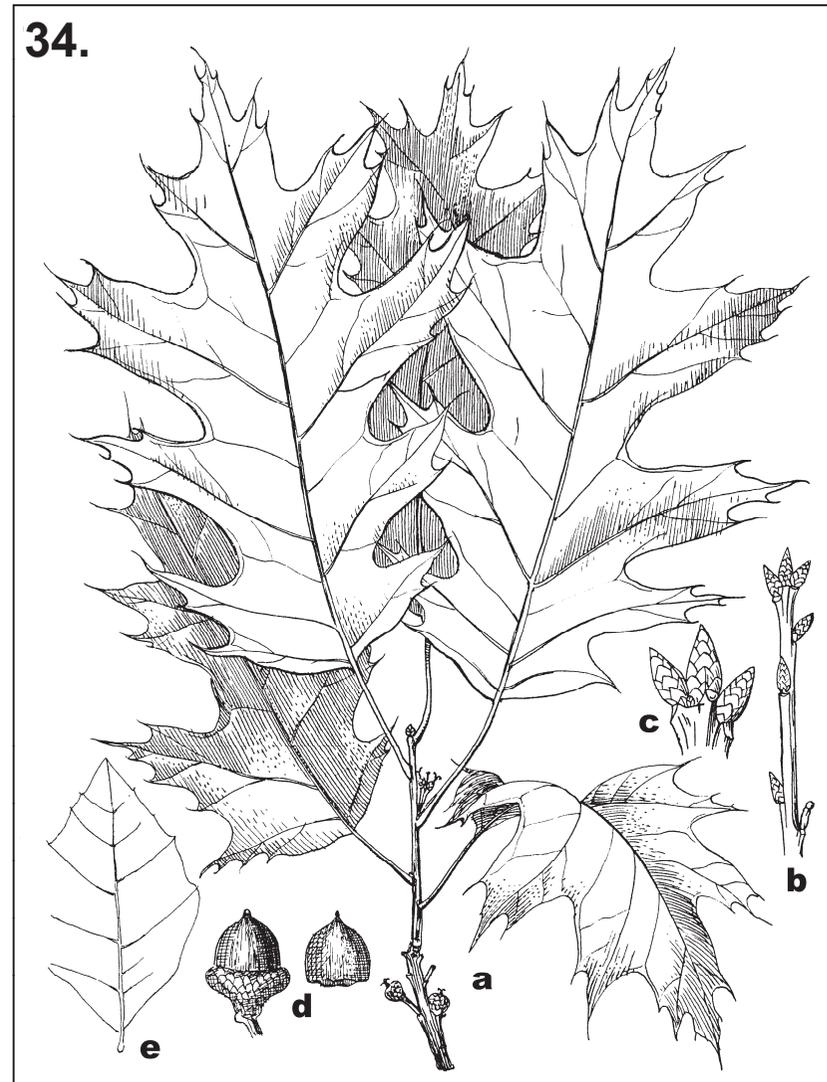
*Quercus petraea*: a) b) branchlet with ♂ and ♀ flowers,  
c) buds, d) leaves, e) ♂ flower and anthers, f) caps, g) seedling



*Quercus cerris*: a) fruting twig, b) types of leaves, c) shoot with buds and stipules,  
d) bud with stipules, e) ♂ flowers, f) anthers, g) ♀ flower

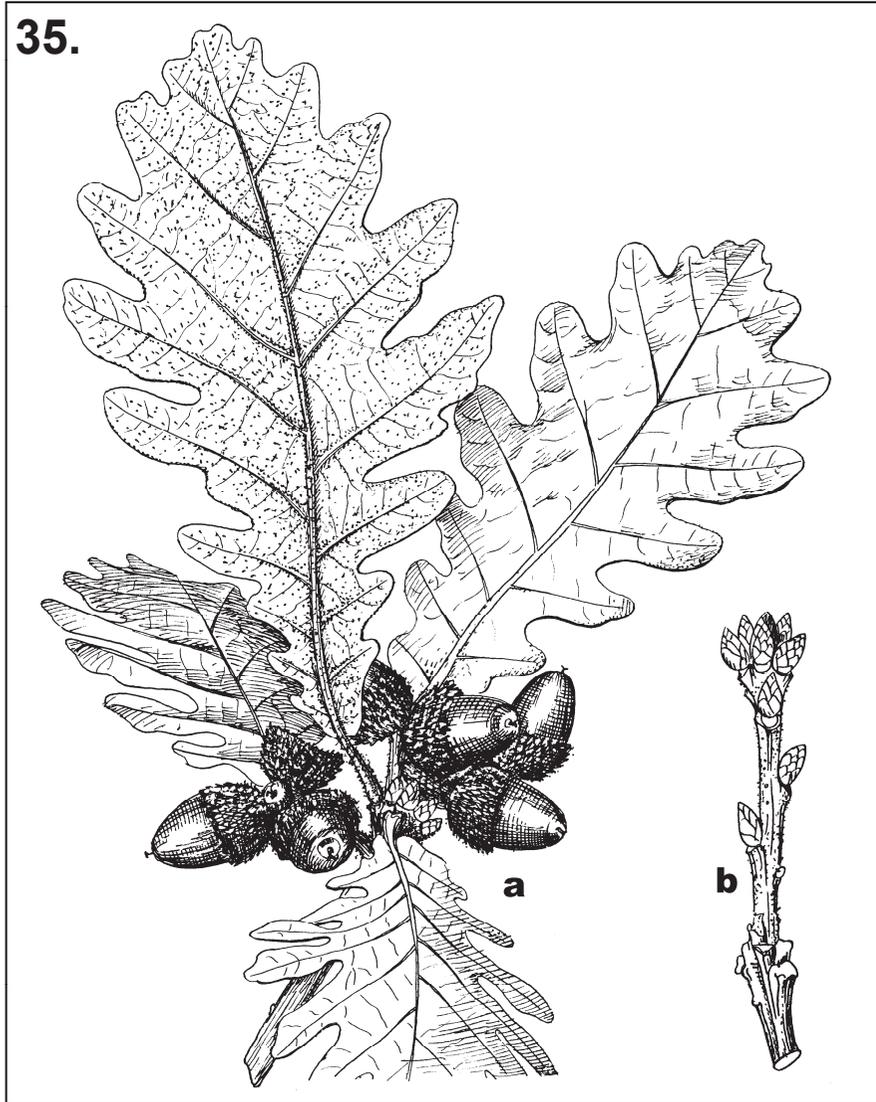


*Quercus pubescens*: a) fructing twig, b) shoot with ♂ inflorescence, c) shoot with buds, d) terminal buds, e) twig cross-section, f) types of leaves, g) ♂ flower, h) anthers, i) ♀ flower



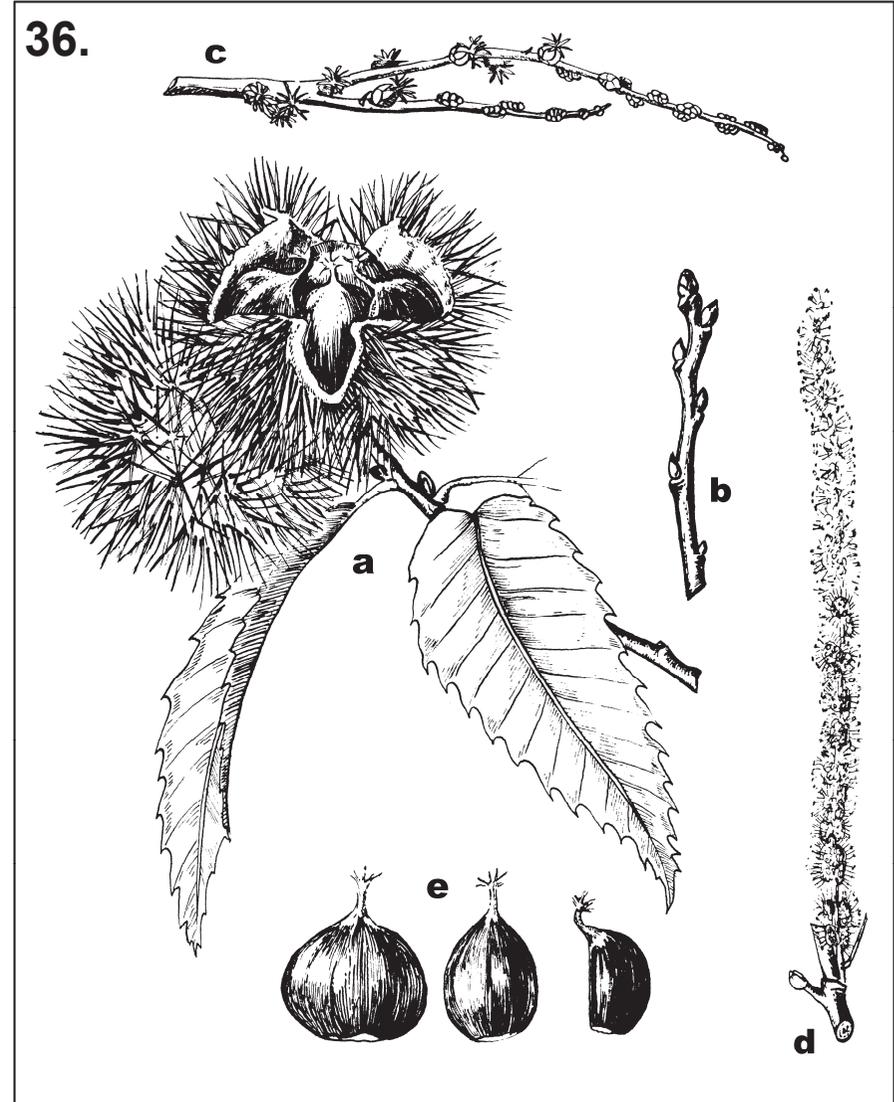
*Quercus rubra*: a) twig with leaves, ♀ flowers and one year old acorns, b) shoot with buds, c) terminal buds, d) acorns, e) other shape of leaf

35.

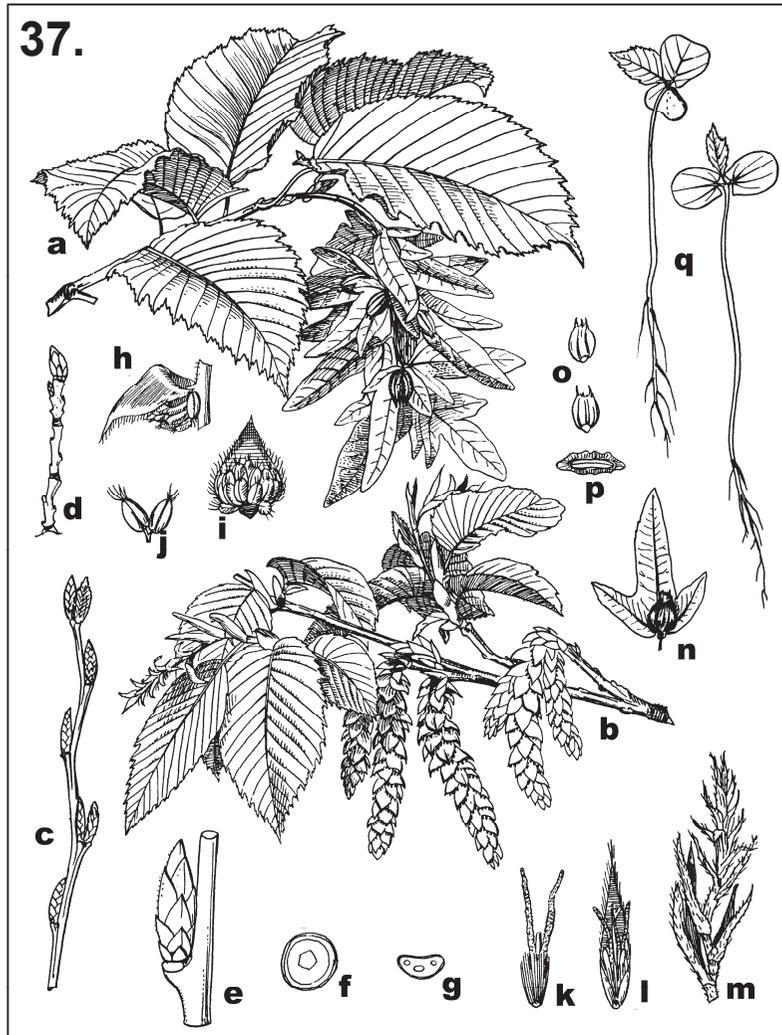


*Quercus franeetto*: a) fructing twig, b) shoot with buds

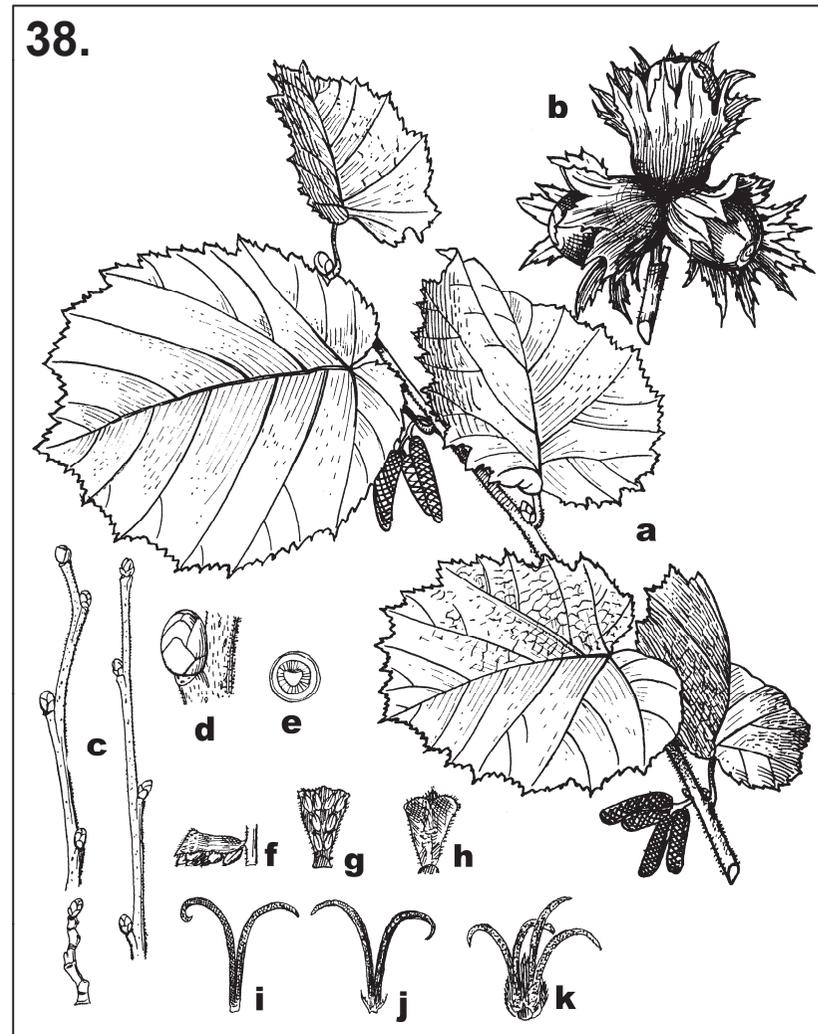
36.



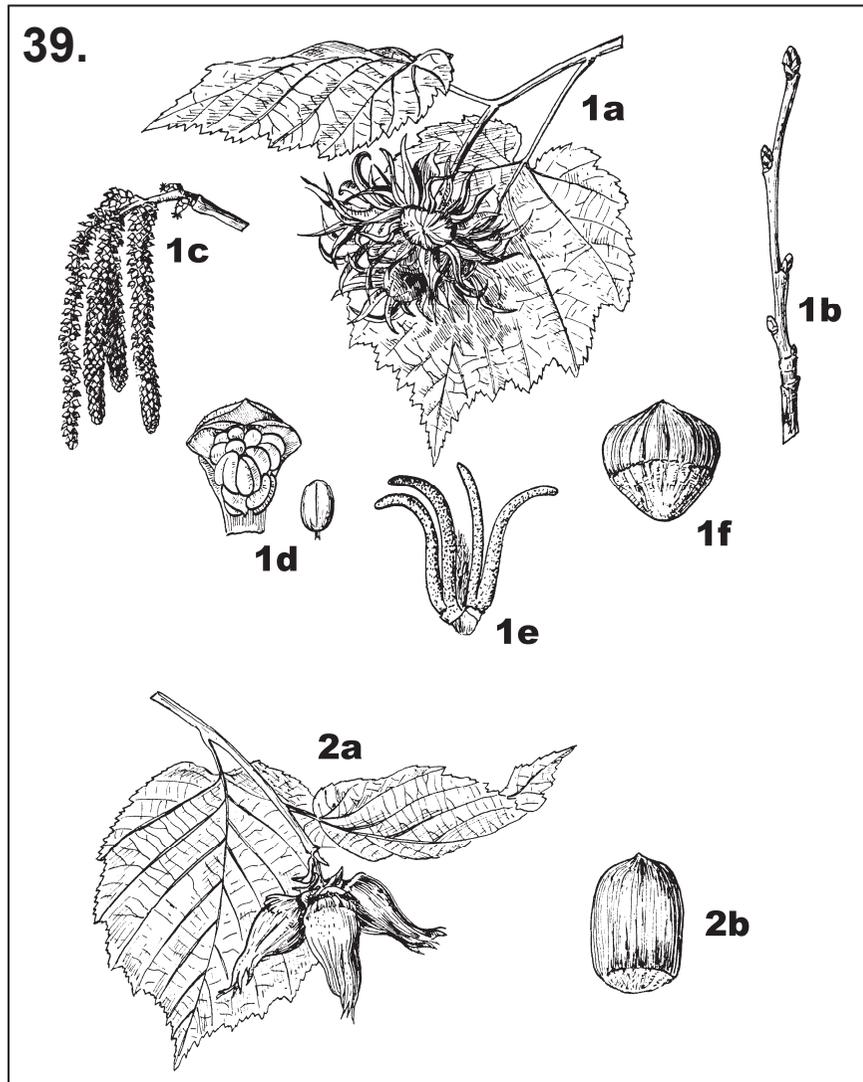
*Castanea sativa*: a) fructing twig, b) shoot with buds, c) ♀ inflorescence, d) ♂ inflorescence, e) fruits



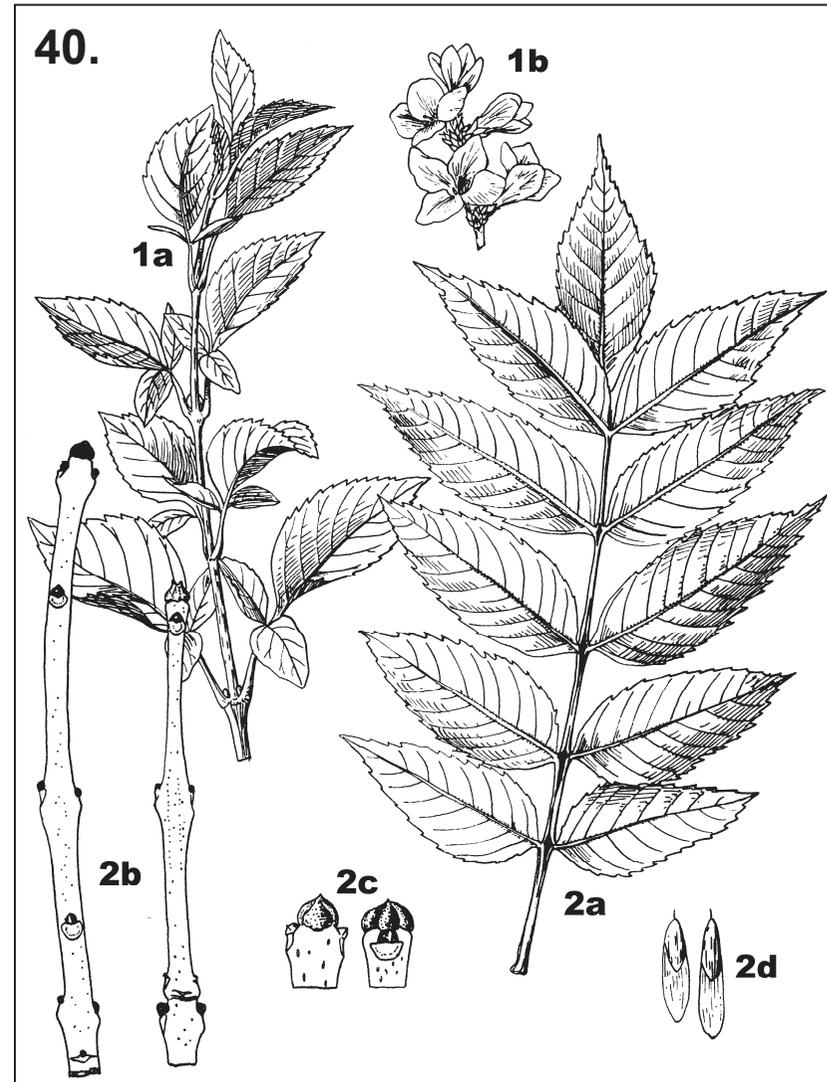
*Carpinus betulus*: a) fructing twig, b) branchlet with ♂ a ♀ inflorescences, c) shoot with buds, d) short twig, e) bud, f) twig cross-section, g) leaf scar, h) ♂ flower – side view, i) ♂ flower, j) anthers, k) ♀ flower with bractlet, l) two ♀ flowers, m) ♀ inflorescence, n) semeno s bractlet podpůrným listenem, o) seeds without bractlet, p) seed – cross-section, q) seedlings



*Corylus avellana*: a) twig with leaves and catkins, b) fruits – nuts, c) shoot with buds, d) one bud, e) twig – cross-section, f) scale of ♂ inflorescence with anthers – side view, g) scale of ♂ inflorescence with anthers, h) scale of ♂ inflorescence without anthers, i) ♀ flower without bract, j) ♀ flower with bract, k) ♀ flowers

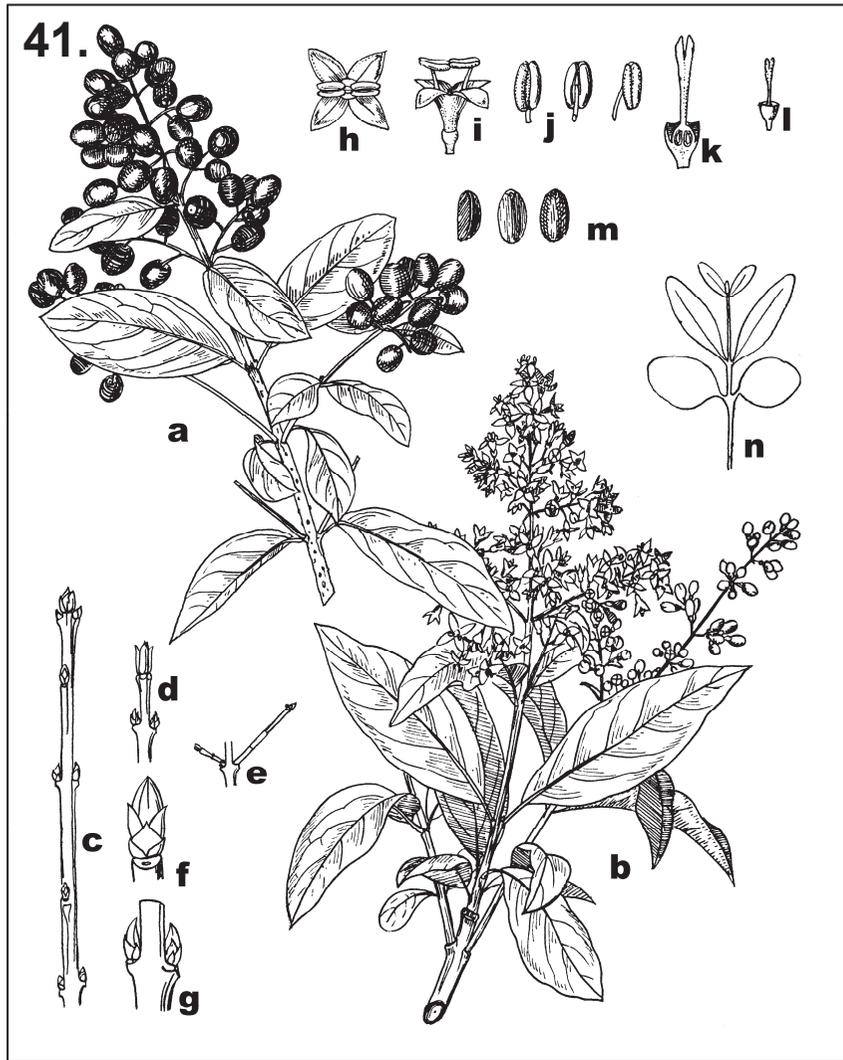


1. *Corylus colurna*: a) fructing twig, b) shoot with buds, c) ♂ inflorescence (catkin),  
d) scale of ♂ inflorescence with anthers, e) ♀ inflorescence, f) fruit  
2. *Corylus maxima*: a) fructing twig, b) nut

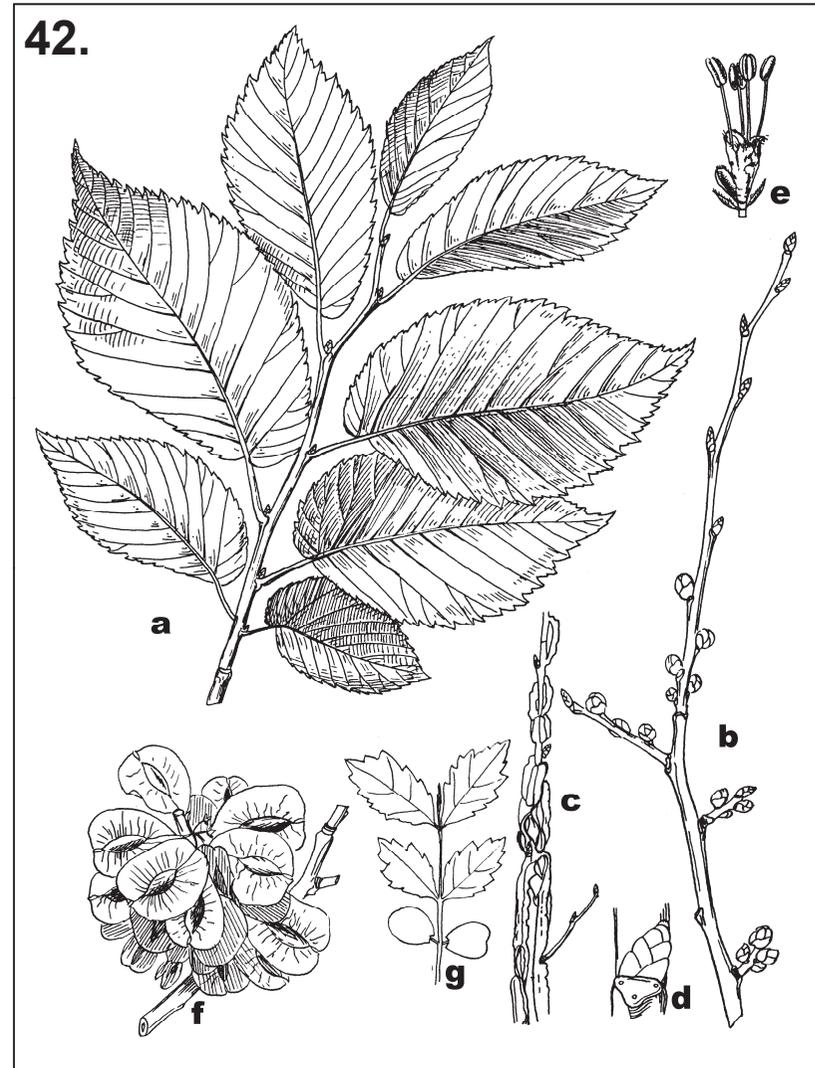


1. *Forsythia suspensa*: a) branchlet with leaves, b) flowers  
2. *Fraxinus excelsior*: a) pinnate leaf, b) shoot with buds,  
c) terminal buds, d) fruits

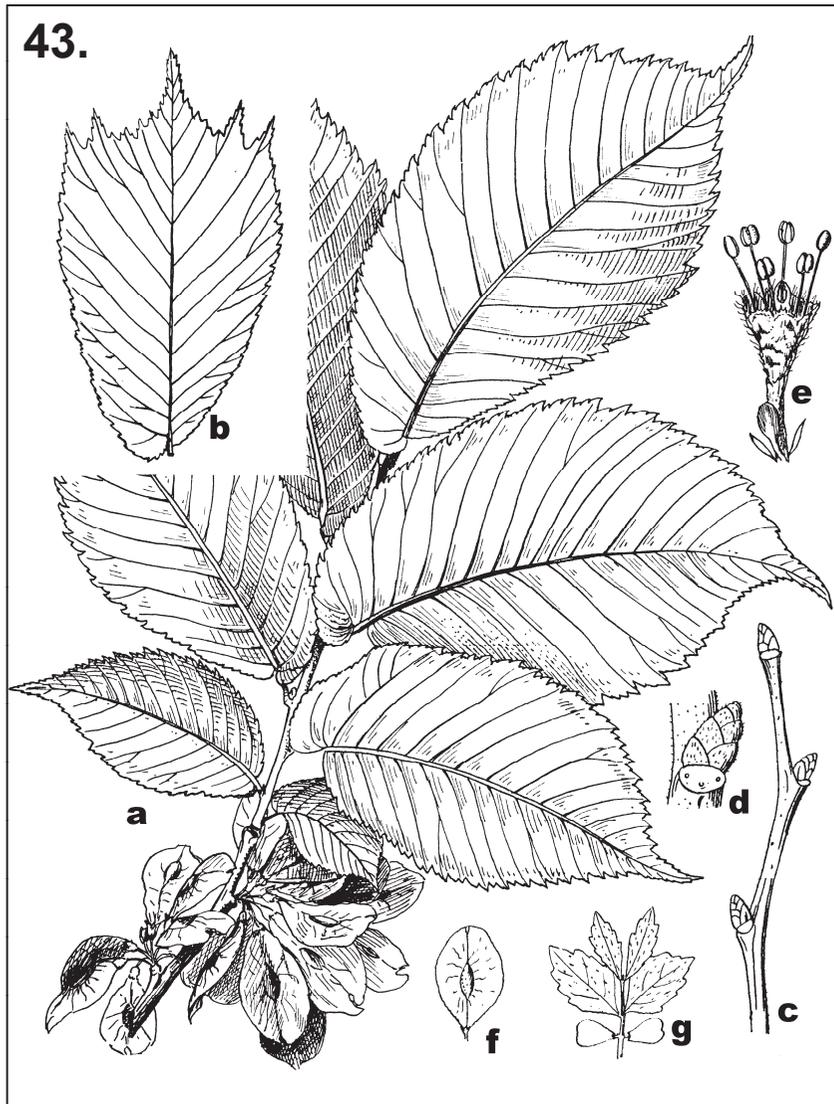




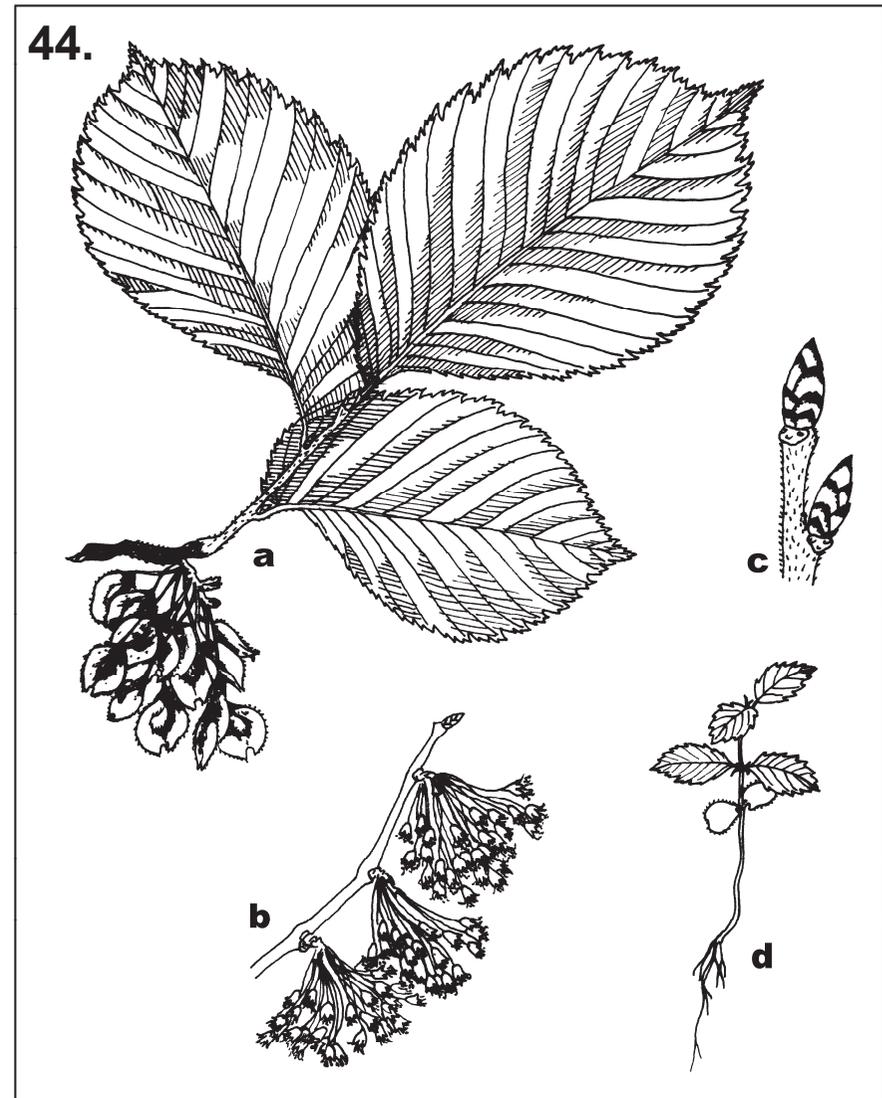
*Ligustrum vulgare*: a) fructing twig, b) branchlet with inflorescence, c) shoot with buds, d) terminal part of twig, e) short branchlets, f) terminal bud, g) buds, h) flower, i) flower – side view, j) anthers,



*Ulmus minor*: a) twig with leaves, b) branchlet with flower and leaf buds, c) twig with cork stripes, d) bud, e) flower, f) fruits, g) seedling



*Ulmus glabra*: a) fructing twig, b) lobed leaf, c) shoot with buds, d) bud, e) flower, f) fruit, g) seedling



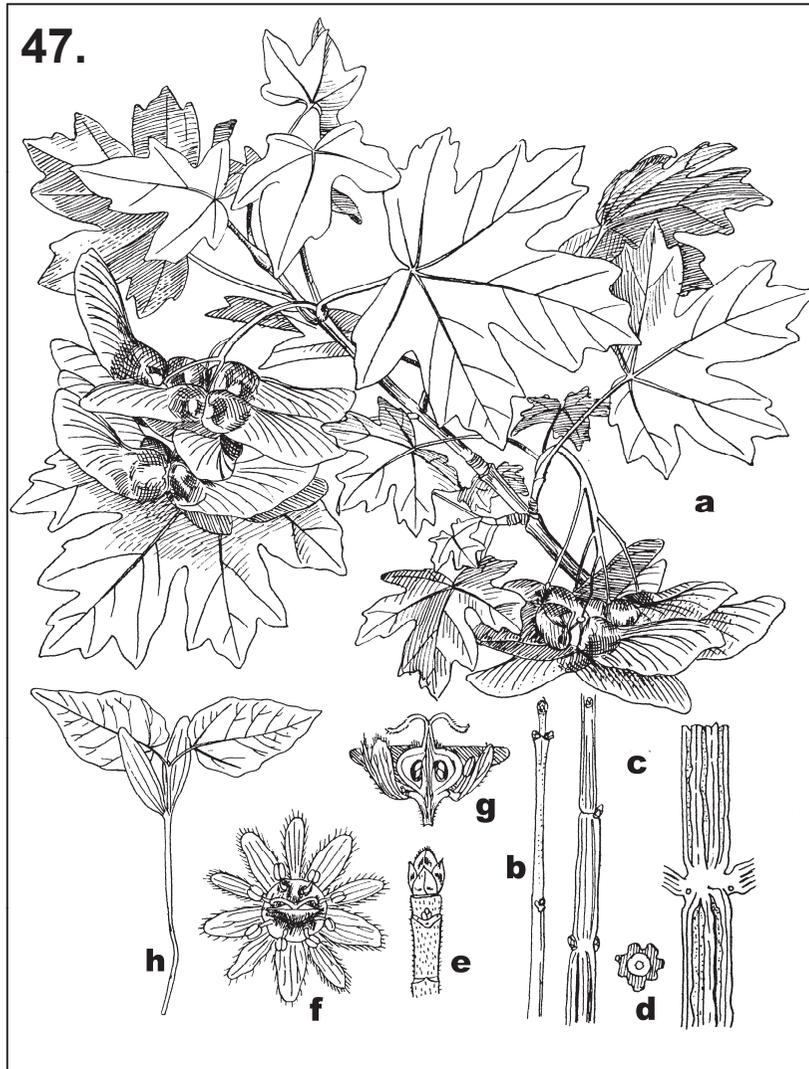
*Ulmus laevis*: a) fructing twig, b) flowering twig, c) buds, d) seedling



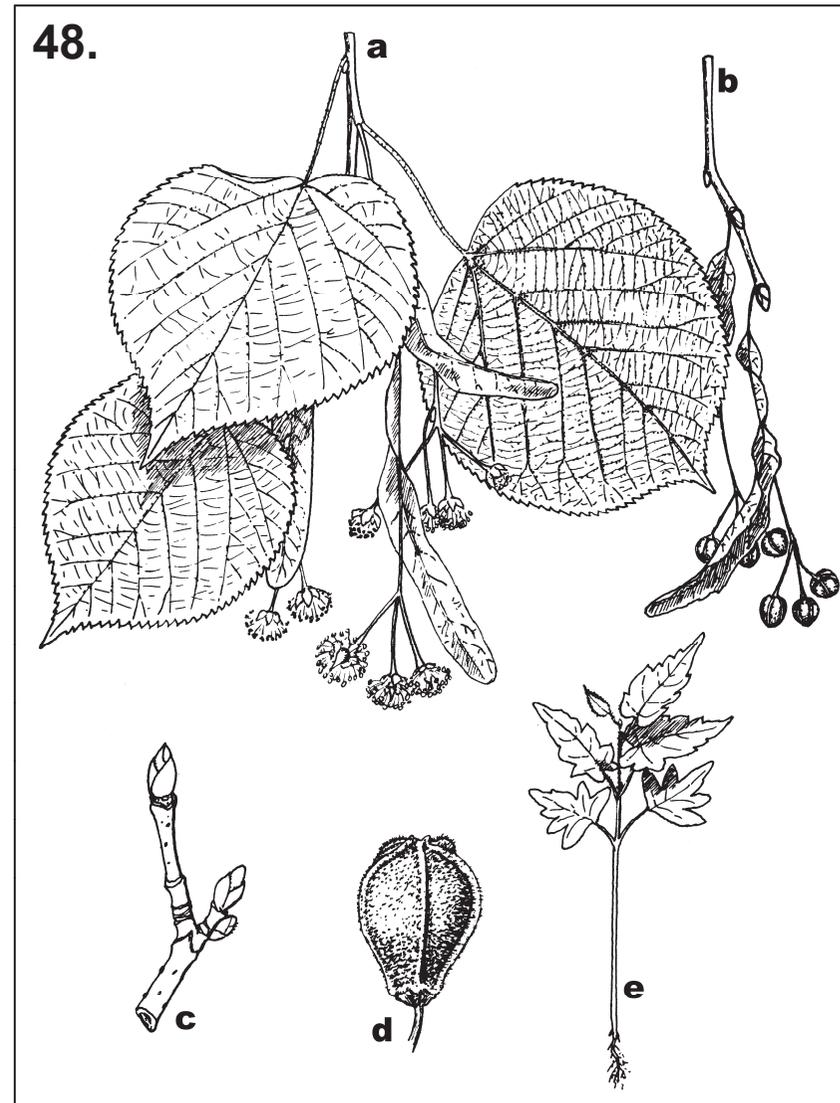
*Acer pseudoplatanus*: a) flowering twig, b) flowers,  
c) fruits, d) seed without cover



*Acer platanoides*: a) fructing twig, b) long shoot with buds,  
c) branchlet with short twigs, d) short twig, e) bud with leaf scar,  
f) terminal bud, g) ♂ flowers, h) seedling

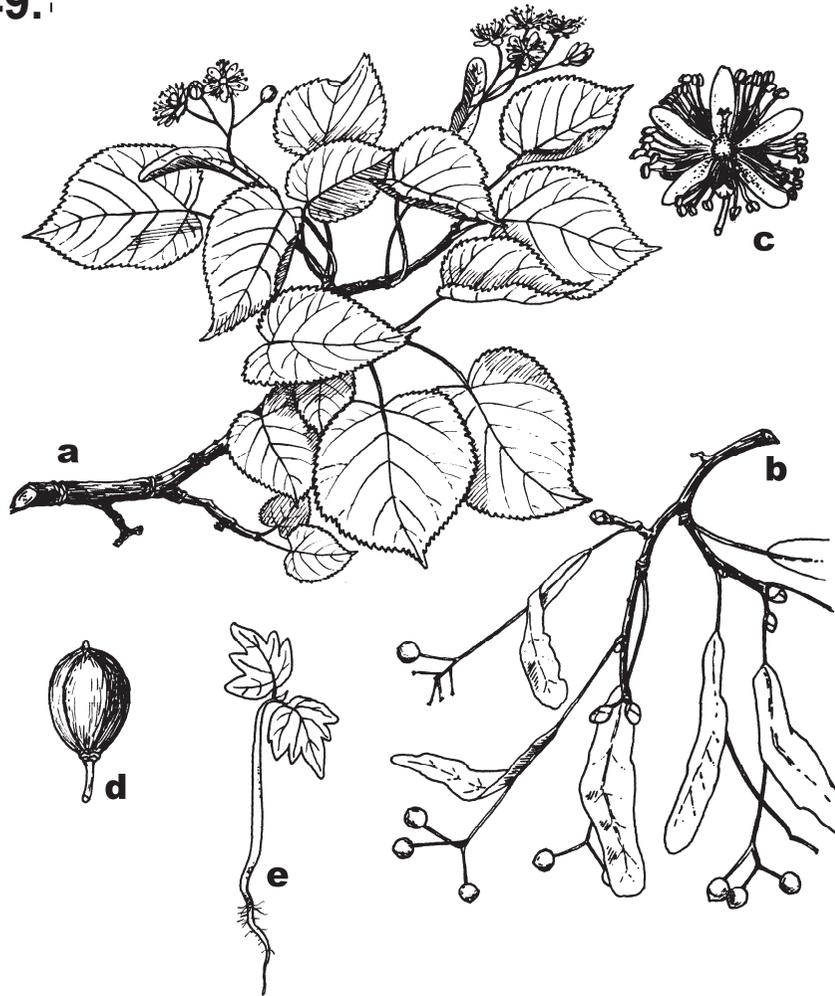


*Acer campestre*: a) fructing twig, b) shoot with buds, c) twig with cork stripes, d) twig with cork stripes – cross-section, e) terminal bud, f) ♂ flower, g) ♀ flower – longitudinal section, h) seedling



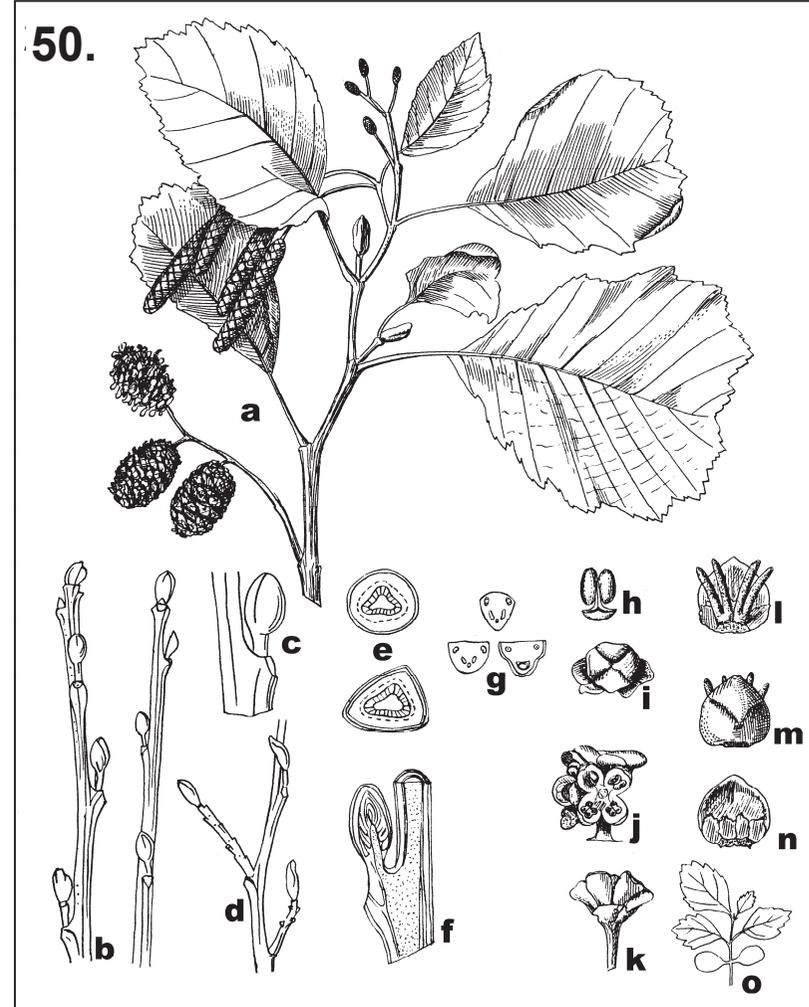
*Tilia platyphyllos*: a) flowering twig, b) twig with buds and infructescence, c) shoot with buds, d) fruit, e) seedling

49.



*Tilia cordata*: a) flowering twig, b) shoot with buds and fruits, c) flower, d) fruit, e) seedling

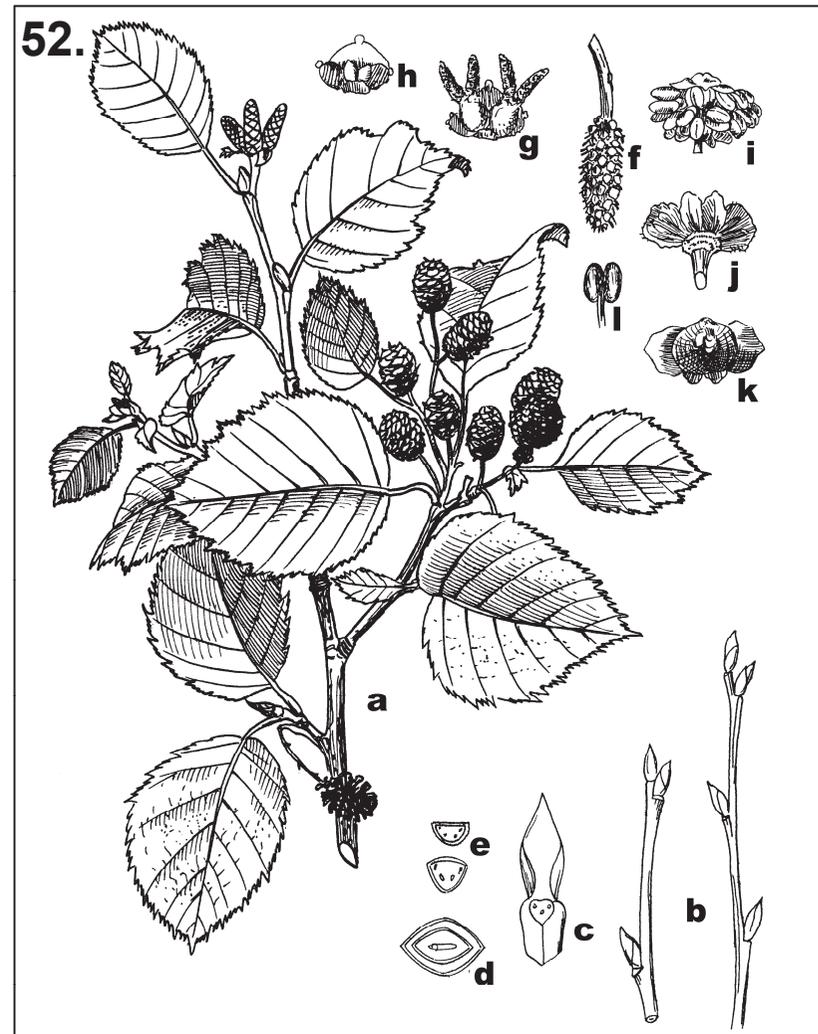
50.



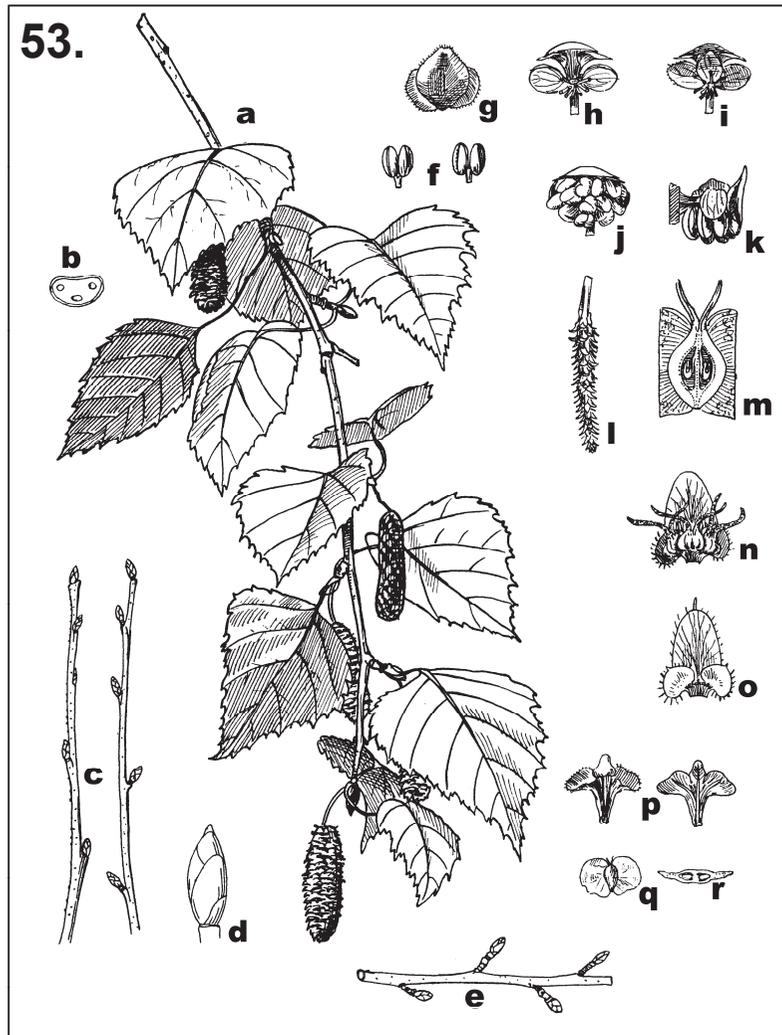
*Alnus glutinosa*: a) fructing twig, b) dlouhé prýty c) bud, d) short twig, e) twig – cross-sections, f) twig and bud – longitudinal section, g) leaf scars, h) anther, i) scale of ♂ inflorescence without flowers, j) part of ♂ inflorescence with scale, k) inner part of scales in ♂ inflorescence, l, m) double ♀ flower with bract, n) bract of ♀ inflorescence, o) seedling



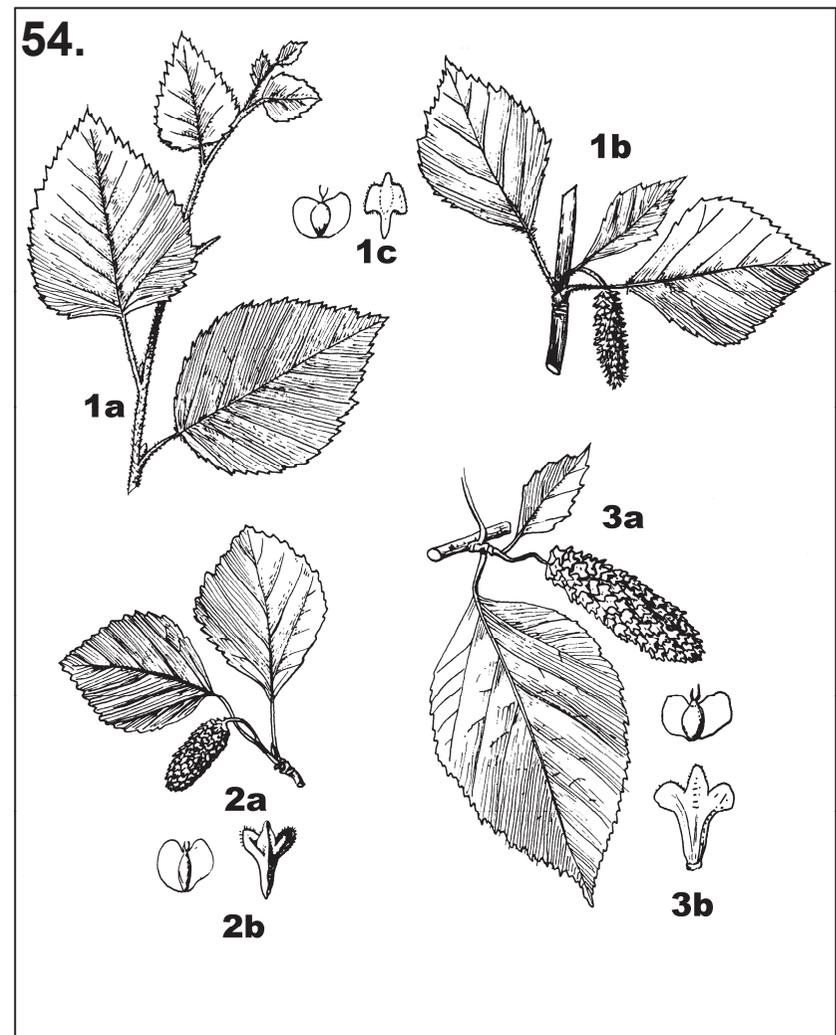
51. *Alnus incana*: a) fructing twig, b) branchlet with ♂ a ♀ inflorescences and „cones“, c) ♂ inflorescence, d) shoot with buds



52. *Alnus viridis*: a) fructing twig, b) shoot with buds, c) jednotlivý pupen, d) bud – cross section, e) eaf scars, f) ♀ inflorescence, g) double ♀ flower with scale, h) scale of ♀ inflorescence, i) part of ♂ inflorescence with scale, j) inner part of scale in ♂ inflorescence, k) scale of ♂ inflorescence without flowers, l) anther

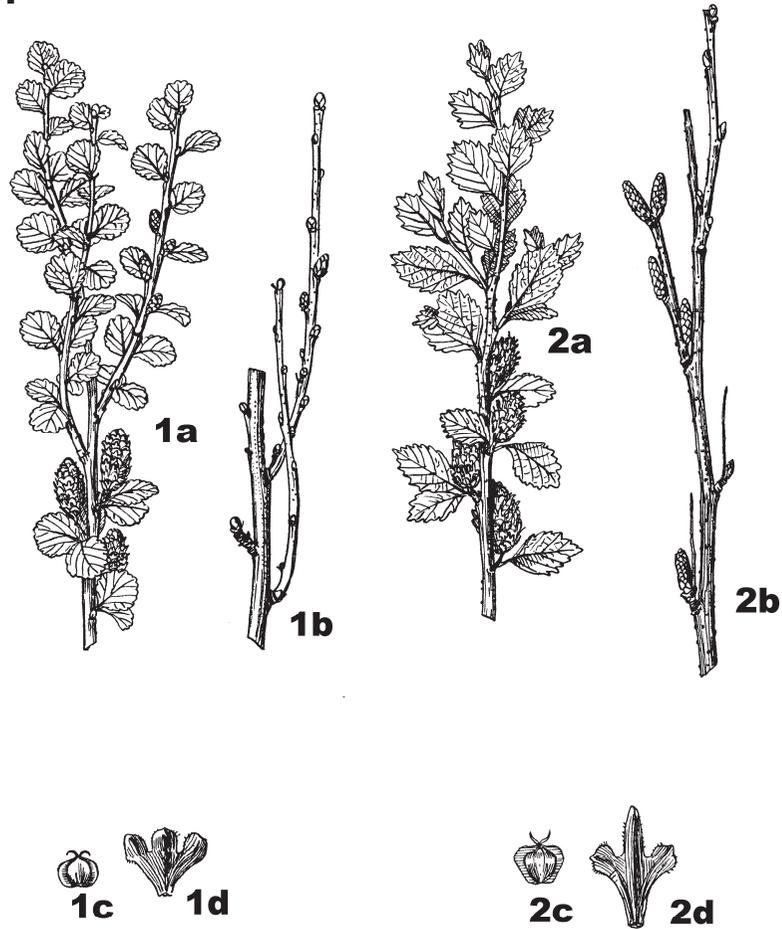


**53. *Betula pendula*:** a) fructing twig, b) leaf scar, c) long shoot with buds, d) bud, e) branchlet with short twigs, f) anthers, g, h) scale of ♂ inflorescence, i) part of ♂ inflorescence without anther, j, k) part of ♂ inflorescence with anthers, l) ♀ inflorescence, m) ♀ flower – longitudinal section, n) part of ♀ inflorescence, o) scale of ♀ inflorescence without flowers, p) fruit scales, q) seed, r) seed – cross section



**54.**  
**1. *Betula pubescens*:** a) long shoot with leaves, b) twig with infructescence, c) seed and fruit scale  
**2. *Betula tortuosa*:** a) twig with infructescence, b) seed and fruit scale  
**3. *Betula papyrifera*:** a) twig with infructescence, b) seed and fruit scale

55.



1. *Betula nana*: a) fructing twig, b) shoot with buds, c) seed, d) fruit scale

2. *Betula humilis*: a) fructing twig, b) shoot with buds, c) seed, d) fruit scale

56.

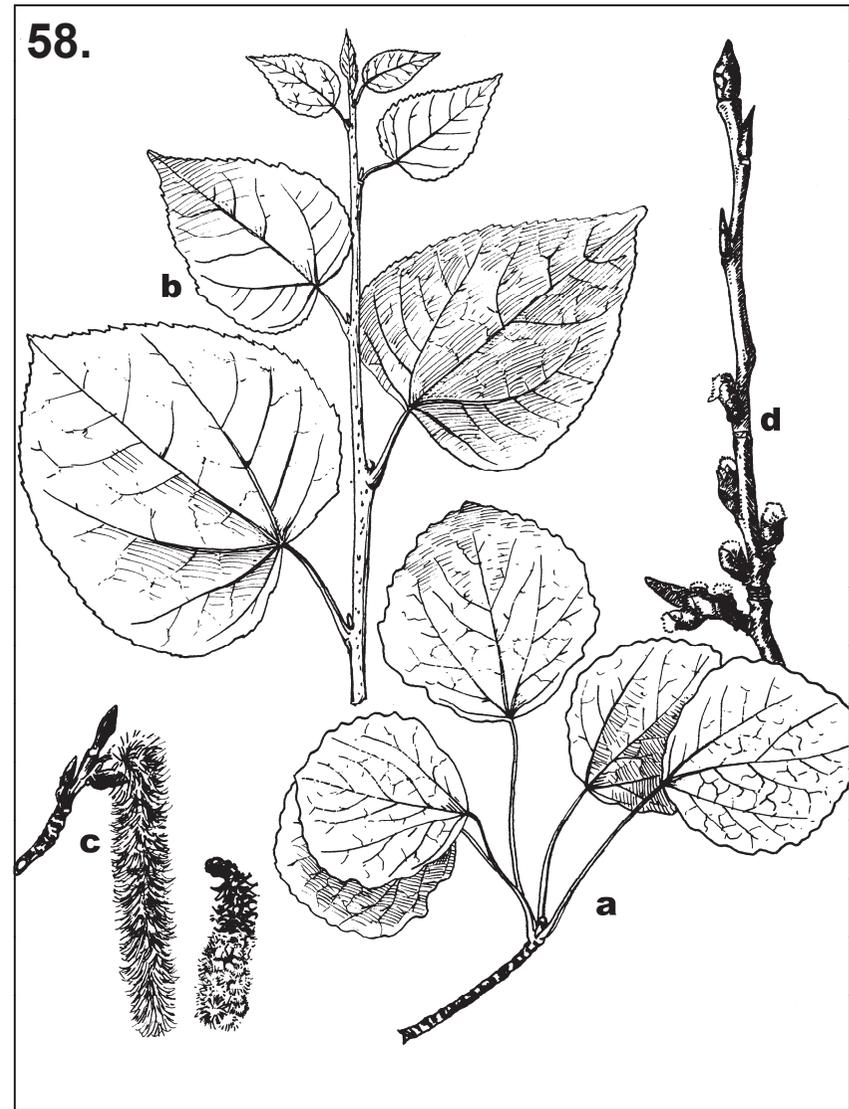


*Populus nigra*: a) twig with leaves and infructescence, b) branchlet with ♀ inflorescence, c) ♂ inflorescence (catkin), d) shoot with buds





*Populus alba*: a) fructing twig, b) twig with ♂ inflorescences,  
c) twig with ♀ inflorescences, d) shoot with buds, e) seedling



*Populus tremula*: a) twig with leaves, b) sprout, c) ♂ inflorescence,  
d) branchlet with leaf buds and flower buds



*Salix alba*: a) fructing twig, b) ♀ inflorescence (catkin), c) ♂ inflorescence, d) shoot with buds



*Salix fragilis*: a) fructing twig, b) ♀ inflorescence, c) ♂ inflorescence (catkin), d) shoot with buds



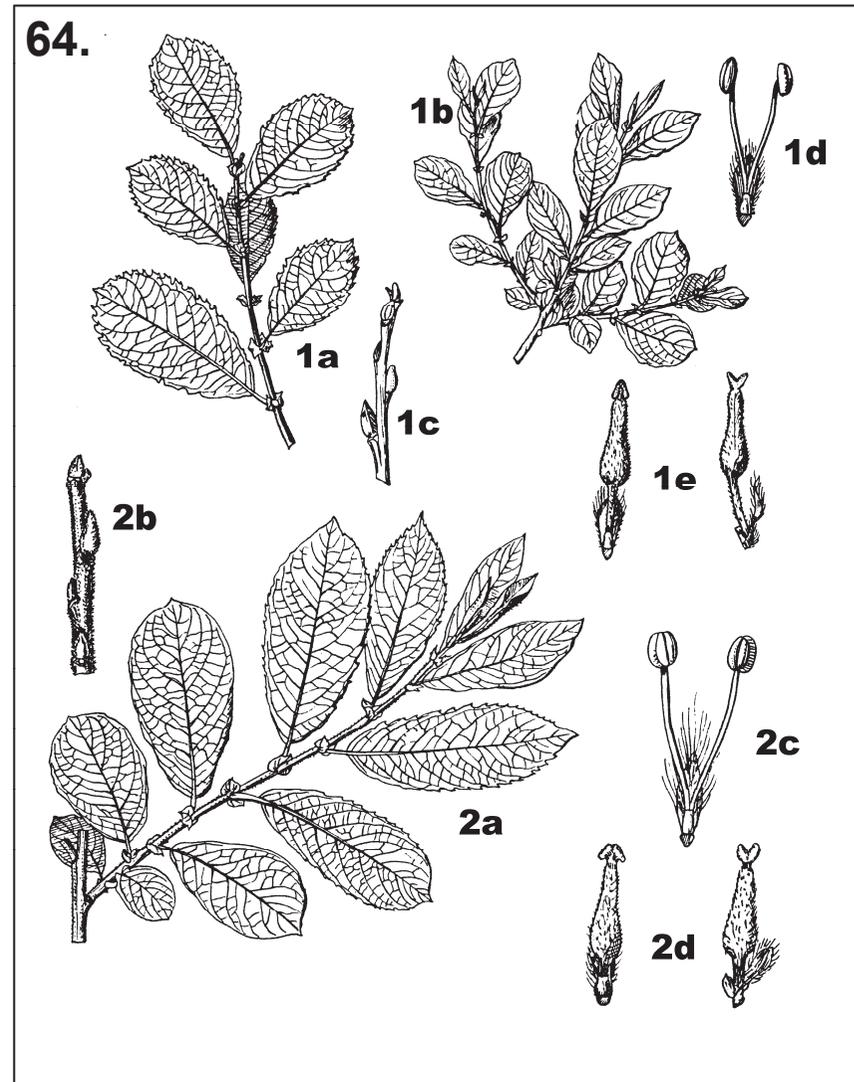
*Salix caprea*: a) fructing twig, b) branchlet with ♂ inflorescences, c) twig with ♀ inflorescences, d) shoot with buds, e) twig with leaves



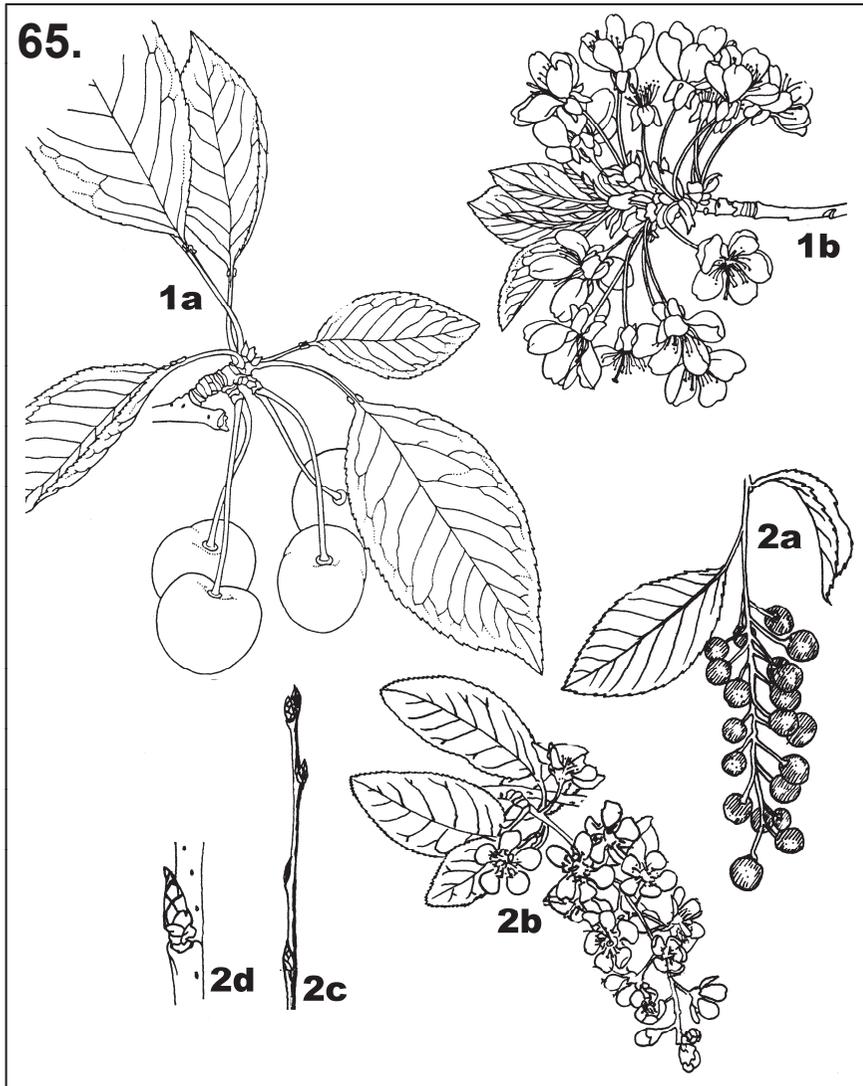
*Salix viminalis*: a) fructing twig, b) twig with ♀ inflorescens (catkin), c) branchlet with ♂ inflorescences, d) shoot with buds



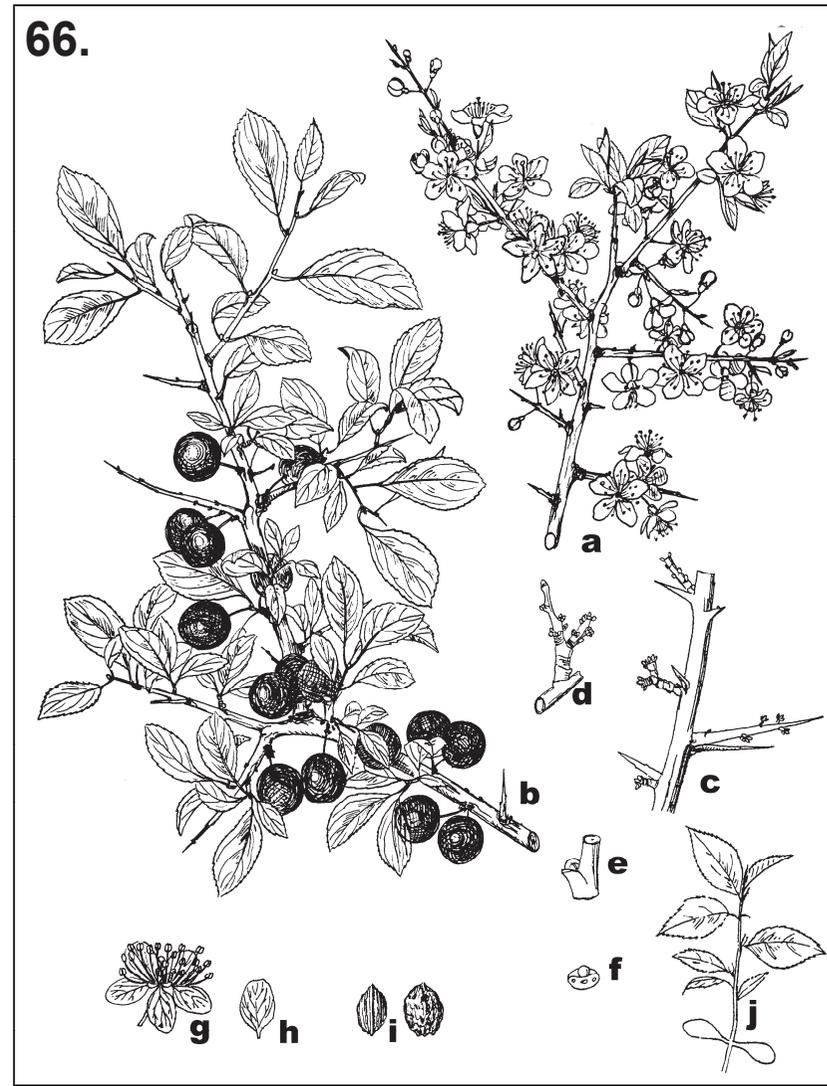
*Salix purpurea*: a) fruting twig, b) branchlet with ♂ inflorescences, c) twig with ♀ inflorescences, d) shoot with buds



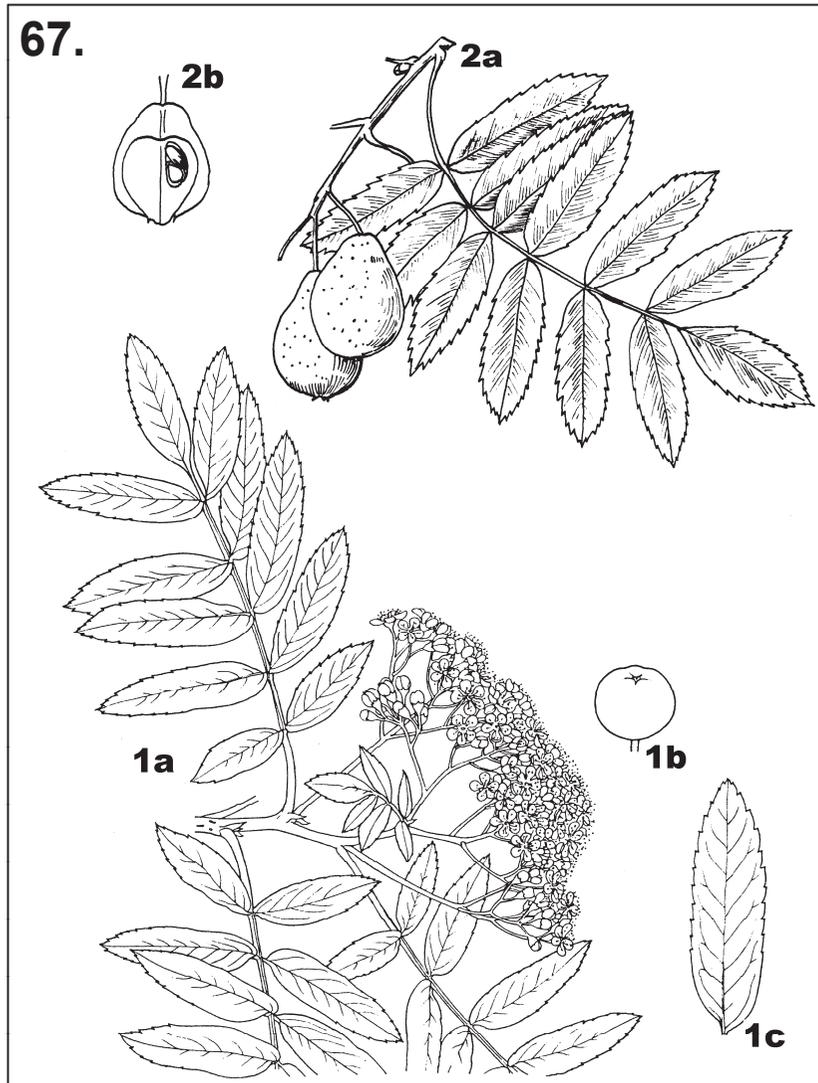
1. *Salix aurita*: a) twig with stipules, b) shoot with buds, c) ♂ flower, d) ♀ flower  
 2. *Salix cinerea*: a) twig with leaves, b) shoot with buds, c) ♂ flower, d) ♀ flowers



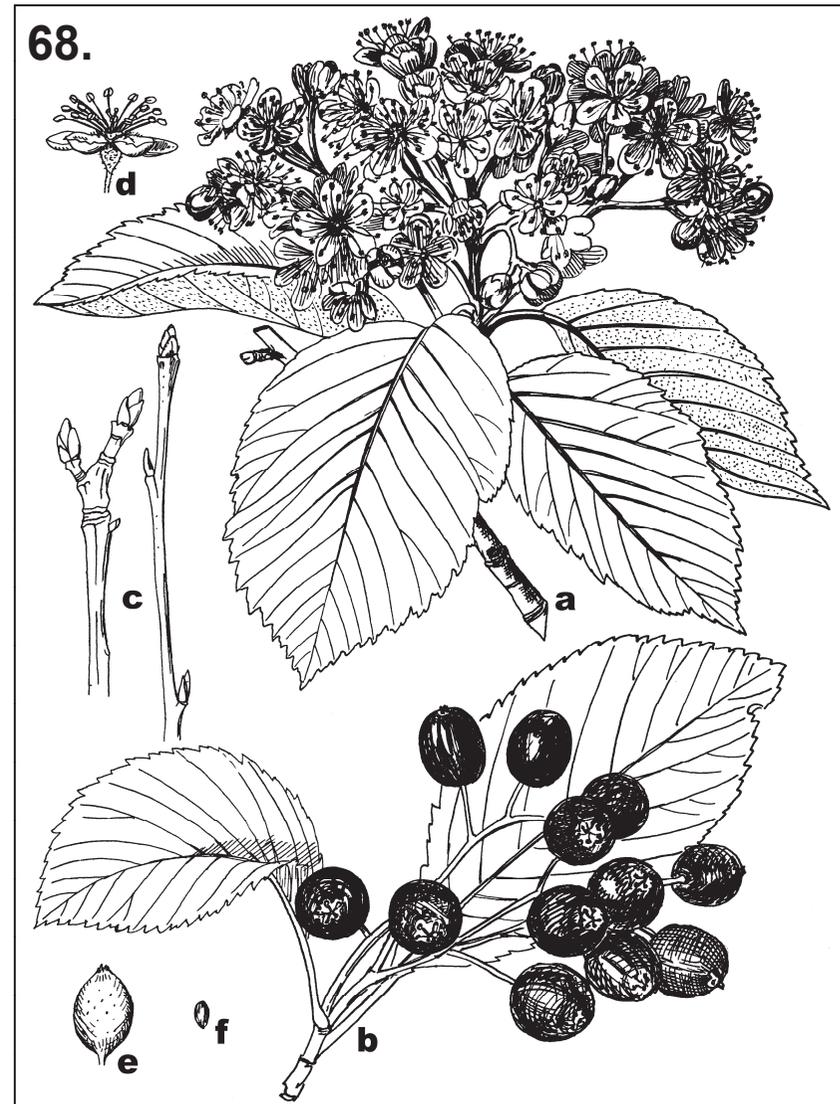
1. *Cerasus avium*: a) fructing twig, b) flowering twig,  
 2. *Padus racemosa*: a) flowering twig, b) fructing twig, c) twig with buds, d) bud



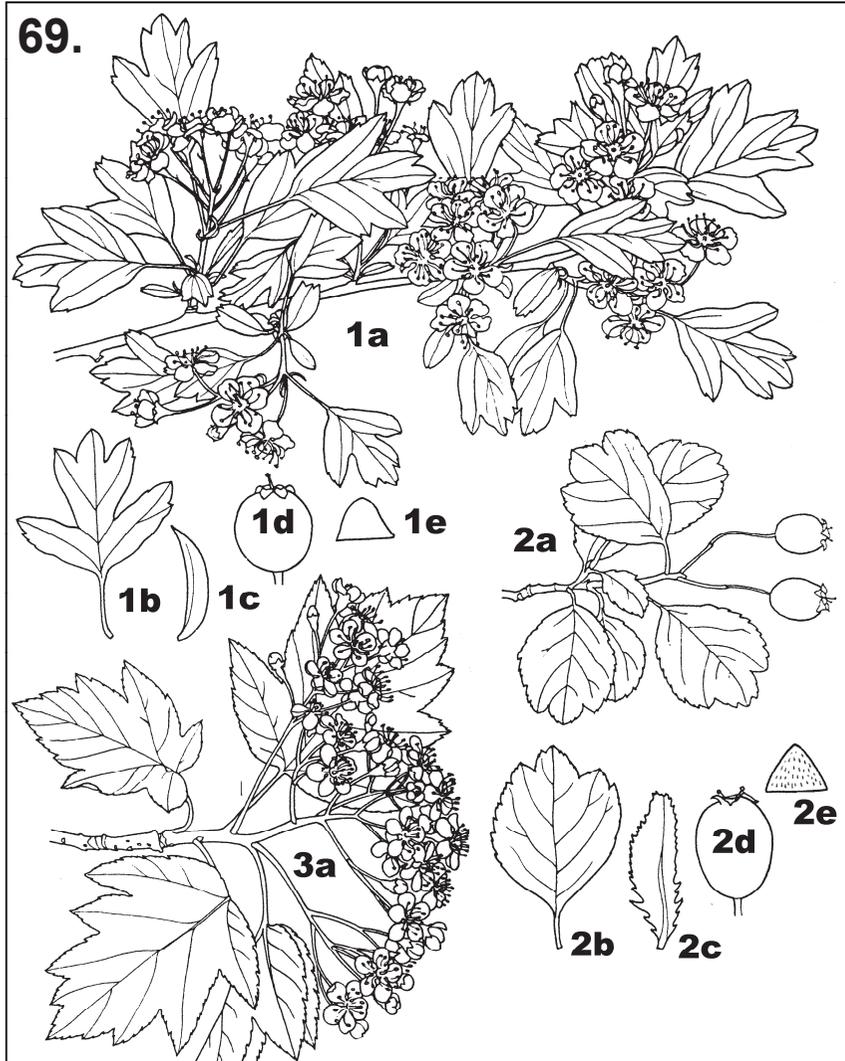
*Prunus spinosa*: a) flowering twig, b) fructing twig, c) twig with thorns,  
 d) brachyblast, e) bud, f) bud with leaf scar g) flower,  
 h) petal, i) seed – various views



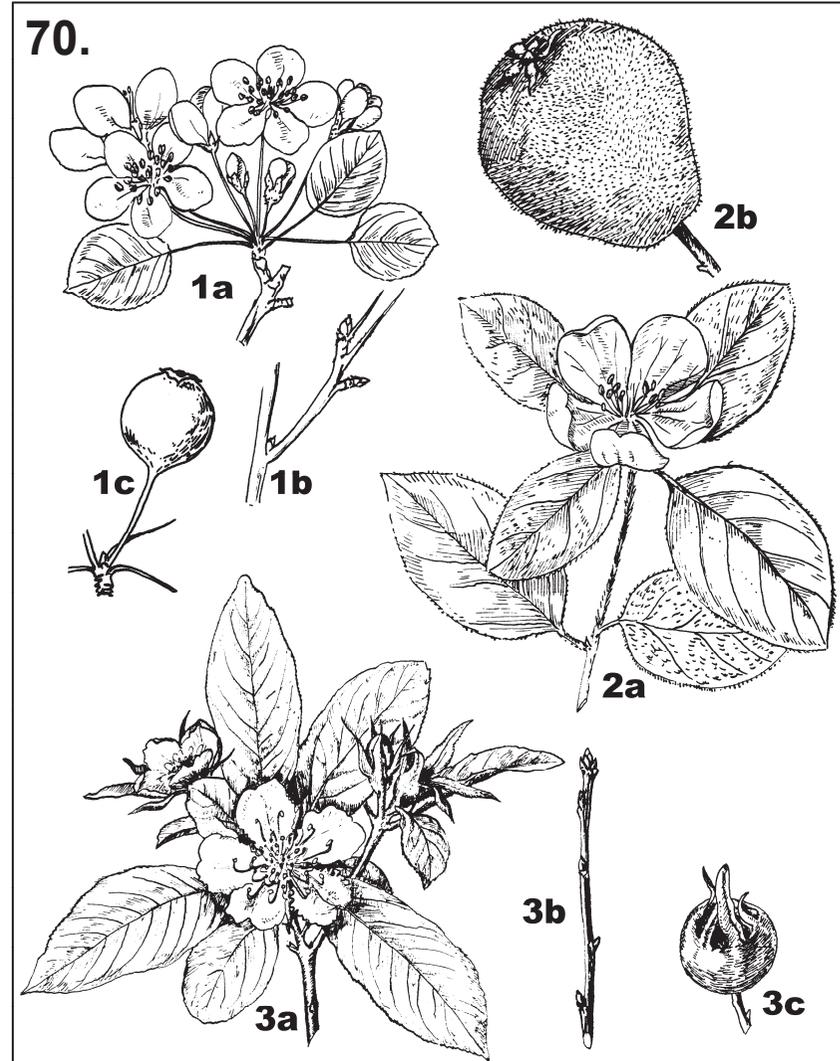
1. *Sorbus aucuparia*: a) flowering twig, b) fruit, c) leaflet  
 2. *Sorbus domestica*: a) fruting twig, b) fruit – cross-section



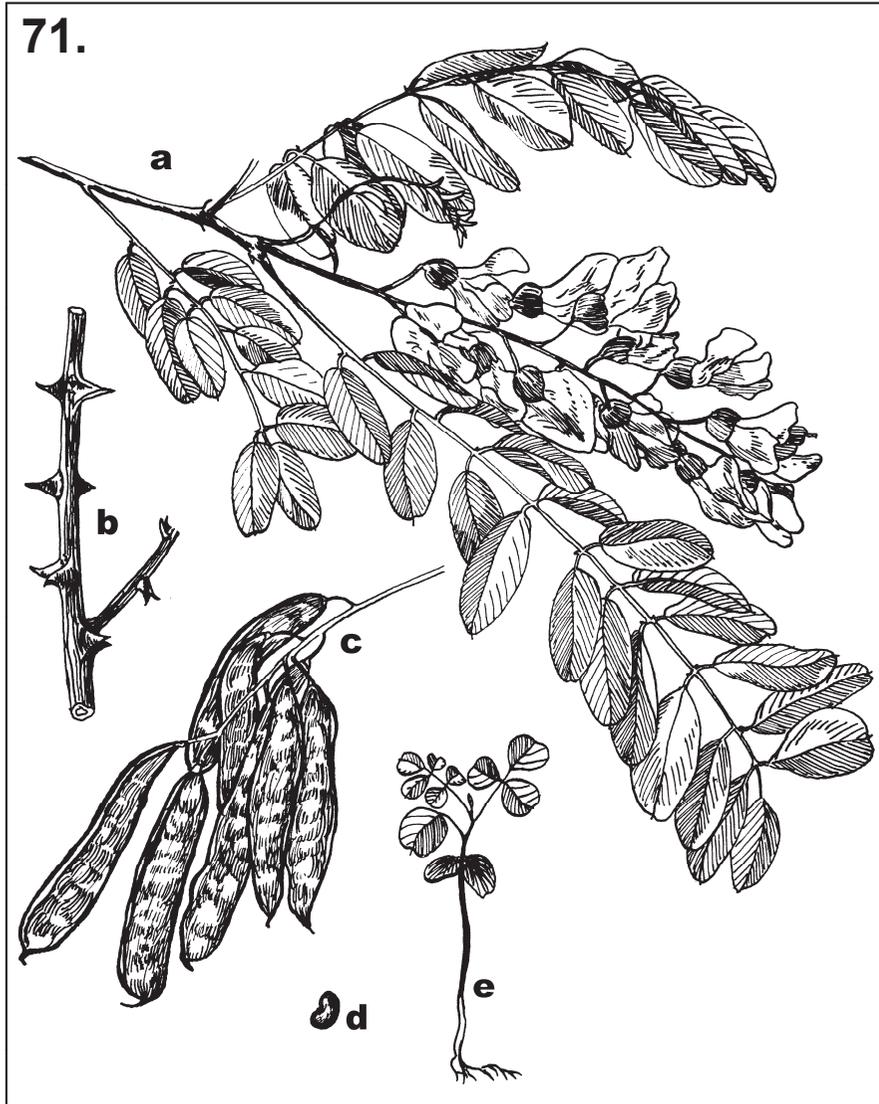
*Sorbus aria*: a) flowering twig, b) fruting twig, c) branchlet with buds,  
 d) flower, e) fruits, f) sseed



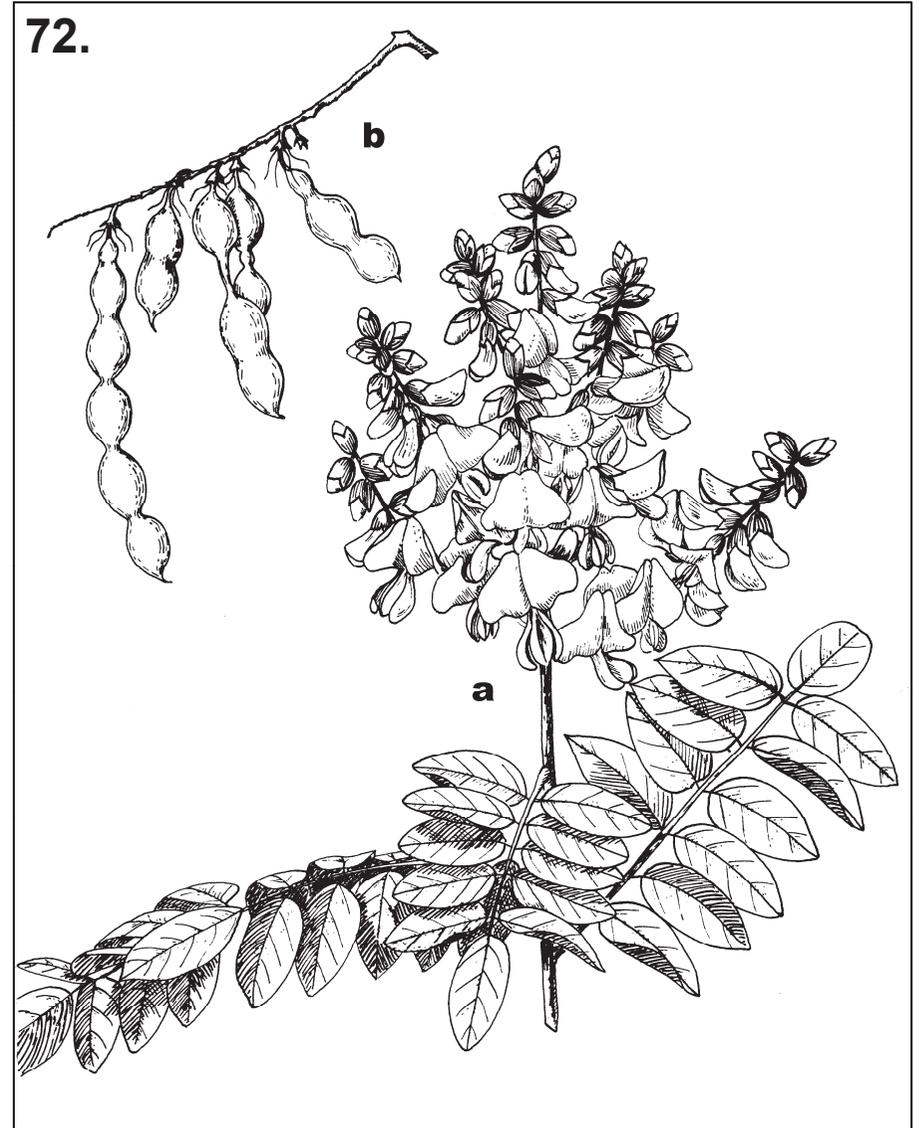
1. *Crataegus monogyna*: a) flowering twig, b) leaf, c) stipule, d) fruit, e) calyx lobe  
 2. *Crataegus laevigata*: a) fructing twig, b) leaf, c) stipule, d) fruit, e) calyx lobe  
 3. *Sorbus torminalis*: a) flowering twig,



1. *Pyrus pyraeaster*: a) flowering twig, b) twig with spiny spur and buds, c) fruit  
 2. *Cydonia oblonga*: a) flowering twig, b) fruit  
 3. *Mespilus germanica*: a) flowering twig, b) twig with buds, c) fruit

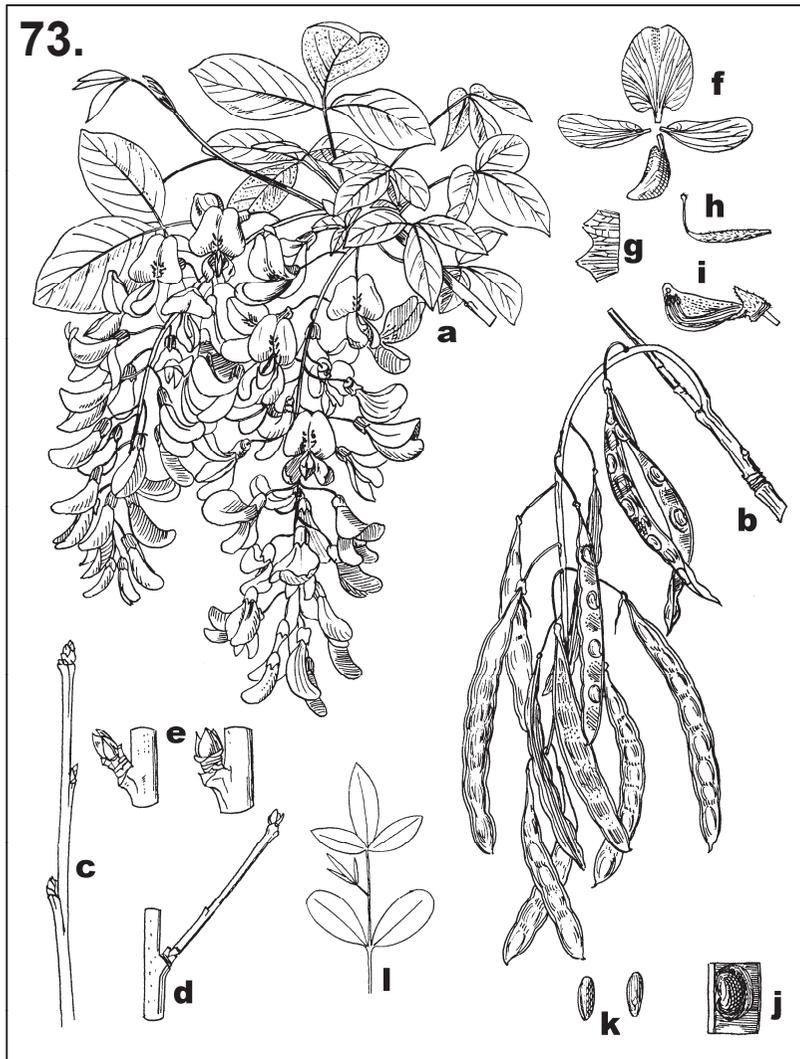


*Robinia pseudoacacia*: a) flowering twig, b) branchlet with spines(thorns), c) infructescence, d) seed, e) seedling

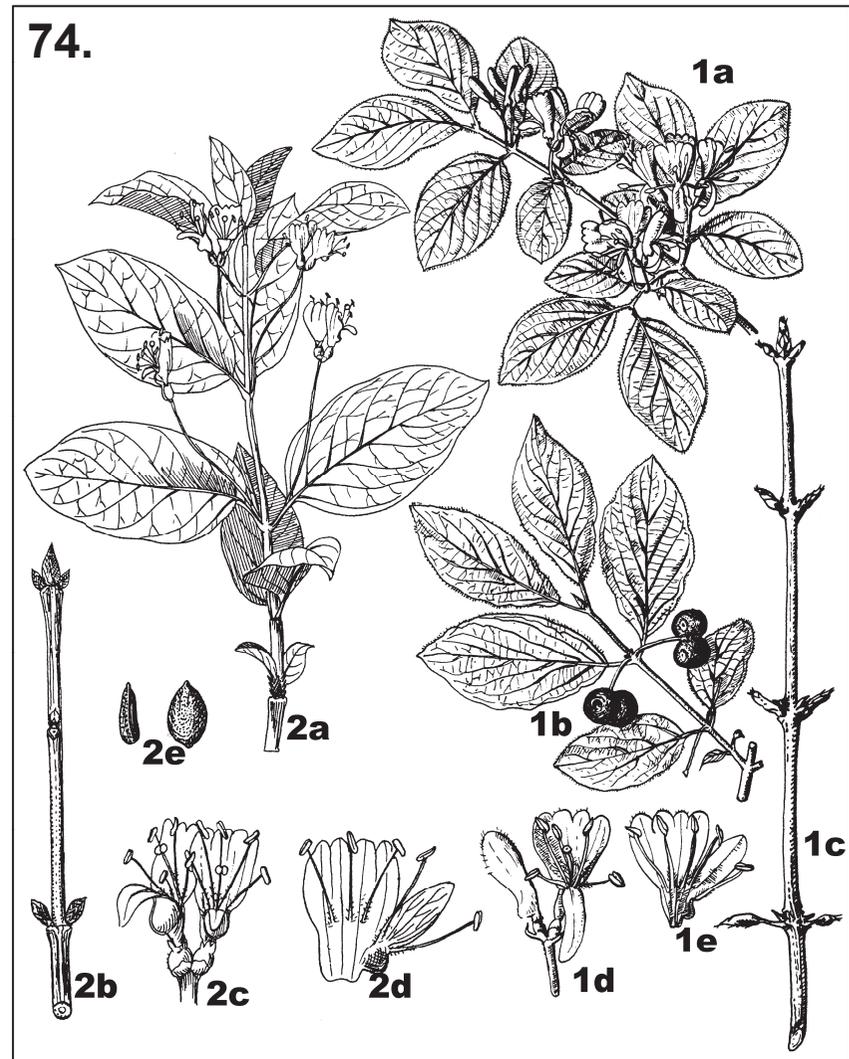


*Sophora japonica*: a) flowering twig, b) infructescence

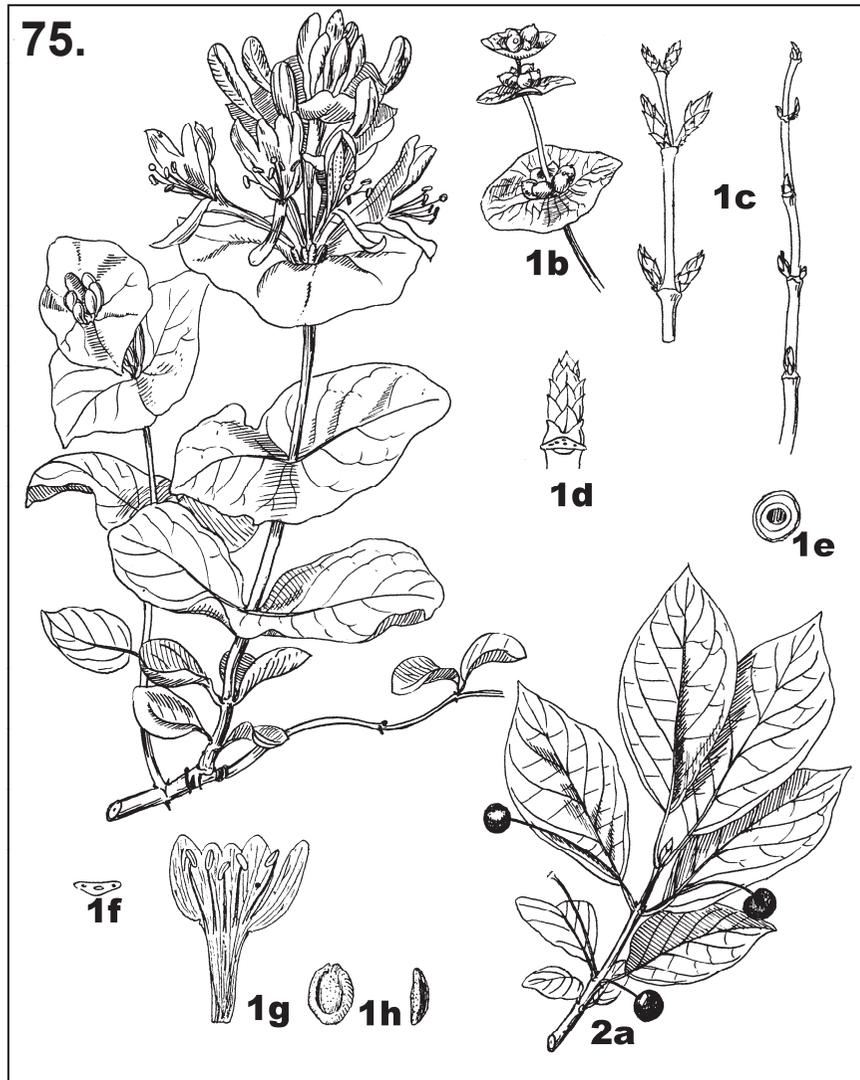




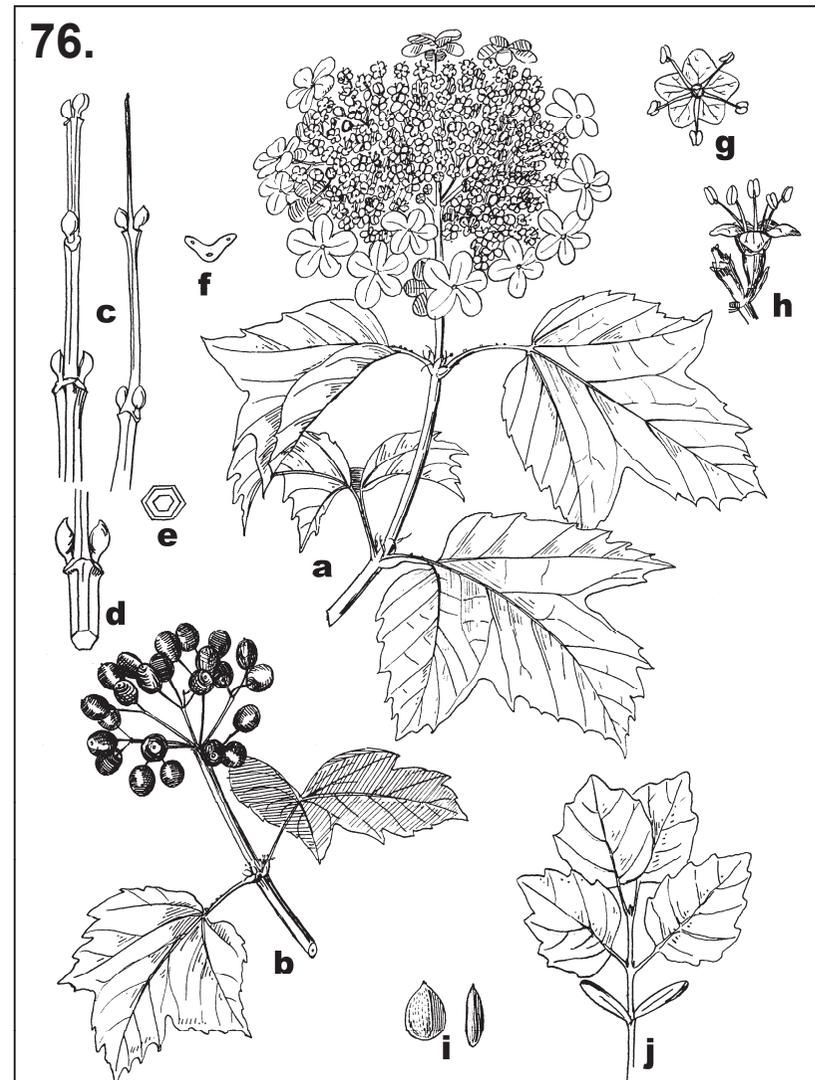
**73. *Laburnum anagyroides*:** a) flowering twig, b) fruting twig, c) long shoot with buds, d) short shoot, e) bud, f) flower corola, g) calix, h) pistil, i) stamens with calyx, j) pod with seed, k) seed – various views, l) seedling



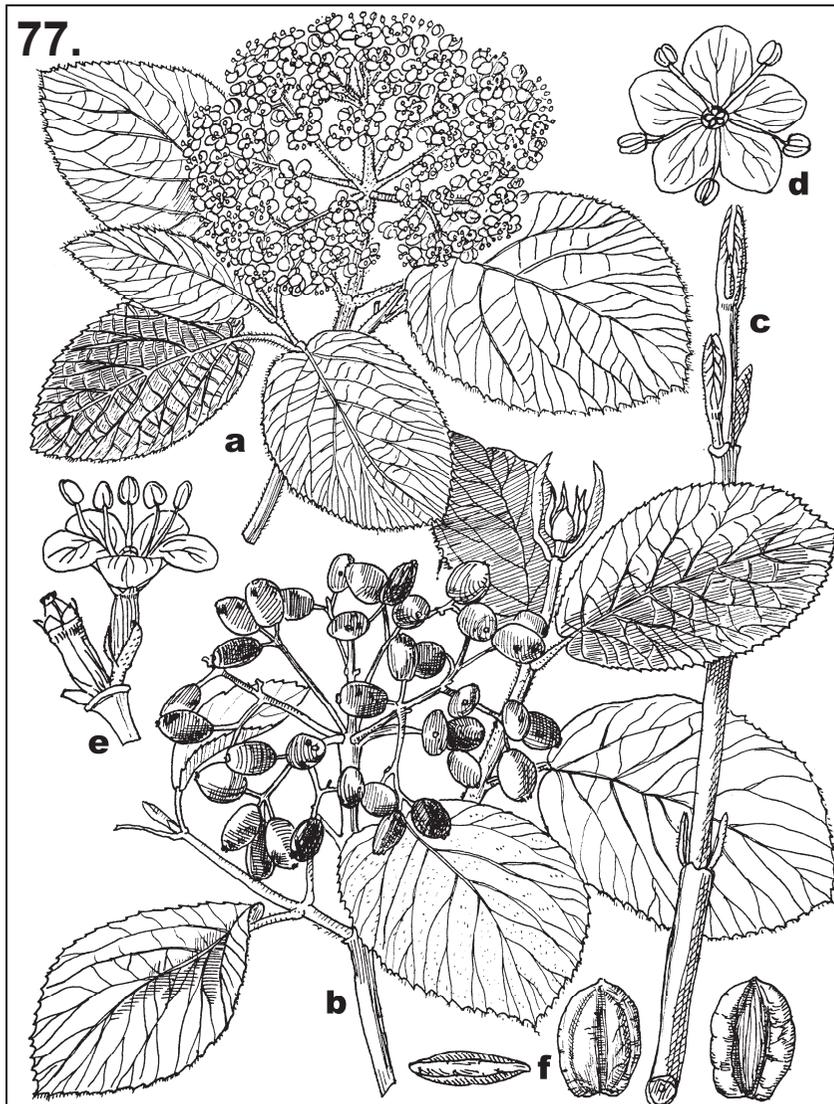
**74.**  
**1. *Lonicera xylosteum*:** a) flowering twig, b) fruting twig, c) long shoot with buds, d) double flower, e) corola with stamens - section  
**2. *Lonicera nigra*:** a) flowering twig, b) twig with buds, c) double flowers, d) flower, e) seed – various views



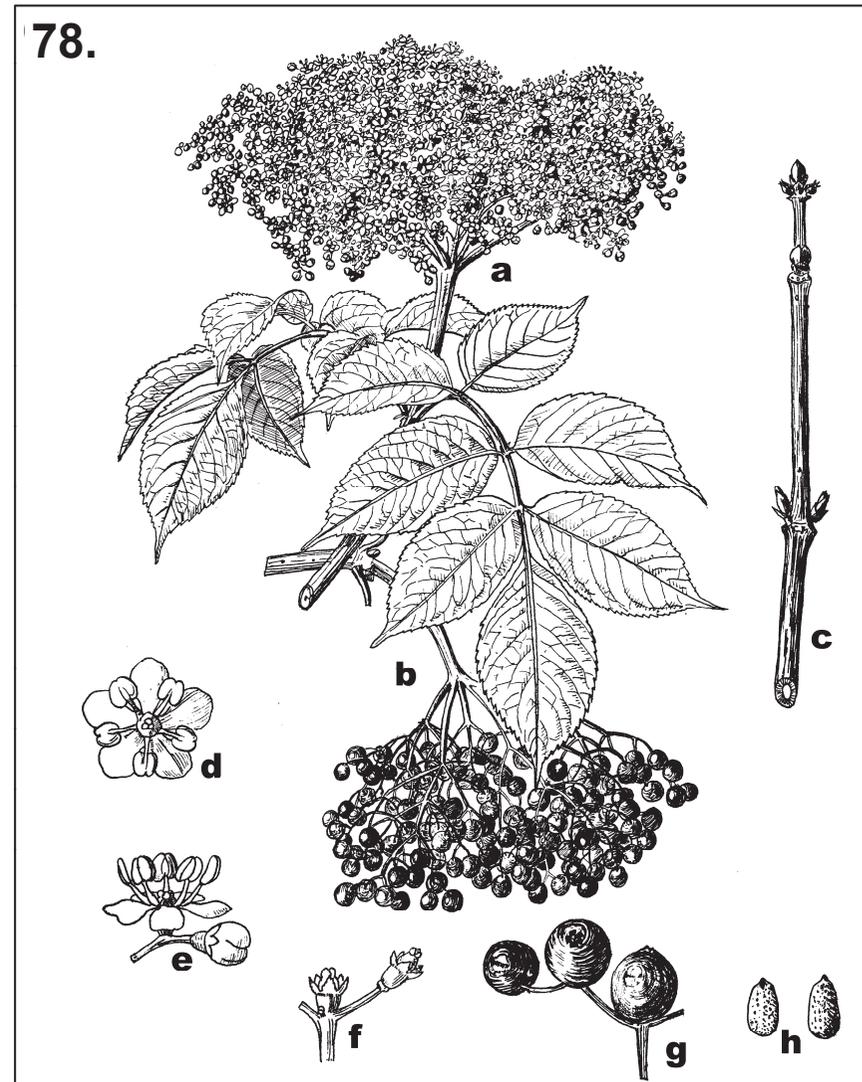
1. *Lonicera caprifolium*: a) flowering twig, b) fruting twig, c) twig with buds, d) bud, e), f) leaf scar, g) corola with stamens – sectional view, h) seed – various views  
 2. *Lonicera alpigena*: a) fruting twig



76. *Viburnum opulus*: a) flowering twig, b) fruting twig, c) long shoots with buds, d) buds, e) twig – cross section, f) leaf scar, g) flower, h) flower – side view, i) seed – various views, j) seedling



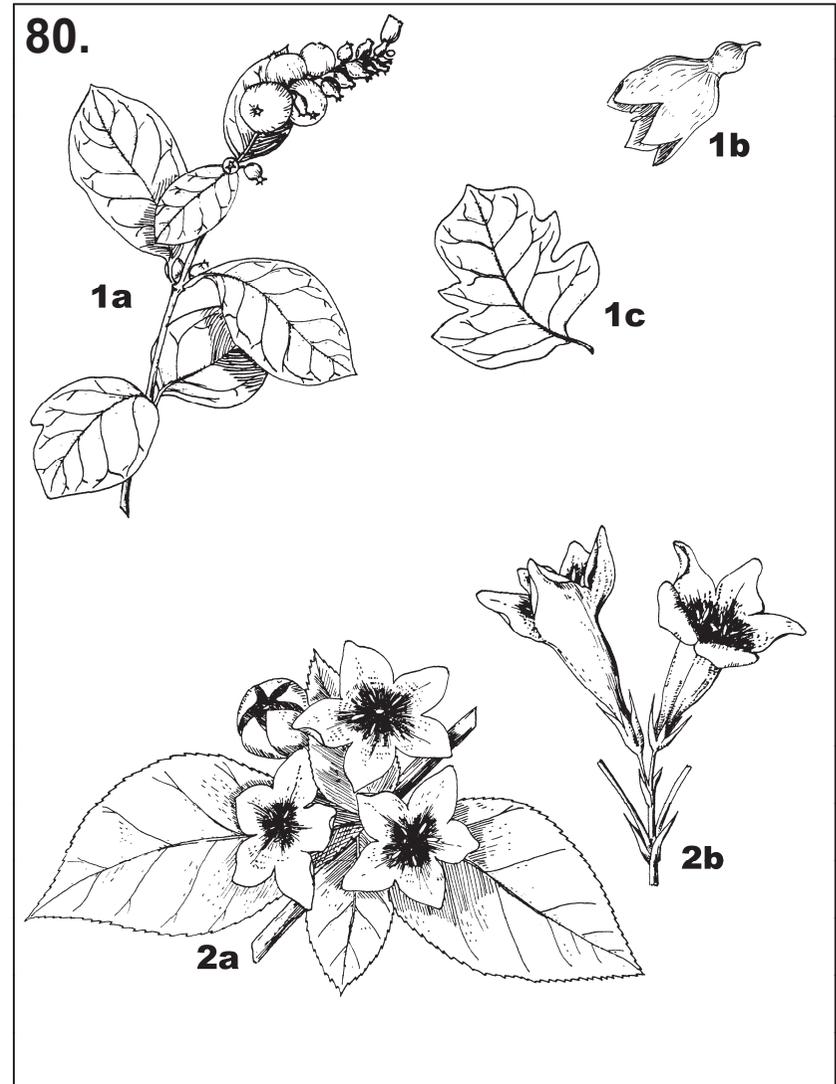
*Viburnum lantana*: a) flowering twig, b) fructing twig,  
c) twig with buds, d) flower, e) flower – side view, f) seed – various views



*Sambucus nigra*: a) flowering twig, b) infructescence, c) long shoot with buds, d) flower,  
e) opened and closed flower, f) flower without corolla and stamens,  
g) branchlet with mature fruits, h) seeds



79. *Sambucus racemosa*: a) flowering twig, b) fruting twig,  
 c) twigs with buds, d) buds, e) leaf scar, f) closed flower,  
 g) flower, h) flower – side view, i) fruting twig, j) seed – various views  
 k)



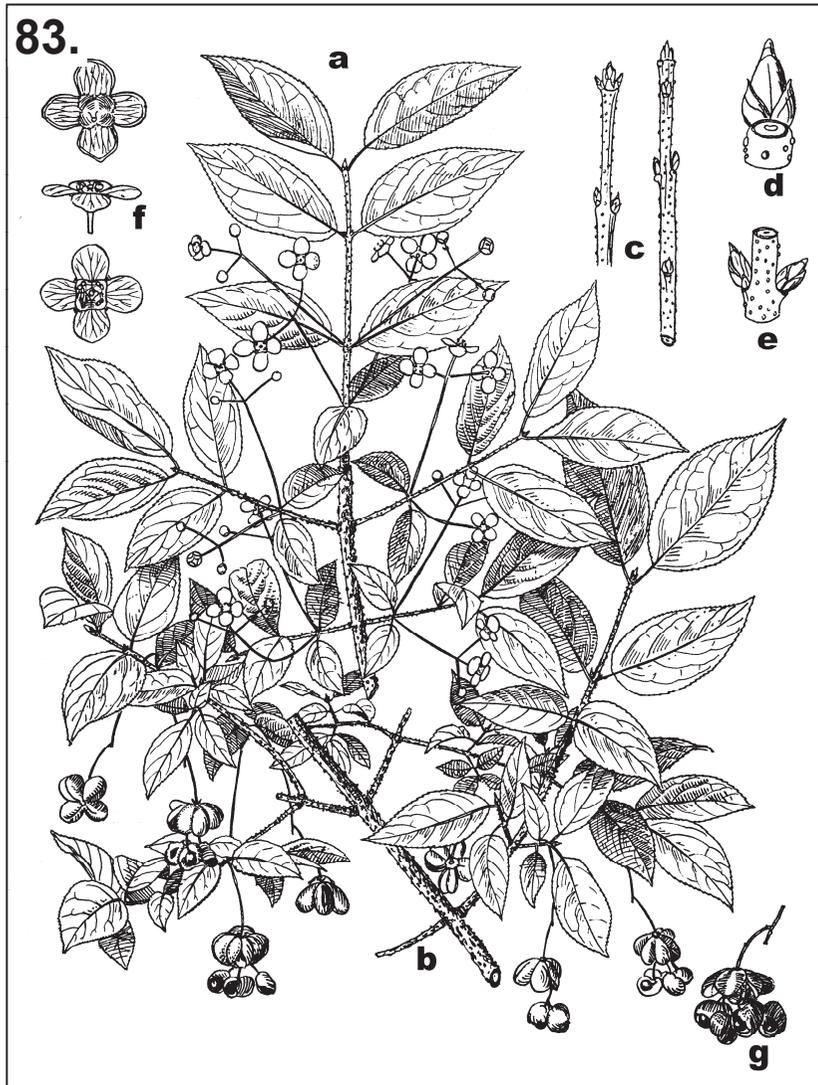
80. 1. *Symphoricarpos albus*: a) fruting twig, b) flower, c) leaf from sprout  
 2. *Weigelia florida*: a) flowering twig, b) flowers



*Rhamnus cathartica*: a) flowering twig, b) fructing twig, c) twig with buds, d) brachyblast, e) buds, f) bud with leaf scar, g) ♀ flower, h) ♂ flower, i) anther, j) seed – various views, k) seedling



*Euonymus europaeus*: a) flowering twig, b) fructing twig, c) twig with buds, d) branchlet, e) bud with leaf scar, f) buds, g) twig – cross-section, h) bud – cross-section, i) flower, j) closed fruit, k) seedling

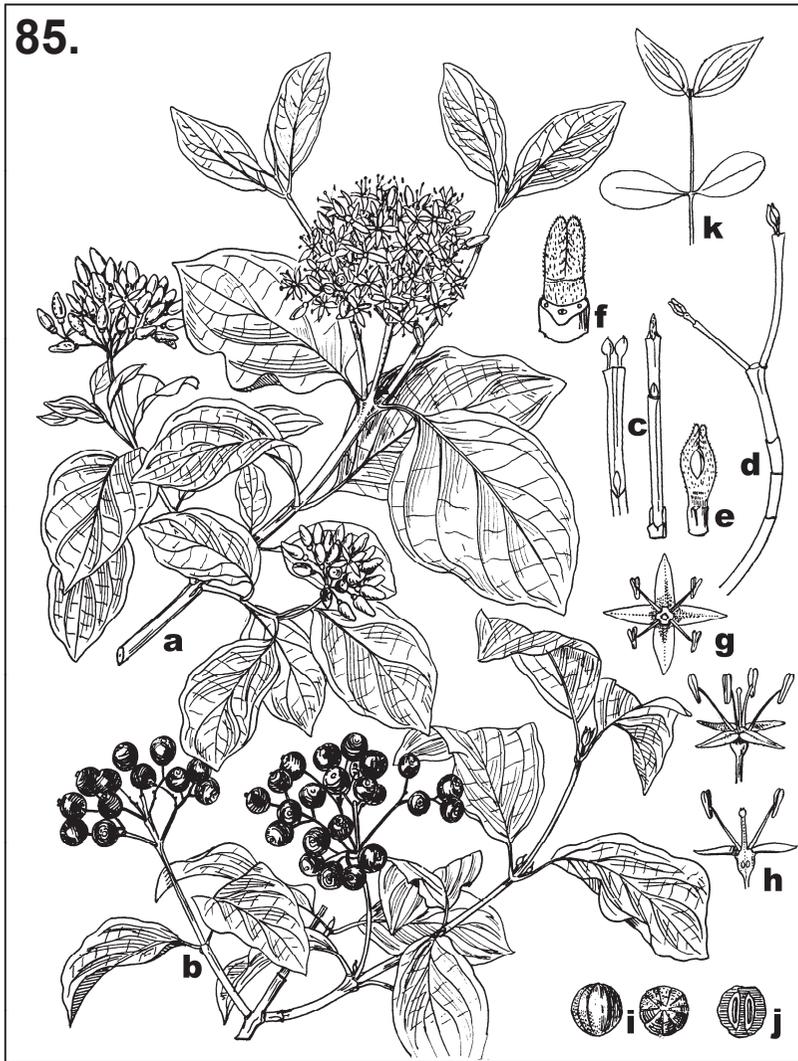


*Euonymus verrucosus*: a) flowering twig, b) fructing twig,  
c) twigs with buds, d) bud and leaf scar, e) opposite buds,  
f) flower, g) fruit



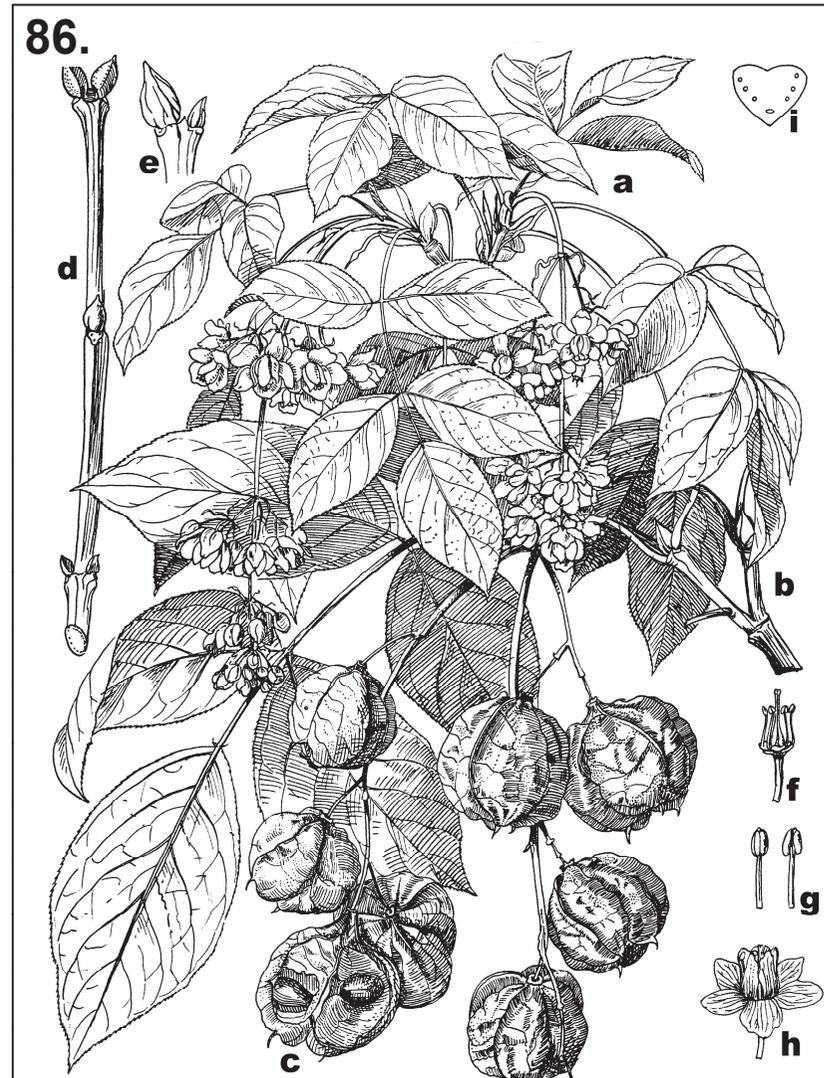
*Cornus mas*: a) fructing twig, b) flowering twig,  
c) branchlet with flower buds, d) terminal bud, e) flower bud, f) leaf scar,  
g) flower, h) seed – various views, i) seed – cross-section, j) seedling

85.



*Cornus sanguinea*: a) flowering twig, b) fructing twig, c) shoots with buds, d) lateral twig with buds, e) terminal bud, f) bud with leaf scar, g) flower – various views, h) flower - longitudinal section, i) seed, j) seed – cross-section, k) seedling

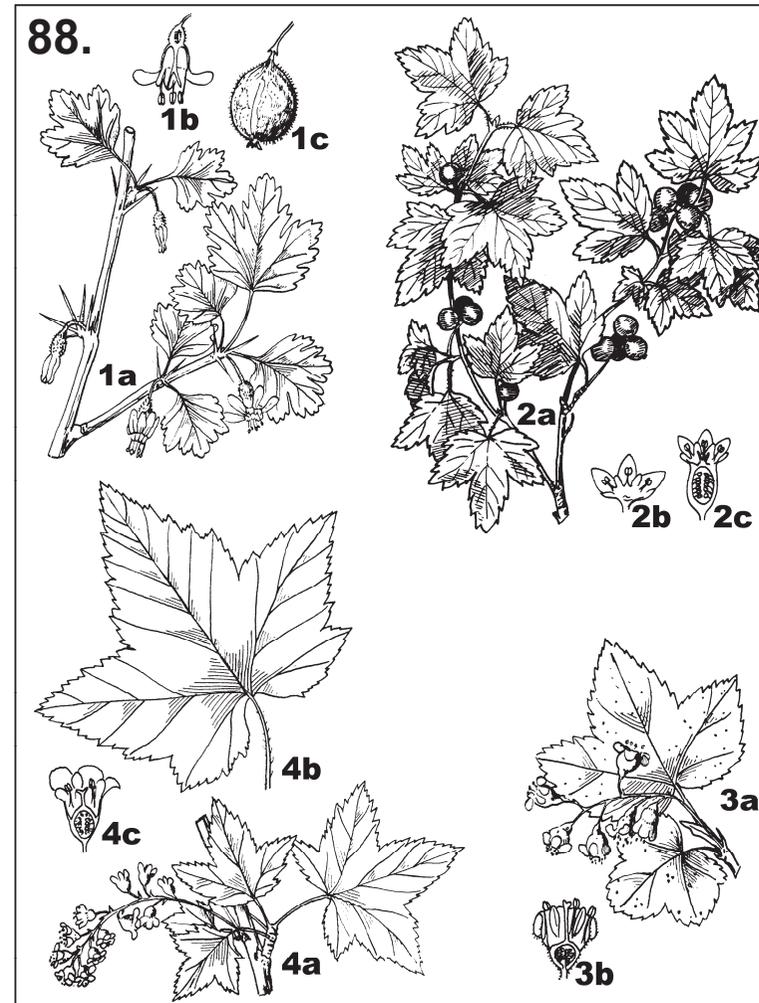
86.



*Staphylea pinnata*: a) flowering twig, b) fructing twig, c) fruit with seeds – cross-section, d) twig with buds, e) terminal buds, f) flower without floral leaves, g) stamens, h) flower, i) leaf scar



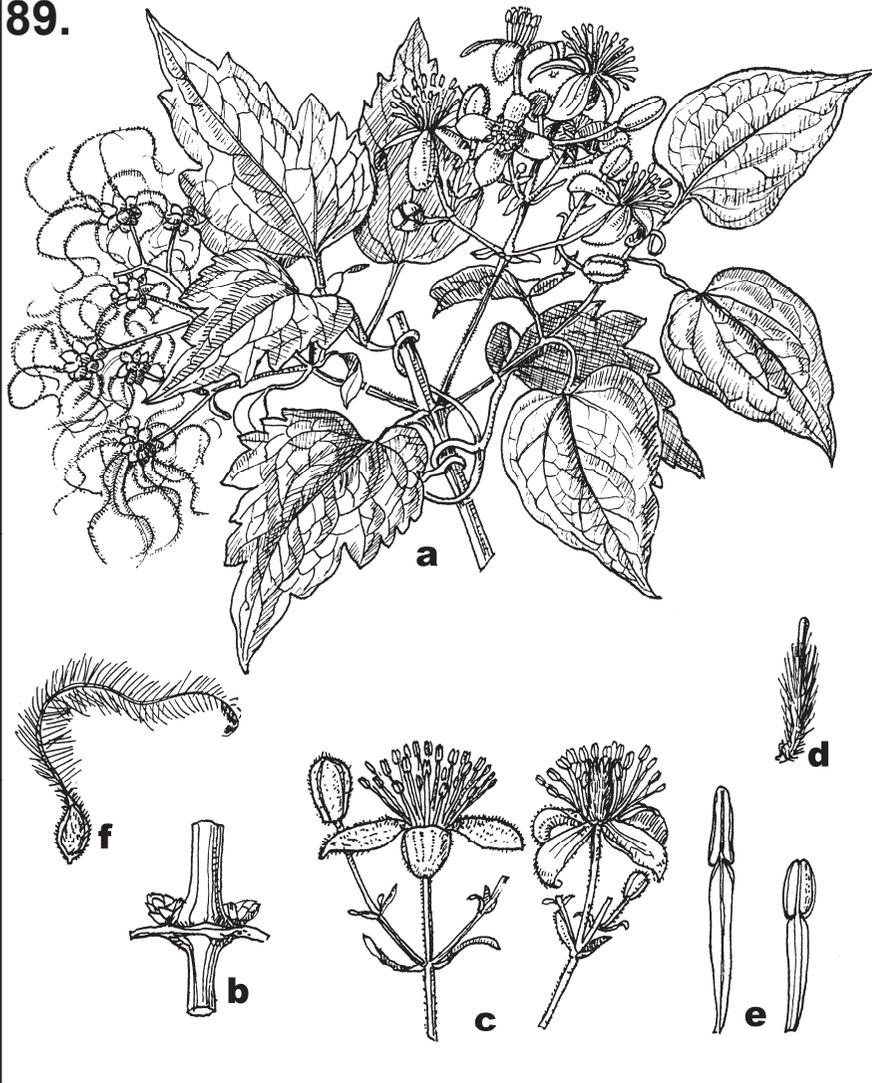
*Berberis vulgaris*: a) flowering twig, b) fructing twig, c) twig with buds and thorns, d) buds with thorn (spine), e) flower, f) flower without petals, g) stamen, h) petal, i) fruit, j) seedling



1. *Ribes grossularia*: a) flowering twig, b) flower, c) fruit  
 2. *Ribes alpinum*: a) fructing twig, b) ♂ flower – cross-section, c) ♀ flower – cross-section,  
 3. *Ribes petraeum*: a) fructing twig, b) flower – cross-section  
 4. *Ribes nigrum* Chyba! Záložka není definována.: a) fructing twig, b) leaf, c) flower – cross-section

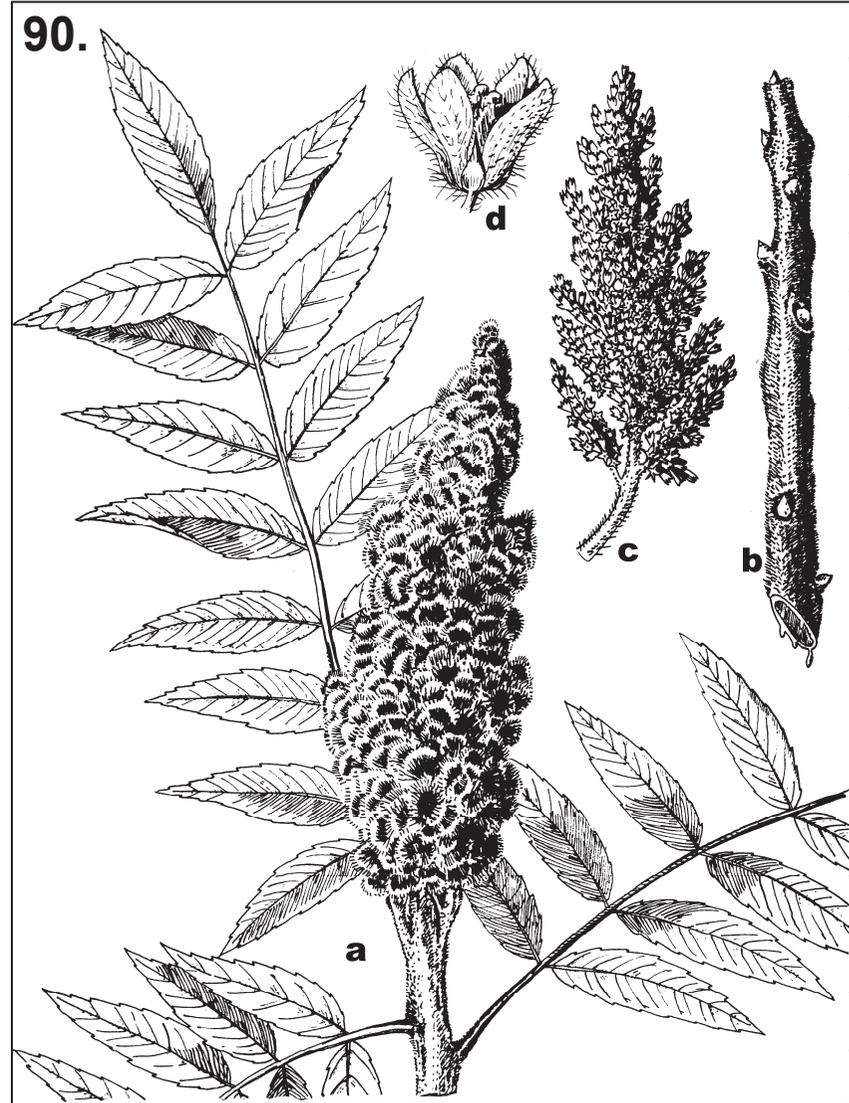


89.

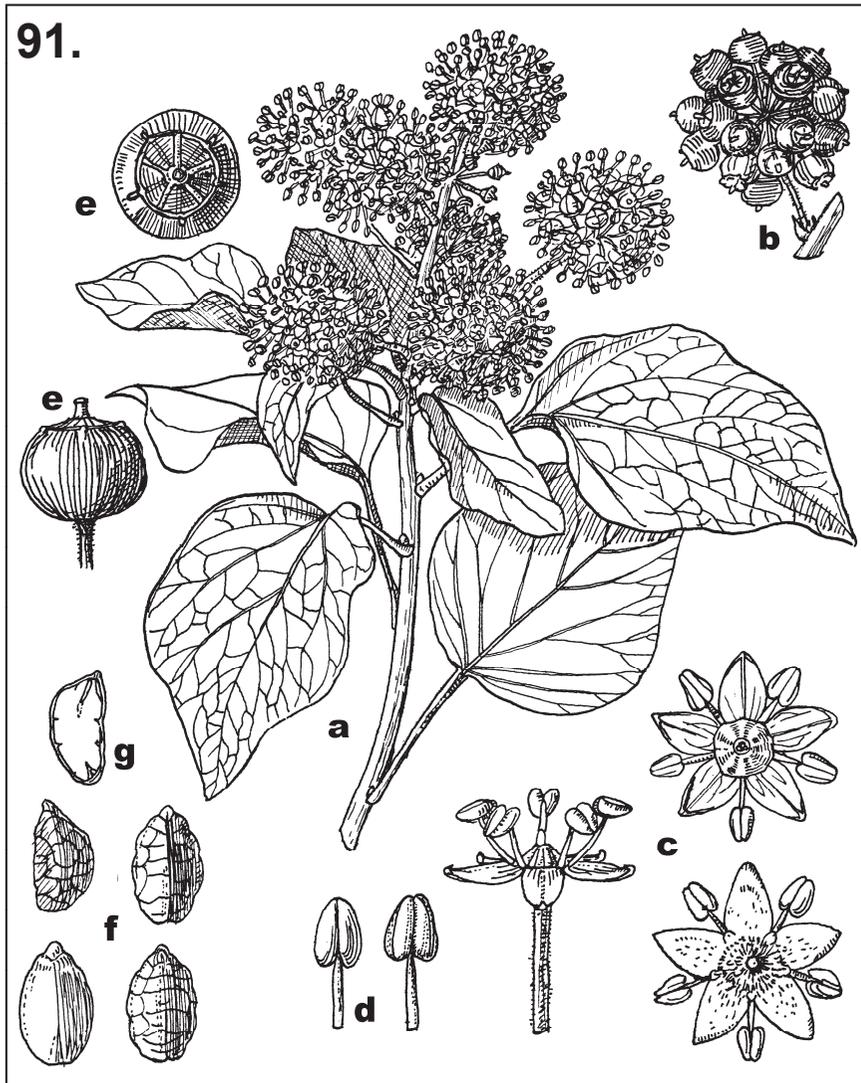


*Clematis vitalba*: a) flowering twig with fruits, b) twig with buds, c) flowers, d) pistil, e) stamens, f) fruit

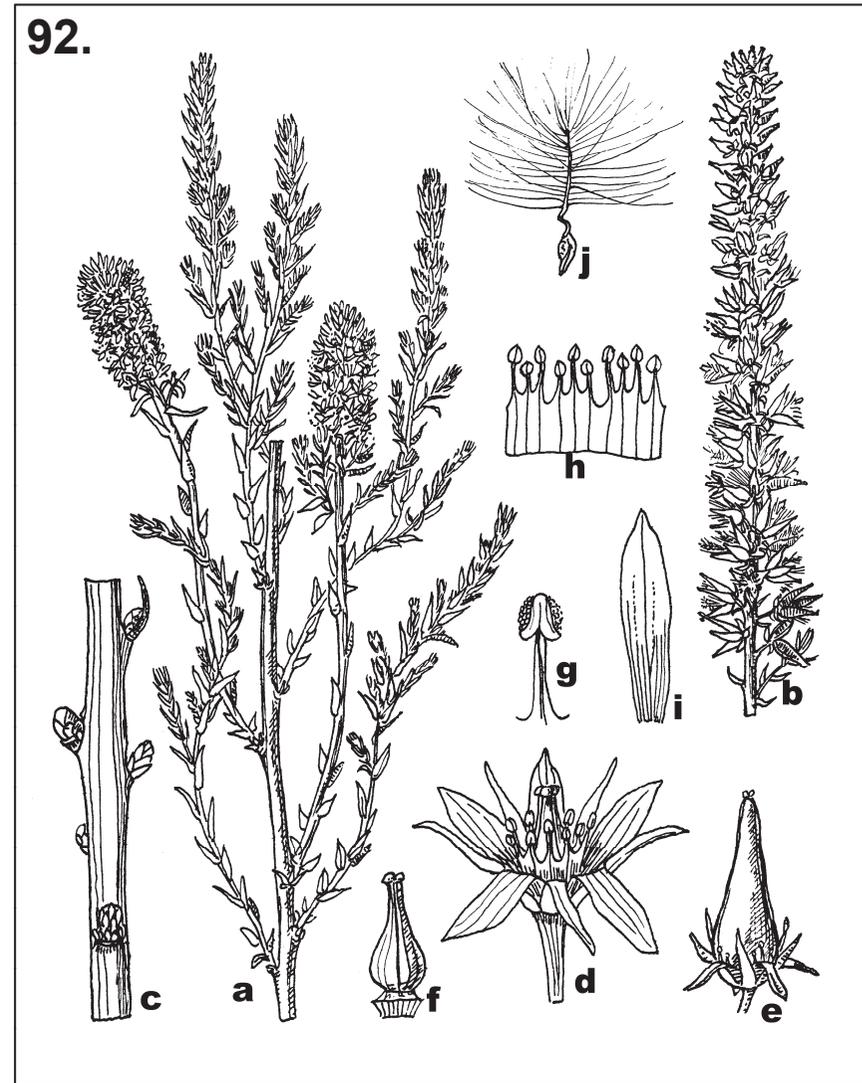
90.



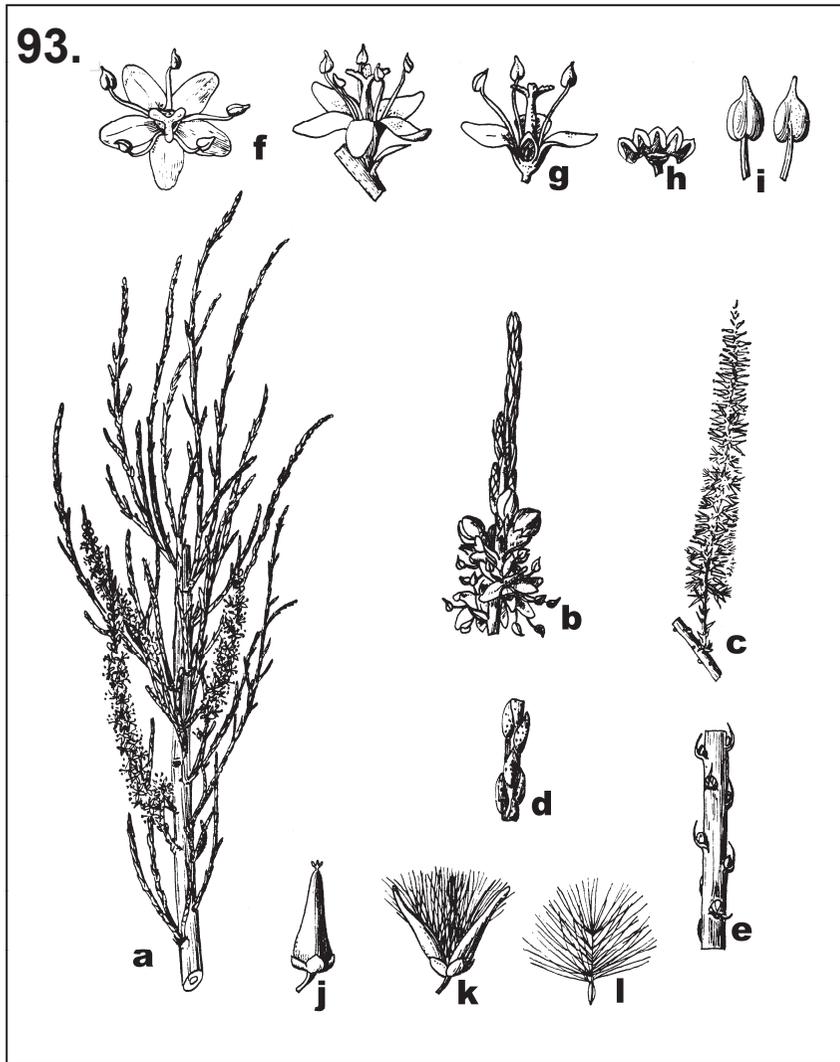
*Rhus typhina*: a) fructing twig, b) twig with buds, c) inflorescence, d) flower



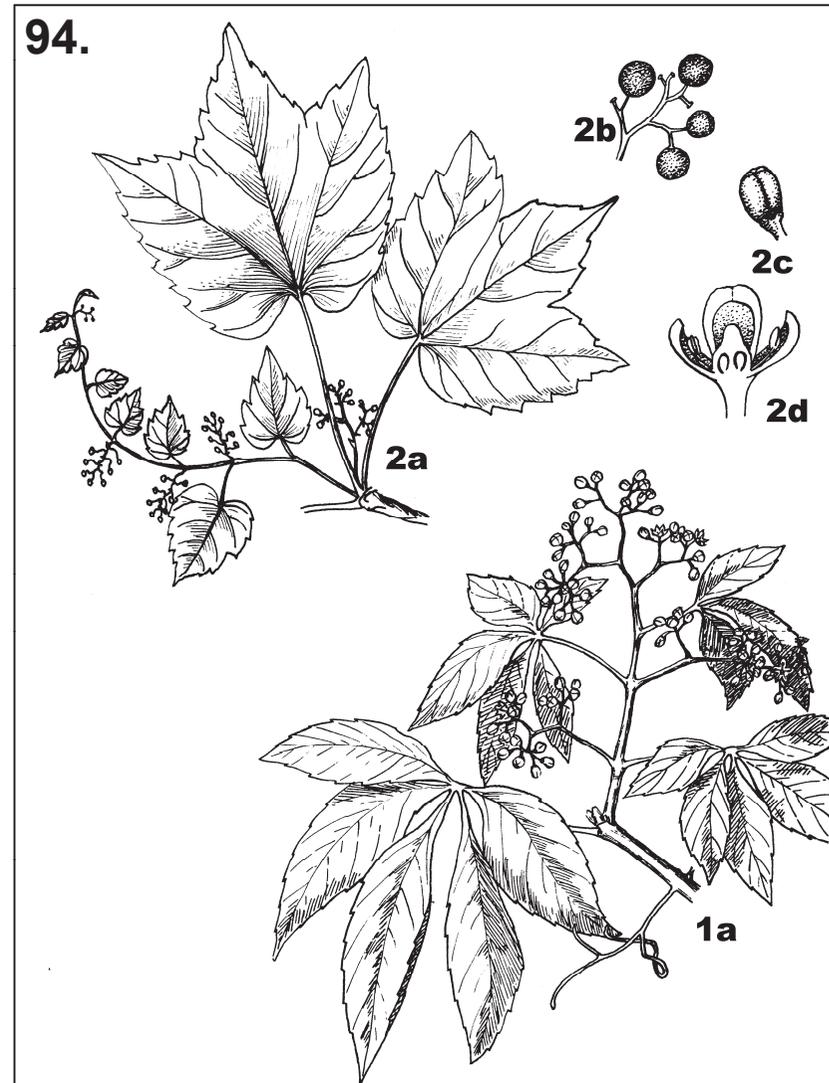
*Hedera helix*: a) flowering twig, b) plodenství, c) flower, d) stamens,  
e) fruit – various views, f) seed, g) seed – longitudinal section



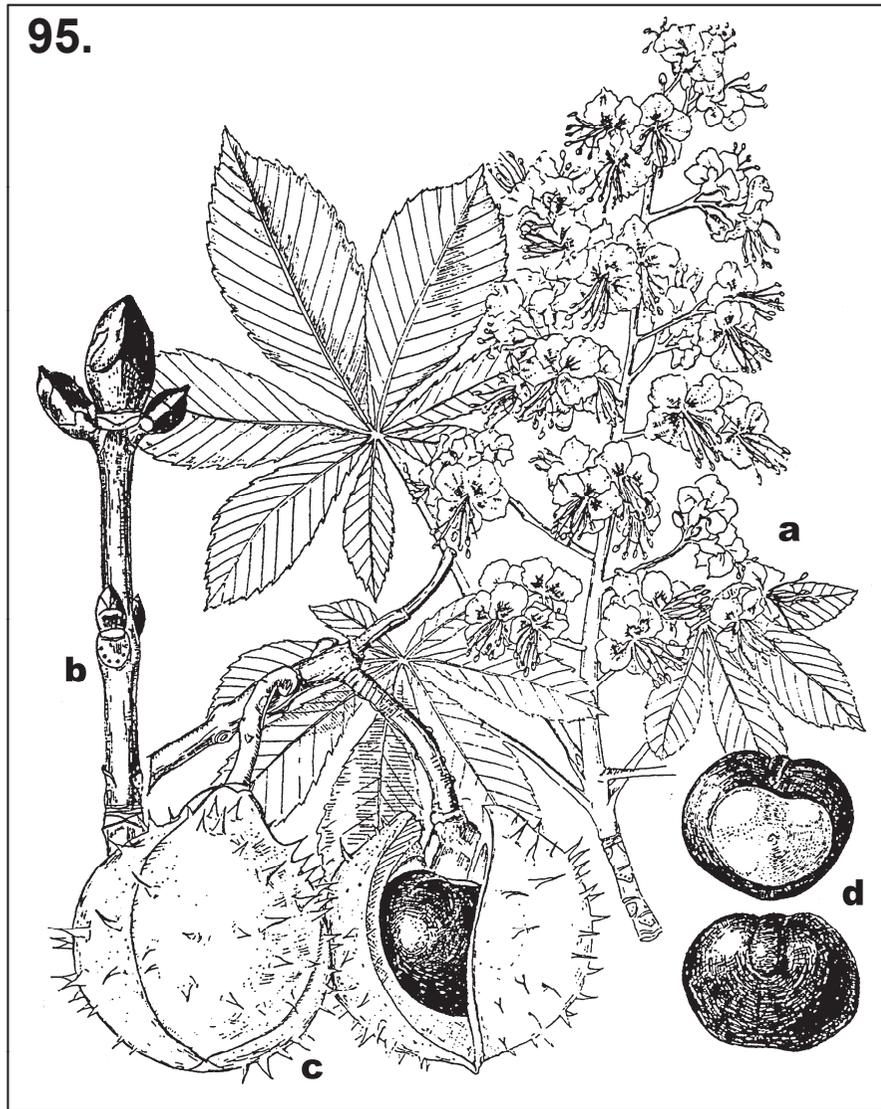
*Myricaria germanica*: a) flowering twig, b) ripen infructescenc,  
c) twig with buds, d) flower, e) closed flower, f) pistil,  
g) stamen, h) opened stamens, grow together, i) petal, j) seed



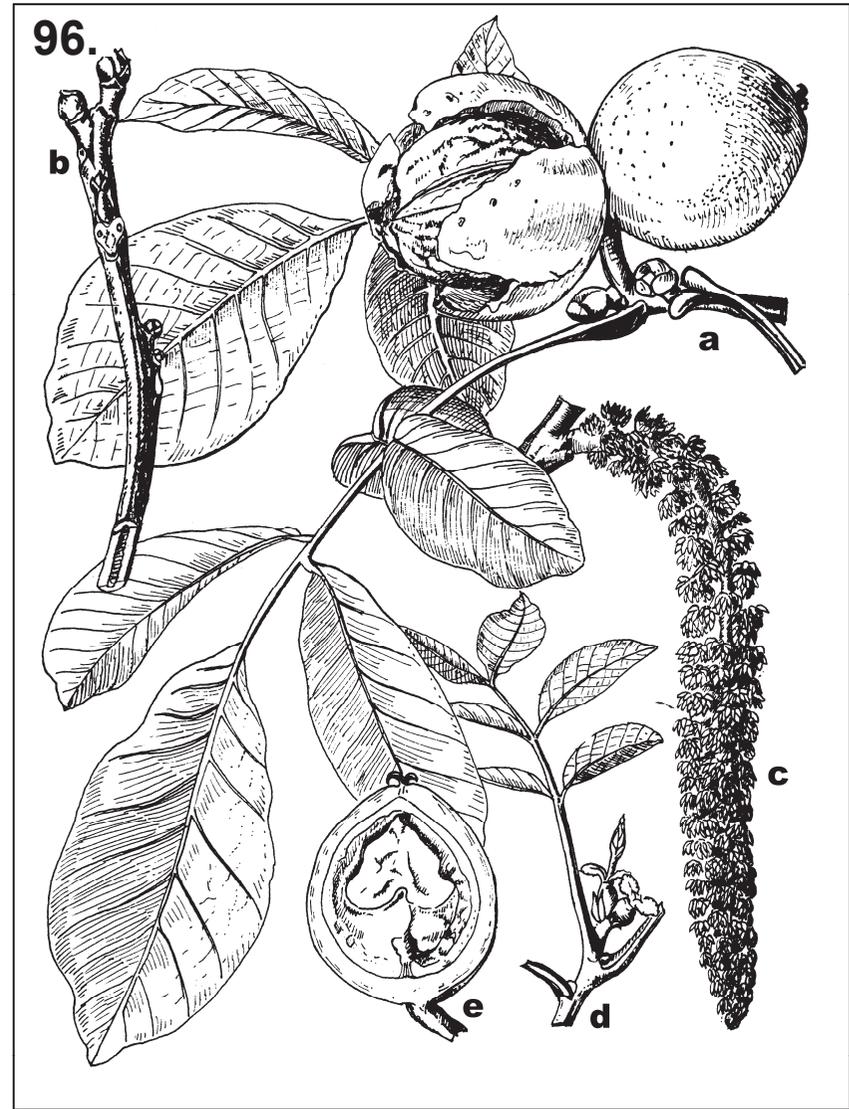
*Tamarix gallica*: a) flowering twig, b) part of inflorescence, c) mature infructescence, d) shoot with leaves, e) twig with buds, f) flower, g) flower – longitudinal section, h) opened calyx, i) anthers, j) closed capsule, k) ripe fruit, l) seed



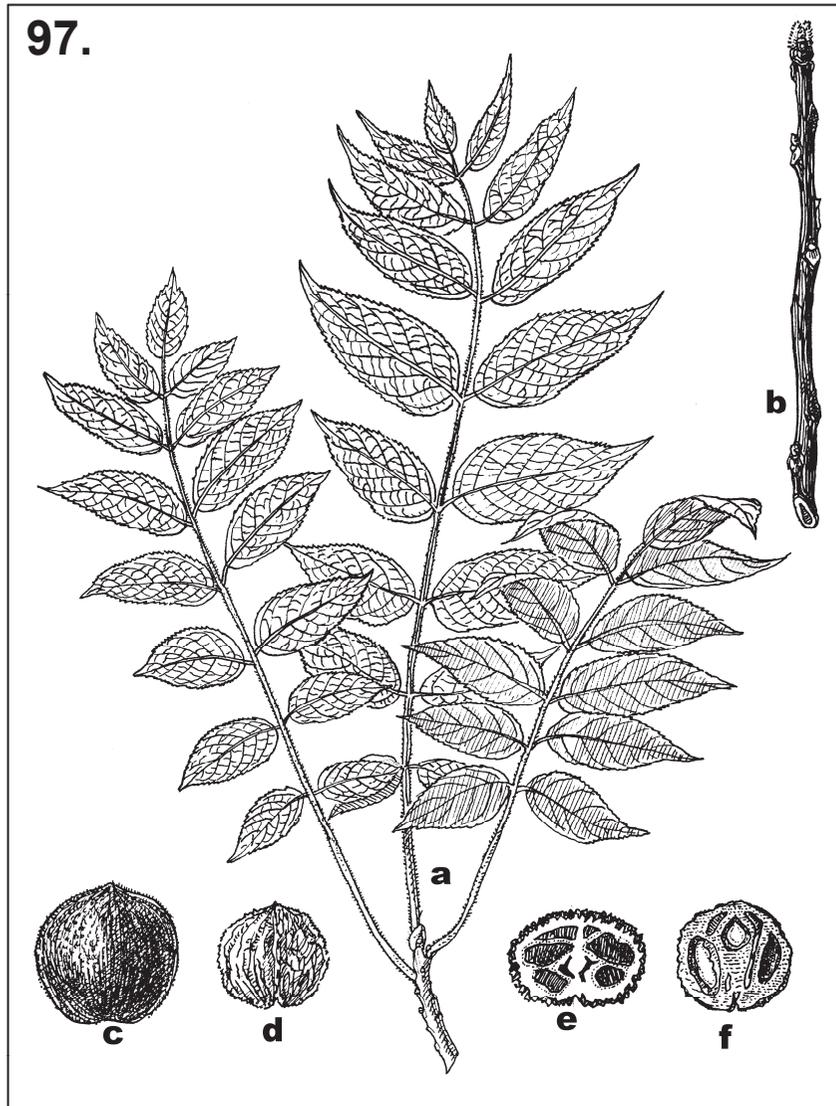
1. *Parthenocissus quinquefolia*: a) twig with leaves  
 2. *Parthenocissus tricuspidata*: a) flowering twig, b) inflorescence, c) closed flower, d) flower – cross-section



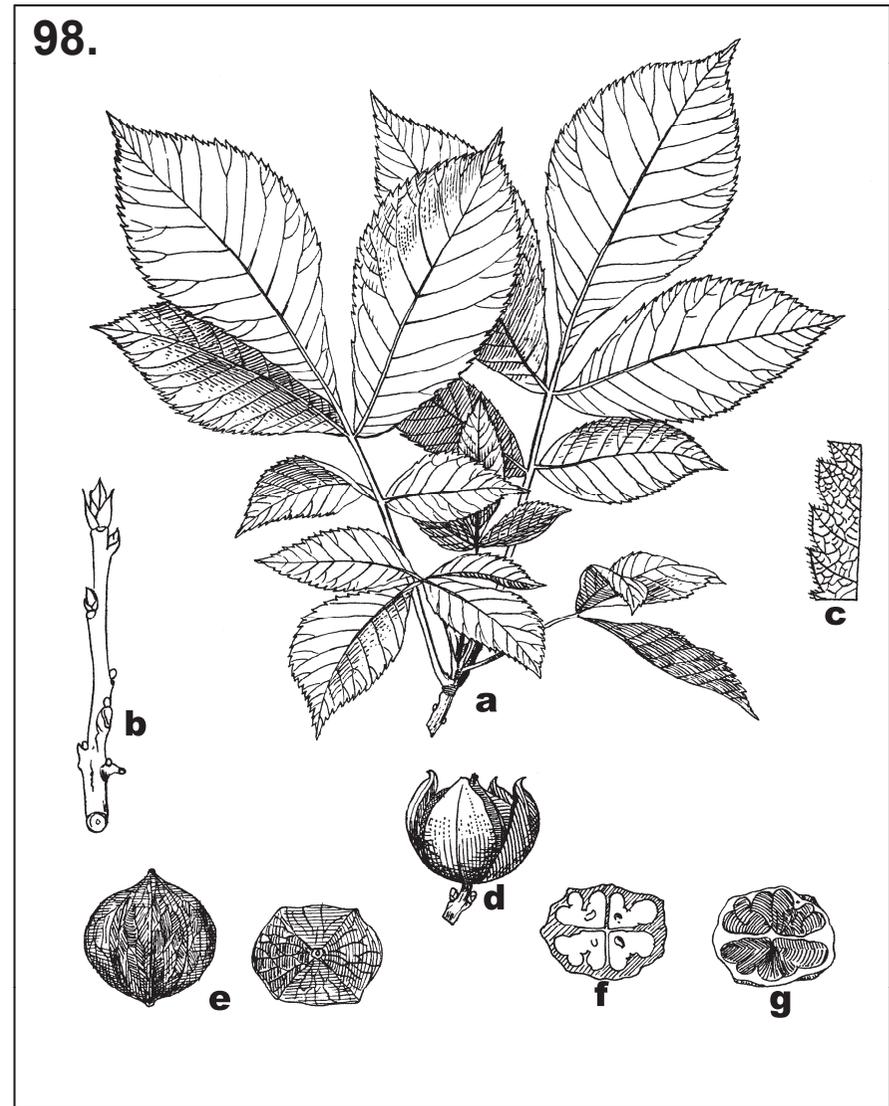
*Aesculus hippocastanum*: a) flowering twig, b) twig with buds, c) matured fruits, d) seeds



*Juglans regia*: a) fructing twig, b) twig with buds and leaf scar, c) ♂ inflorescence, d) twig with ♀ inflorescence, e) fruit – cross-section

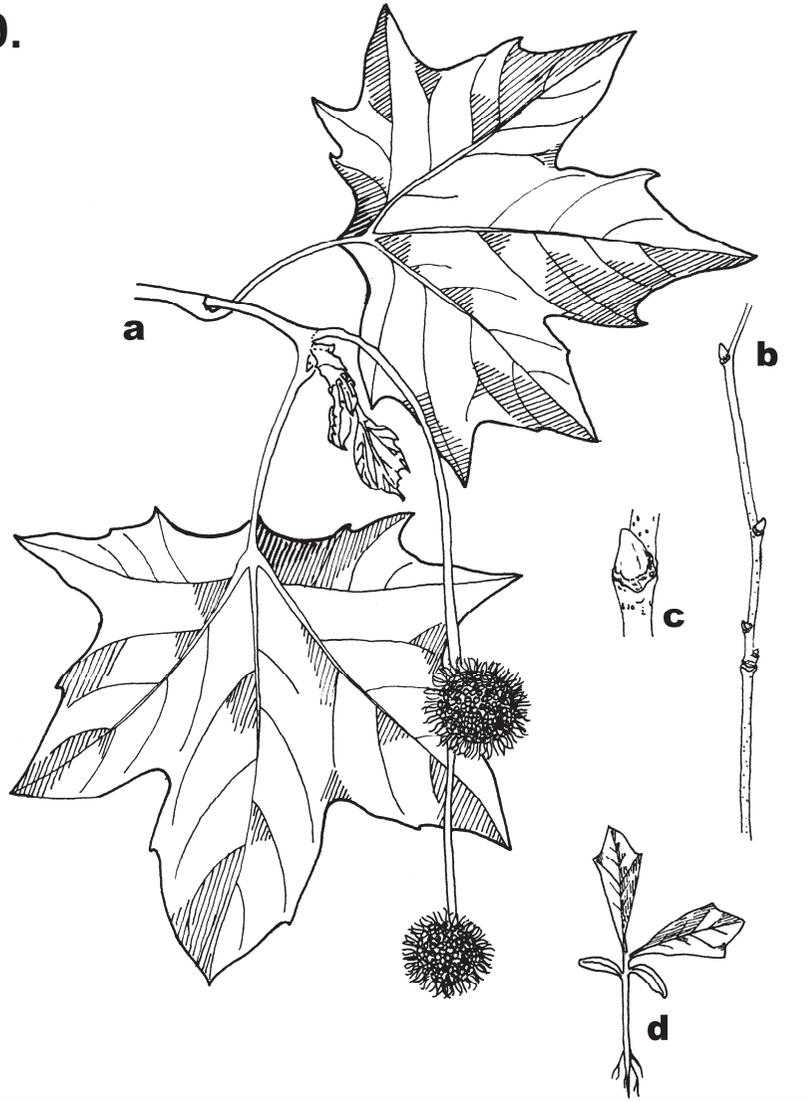


*Juglans nigra*: a) twig with leaves, b) shoot with buds, c) fruit  
d) seed, e) seed – longitudinal section f) seed – cross-section



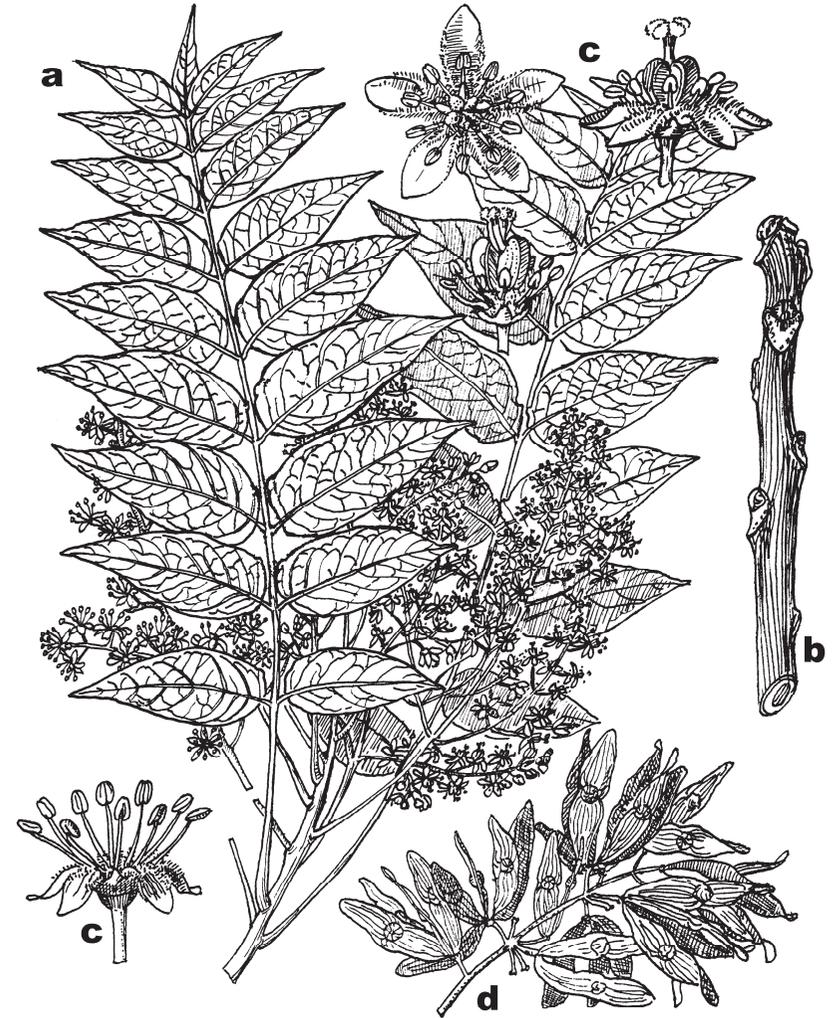
*Carya ovata*: a) twig with leaves, b) shoot with buds, c) leaf margin – enlarged, d) fruit,  
e) seed, f, g) seed – cross-section

99.



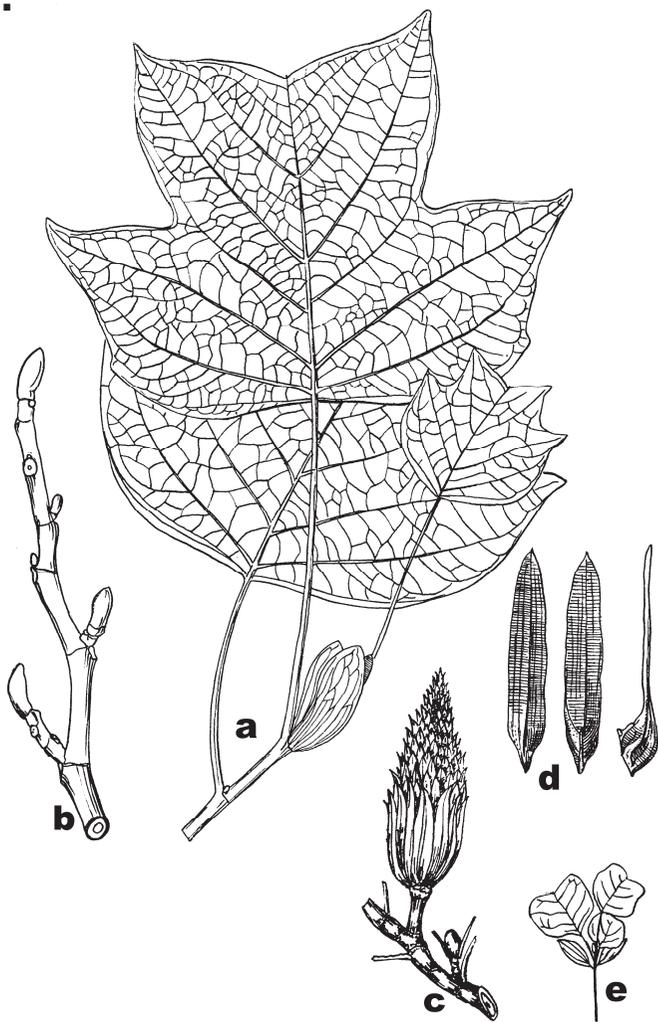
*Platanus x acerifolia*: a) fructing twig, b) part of branchlet with buds, c) bud with leaf scar, d) seedling

100.



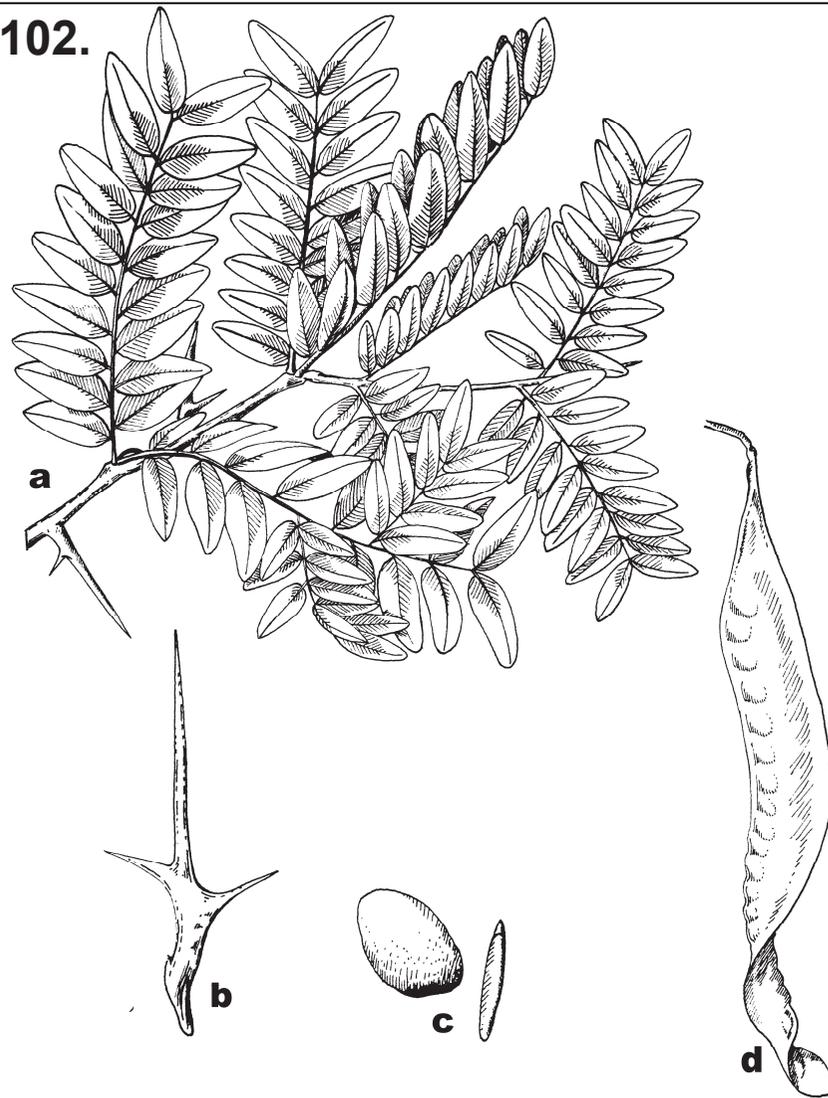
*Ailanthus glandulosa*: a) flowering twig, b) twig with buds, c) flower, d) infructescens

101.



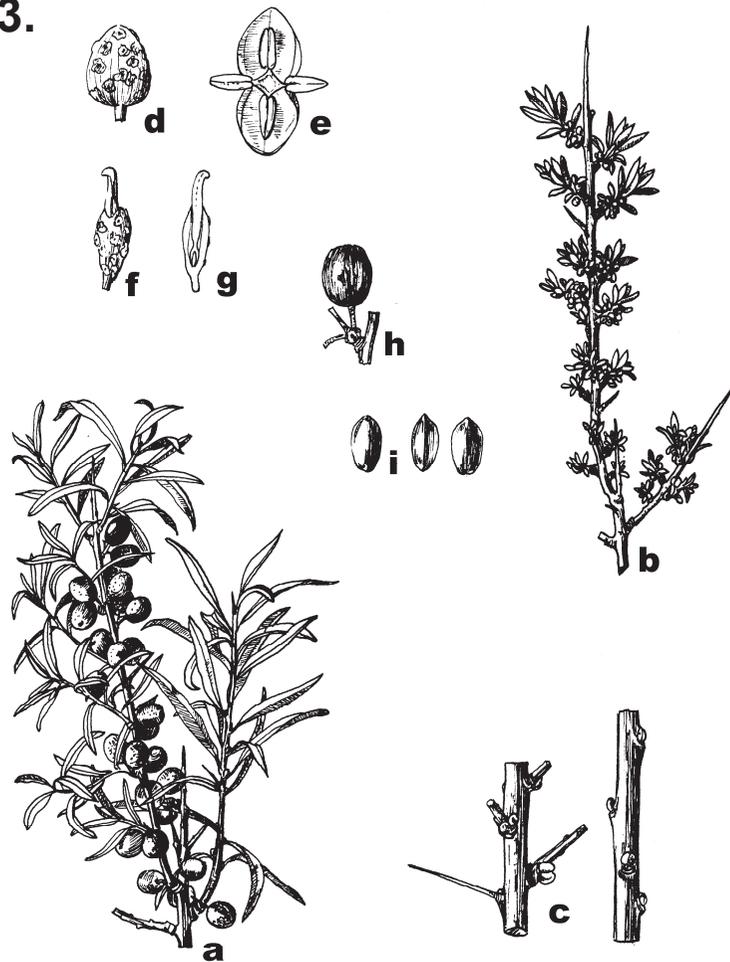
*Liriodendron tulipifera*: a) branchlet with leaves, b) twig with buds, c) infructescens, d) seed, e) seedling

102.



*Gleditsia triacanthos*: a) branchlet with paripinnated and two times paripinnated leaves, b) thorn (spine), c) seed – various views, d) fruit

103.



*Hippophaë rhamnoides*: a) fructing twig, b) flowering twig, c) branchlet with buds, d) closed ♂ flower, e) opened ♂ flower, f) ♀ flower, g) ♀ flower – longitudinal section, h) fruit, i) seed – various views

104.



*Ilex aquifolium*: a) fructing twig, b) flowering twig, c) fruit – various views, d) pistil, e) fruit, f) seed – various views



Maps 1



*Abies alba*



*Juniperus communis ssp. communis*



*Larix decidua*



*Picea abies*



*Pinus mugo*



*Pinus uncinata ssp. uliginosa*



*Pinus sylvestris*



*Taxus baccata*



*Fagus sylvatica*



*Quercus robur*



*Quercus petraea*



*Carpinus betulus*



*Acer pseudoplatanus*



*Acer platanoides*



*Acer campestre*



*Fraxinus excelsior*



*Ulmus glabra*



*Ulmus minor*



*Ulmus laevis*



*Cerasus avium*



*Betula pendula*



*Betula pubescens*



*Alnus glutinosa*



*Sorbus aucuparia*



*Tilia cordata*



*Tilia platyphyllos*



*Salix alba*



*Populus tremula*

## Index of scientific names

- Abies* 4, 8  
*Abies alba* 8, 9  
*Abies borisii-regis* 8  
*Abies cephalonica* 8  
*Abies concolor* 10  
*Abies grandis* 9  
*Abies homolepis* 8  
*Abies nebrodensis* 8  
*Abies nordmanniana* 9  
*Abies pinsapo* 8  
*Abies veitchii* 8  
*Acer* 33  
*Acer campestre* 33, 34  
*Acer dasycarpum* 33  
*Acer negundo* 33, 35  
*Acer palmatum* 33  
*Acer platanoides* 33, 34  
*Acer pseudoplatanus* 33  
*Acer saccharinum* 33  
*Acer saccharum* 33  
*Aceraceae* 32  
*Adelges nordmanniana* 9  
*Aesculus hippocastanum* 56  
*Agathis* 20  
*Agathis robusta* 20  
*Ailanthus glandulosa* 56  
*Alnus* 36, 37  
*Alnus cordata* 37  
*Alnus glutinosa* 37  
*Alnus incana* 37  
*Alnus viridis* 37, 38  
*Amelanchier* 46  
*Amentotaxus* 20  
*Amorpha* 49  
*Amygdalus* 45  
*Amygdalus nana* 45  
*Amygdalus communis* 45  
*Anacardiaceae* 55  
*Andromeda* 55  
*Aphananthe* 30  
*Aquifoliaceae* 58  
*Araliaceae* 55  
*Araucaria araucana* 20  
*Araucariaceae* 20  
*Arbutus* 55  
*Arceuthobium* 56  
*Arctostaphylos* 55  
*Aronia* 46  
*Azalea* 55  
*Berberidaceae* 54  
*Betula* 36, 38  
*Betula carpatica* 38  
*Betula nana* 38, 40  
*Betula papyrifera* 38  
*Betula pendula* 38, 39  
*Betula pubescens* 38, 39  
*Betulaceae* 36  
*Bignoniaceae* 58  
*Buxaceae* 57  
*Buxus sempervirens* 57  
*Clematis* 55  
*Caesalpiniaceae* 57  
*Calluna* 55  
*Calocedrus* 17  
*Campsis radicans* 58  
*Caprifoliaceae* 51  
*Caragana* 49  
*Carpinus* 27  
*Carpinus betulus* 27  
*Carya* 50, 51  
*Carya pecan* 51  
*Castanea* 27  
*Castanea crenata* 27  
*Castanea dentata* 27  
*Castanea sativa* 27  
*Catalpa* 58  
*Catalpa bignonioides* 58  
*Catalpa speciosa* 58  
*Cathaya* 4  
*Cedrus* 4, 16  
*Cedrus atlantica* 16  
*Cedrus deodara* 16  
*Cedrus libani* 16  
*Celastraceae* 53  
*Celtis* 30  
*Cephalotaxaceae* 20  
*Cephalotaxus* 20  
*Cerasus* 44  
*Cerasus avium* 44  
*Cerasus fruticosa* 44  
*Cerasus mahaleb* 44, 45  
*Cerasus serrulata* 44  
*Ceratonia siliqua* 57  
*Cercis* 57  
*Cladrastis lutea* 49  
*Clematis* 54  
*Clematis vitalba* 55  
*Colutea* 49  
*Cornaceae* 53  
*Cornus* 53  
*Cornus alba* 53  
*Cornus mas* 53  
*Cornus sanguinea* 53  
*Cornus stolonifera* 53  
*Cornus mas* 53  
*Coronilla* 49  
*Corylaceae* 27  
*Corylus* 27, 28  
*Corylus avellana* 28  
*Corylus colurna* 28  
*Cotinus* 55  
*Cotoneaster* 46  
*Crataegius laevigata* 48  
*Crataegus* 46, 48  
*Crataegus calycina* 48  
*Crataegus monogyna* 48



*Crataegus oxyacantha* 48  
*Cryptomeria japonica* 19  
Cupressaceae 17  
*Cupressocyparis leylandii* 17  
*Cupressus* 17  
*Cupressus sempervirens* 17  
*Cydonia* 46  
*Deutzia* 54  
Dicotyledonae 20  
*Diervilla* 51  
*Dryas* 48  
*Duschekia* 36  
Elaeagnaceae 57  
*Elaeagnus* 57  
*Elaeagnus angustifolia* 57  
*Empetrum* 55  
*Erica* 55  
Ericaceae 55  
*Eucalyptus* 58  
*Eucalyptus camaldulensis* 58  
*Eucalyptus globulus* 58  
*Eucalyptus botryoides* 58  
*Euonymus* 53  
*Euonymus europaeus* 53  
*Euonymus verrucosus* 53  
Fabaceae 49  
Fagaceae 21  
*Fagus* 21  
*Fagus crenata* 21  
*Fagus engleriana* 21  
*Fagus grandifolia* 21  
*Fagus japonica* 21  
*Fagus orientalis* 21, 22  
*Fagus sylvatica* 21, 22  
*Fagus taurica* 22  
*Ficus* 56  
*Forsythia* 29  
*Frangula* 52  
*Frangula alnus* 52  
*Fraxinus* 29  
*Fraxinus americana* 29  
*Fraxinus angustifolia* 29  
*Fraxinus excelsior* 29  
*Fraxinus ornus* 26, 29  
*Fraxinus pennsylvanica* 29  
*Fraxinus angustifolia* 30  
*Ginkgo biloba* 20  
Ginkgoaceae 20  
*Gleditsia triacanthos* 57  
*Grossularia* 54  
Grossulariaceae 54  
*Gymnocladus dioicus* 57  
*Hebe* 58  
*Hedera* 55  
*Hedera helix* 55  
*Hemiptelea* 30  
Hippocastanaceae 56  
*Hippophaë* 57  
*Hippophaë rhamnoides* 57  
*Hydrangea* 54  
Hydrangeaceae 54  
*Chaenomeles* 46  
*Chamaecyparis* 16, 17, 19  
*Chamaecyparis lawsoniana* 19  
*Chamaecyparis nootkatensis* 19  
*Chamaecyparis obtusa* 19  
*Chamaecyparis pisifera* 19  
*Chosenia* 40  
*Ilex* 58  
*Ilex aquifolium* 58  
*Juglans* 50  
Juglandaceae 50  
*Juglans nigra* 50  
*Juglans regia* 51  
*Juniperus* 17  
*Juniperus communis* 18  
*Juniperus communis* subsp. *communis* 18  
*Juniperus communis* subsp. *alpina* 18  
*Juniperus chinensis* 18  
*Juniperus sabina* 18  
*Juniperus squamata* 18  
*Juniperus virginiana* 18  
*Kerria* 49  
*Keteleeria* 4  
*Kolkwitzia* 51  
Labrador tea 55  
*Laburnum* 49, 50  
*Laburnum alpinum* 50  
*Laburnum anagyroides* 50  
*Larix* 4, 13  
*Larix decidua* 13, 14  
*Larix kaempferi* 13, 14  
*Larix occidentalis* 13  
*Larix sibirica* 13  
*Larix* × *eurolepis* 14  
Lauraceae 58  
*Laurocerasus* 46  
*Laurocerasus officinalis* 46  
*Laurus* 58  
*Ledum* 55  
*Ligustrum vulgare* 29  
Liliaceae 20  
Liliopsida 20  
*Liriodendron tulipifera* 57  
*Lonicera* 51  
*Lonicera caprifolium* 51  
*Lonicera nigra* 51  
*Lonicera tatarica* 51  
*Lonicera xylosteum* 51  
Loranthaceae 56  
*Loranthus* 56  
*Maackia amurensis* 49  
*Maclura* 56  
*Magnolia* 57  
Magnoliaceae 56  
Magnoliopsida 20  
*Mahonia aquifolium* 54  
*Malus* 46, 47  
*Malus domestica* 48  
*Malus sylvestris* 48

*Malus pumila* 47  
*Mespilus* 46  
*Metasequoia glyptostroboides* 19  
*Microbiota* 17  
*Monocotyledonae* 20  
*Moraceae* 56  
*Morus* 56  
*Myricaria* 55  
*Myricaria germanica* 55  
*Myrtaceae* 58  
*Olea europaea* 29  
*Oleaceae* 29  
*Ostrya* 29  
*Ostrya carpinifolia* 29  
*Oxyccus* 55  
*Padus* 46  
*Padus racemosa* 46  
*Paeonia* 54  
*Parthenocissus* 55  
*Paulownia tomentosa* 58  
*Phellodendron* 58  
*Philadelphaceae* 54  
*Philadelphus* 54  
*Physocarpus* 49  
*Picea* 4  
*Picea abies* 4  
*Picea engelmannii* 7  
*Picea obovata* 5  
*Picea omorica* 6  
*Picea pungens* 7  
*Picea sitchensis* 7  
*Pinaceae* 4  
*Pinus* 4, 10  
*Pinus contorta* 12  
*Pinus contorta* subsp. *latifolia* 12  
*Pinus halepensis* 10  
*Pinus leucodermis* 10  
*Pinus longaeva* 10  
*Pinus maritima* 10  
*Pinus merkusii* 10  
*Pinus mugo* 10  
*Pinus nigra* 11  
*Pinus peuce* 10  
*Pinus pinea* 10  
*Pinus ponderosa* 10  
*Pinus strobus* 12  
*Pinus sylvestris* 10  
*Pinus uncinata* subsp. *uliginosa* 10  
*Pinus wallichiana* 10  
*Pistacia* 55  
*Planera* 30  
*Platanaceae* 56  
*Platanus* 56  
*Platanus x acerifolia* 56  
*Platyclusus* 17  
*Poaceae* 20  
*Podocarpaceae* 20  
*Podocarpus* 20  
*Pomoideae* 46  
*Populus* 40  
*Populus alba* 40, 41  
*Populus deltoides* 41  
*Populus nigra* 40  
*Populus tremula* 40, 42  
*Populus x canadensis* 40, 41  
*Populus x euramericana* 40, 41  
*Potentilla* 49  
*Prunoideae* 44  
*Prunus* 45  
*Prunus domestica* 45  
*Prunus spinosa* 45  
*Pseudolarix* 4  
*Pseudotsuga* 4, 14  
*Pseudotsuga glauca* 14, 15  
*Pseudotsuga japonica* 14  
*Pseudotsuga macrocarpa* 14  
*Pseudotsuga menziesii* 4, 14  
*Pseudotsuga sinensis* 14  
*Pseudotsuga wilsoniana* 14  
*Ptelea* 58  
*Pteroceltis* 30  
*Pyracantha* 46  
*Pyrus* 46, 48  
*Pyrus pyraster* 48  
*Pyrus communis* 48  
*Pyrus communis* var. *sativa* 48  
*Quercus* 23  
*Quercus alba* 23  
*Quercus cerris* 25  
*Quercus dalechampii* 25  
*Quercus ilex* var. *rotundifolia* 23  
*Quercus macrocarpa* 23  
*Quercus mongolica* 23  
*Quercus petraea* 24, 26  
*Quercus pubescens* 26  
*Quercus robur* 23  
*Quercus rubra* 23, 26  
*Quercus suber* 23  
*Quercus variabilis* 23  
*Quercus velutina* 23  
*Quercus polycarpa* 25  
*Ranunculaceae* 54  
*Rhamnaceae* 52  
*Rhamnus* 52  
*Rhamnus cathartica* 52  
*Rhodococcum* 55  
*Rhododendron* 55  
*Rhodotypos* 49  
*Rhus* 55  
*Rhus typhina* 55  
*Ribes* 54  
*Ribes grossularia* 54  
*Ribes alpinum* 54  
*Ribes nigrum* 54  
*Ribes petraeum* 54  
*Robinia* 49  
*Robinia pseudoacacia* 49  
*Rosa* 48, 49  
*Rosa pendulina* 49  
*Rosa pimpinellifolia* 49

*Rosa canina* 49  
*Rosa gallica* 49  
Rosaceae 44  
Rosoidaeae 48  
*Rubus* 48  
*Ruscus* 20  
Rutaceae 58  
Salicaceae 40  
*Salix* 40, 42  
*Salix alba* 42  
*Salix caprea* 43  
*Salix cinerea* 44  
*Salix daphnoides* 43  
*Salix elaeagnos* 43  
*Salix fragilis* 43  
*Salix pentandra* 43  
*Salix purpurea* 44  
*Salix triandra* 44  
*Salix viminalis* 44  
*Salix × rubens* 43  
*Sambucus* 51, 52  
*Sambucus nigra* 52  
*Sambucus racemosa* 52  
*Sarothamnus* 49  
Saxifragaceae 54  
Sciadopityaceae 19  
*Sciadopitys* 19  
*Sciadopitys verticillata* 19  
Scrophulariaceae 58  
*Sequoia sempervirens* 19  
*Sequoiadendron giganteum* 19  
*Schisandra* 57  
*Sibiraea* 49  
Simarubaceae 56  
*Sophora* 50  
*Sophora japonica* 49, 50  
*Sorbaria* 49  
*Sorbus* 46  
*Sorbus bohemica* 46  
*Sorbus eximia* 46  
*Sorbus sudetica* 46  
*Sorbus aria* 46, 47  
*Sorbus aucuparia* 46  
*Sorbus danubialis* 46  
*Sorbus domestica* 46  
*Sorbus torminalis* 46, 47  
*Spartium* 20  
Spiraeoideae 49  
*Staphylea pinnata* 54  
Staphyleaceae 53  
*Symphoricarpos* 51  
*Syringa* 29  
Tamaricaceae 55  
*Tamarix* 20, 55  
Taxaceae 16  
*Taxodium distichum* 19  
*Taxus* 16  
*Taxus baccata* 16  
*Taxus cuspidata* 16  
*Thuja* 16, 18  
*Thuja koraiensis* 18  
*Thuja occidentalis* 18  
*Thuja plicata* 18  
*Thujopsis* 17  
*Tilia* 35  
*Tilia argentea* 35  
*Tilia cordata* 35, 36  
*Tilia platyphyllos* 35  
*Tilia tomentosa* 35  
*Tilia × europaea* 35  
*Tilia × vulgaris* 35  
Tiliaceae 35  
*Torreya* 16  
*Tsuga* 4, 15  
*Tsuga canadensis* 15, 16  
*Tsuga heterophylla* 15  
Ulmaceae 30  
*Ulmus* 30  
*Ulmus carpinifolia* 30  
*Ulmus glabra* 30, 31  
*Ulmus laevis* 30, 32  
*Ulmus minor* 30, 31  
*Ulmus scabra* 30  
*Ulmus x hollandica* 31  
*Vaccinium* 55  
*Viburnum* 51, 52  
*Viburnum lantana* 52  
*Viburnum opulus* 52  
*Viscum* 56  
Vitaceae 55  
*Vitis* 55  
*Vitis vinifera* var. *silvestris* 55  
*Weigelia* 51  
*Wisteria* 49  
*Wollemia* 20  
*Wollemia nobilis* 20  
*Yucca* 20  
*Zelkova* 30

## Index of common names

alder 36, 37, 40  
alder buckthorn 52  
almond 45  
almond-leaved willow 44  
apple 46, 47  
arbor-vitae 18  
arrowwood 52  
ash 29  
azalea 55  
bald cypress 19  
bamboo 20  
bastard indigo 49  
bay-leaf willow 43  
beech 21  
bell-heather 55  
big tree 19  
bird cherry 46  
birch 25, 36, 38, 39  
bitter almond 45  
black alder 37  
black currant 54  
black locust 49  
black pine 11  
black poplar 40  
black walnut 50  
black-barried honeysuckle 51  
bladder senna 49  
bladdernut 54  
blue spruce 7  
blueberry 55  
box elder 33, 35  
boxwood 57  
buckthorn 52  
canada hemlock 15  
carob 57  
cat tree 53  
Caucasian fir 9  
cedar 4, 18  
cedar of Lebanon 16  
coastal redwood 19  
coffee tree 57  
Colorado spruce 7  
common ash 29  
common juniper 18  
common laurel cherry 46  
common seabuckthorn 57  
common yew 16  
cork tree 58  
cornelian cherry 53  
crab apple 48  
crack willow 43  
cranberry 55  
crowberry 55  
cucumber tree 57  
currant 54  
deutzia 54  
dog rose 49  
dogberry 55  
dogwood 53  
douglas fir 4, 9, 14, 15  
dutch myrtle 55  
dwarf almond 45  
dwarf birch 38, 40  
eastern arbor-vitae 18  
eastern hemlock 15  
eastern redcedar 18  
eastern white pine 12  
elder 51, 52  
elm 30  
English walnut 51  
eucalypt 58  
European ash 29  
European aspen 40, 42  
European beech 21  
European birch 38, 39  
European elder 52  
European green alder 38  
European hornbeam 27  
European larch 13  
European silver fir 8  
European white elm 30, 32  
evergreen ivy 55  
false cypress 19  
fen-berry 55  
field maple 33, 34  
fir 4, 8  
five finger 49  
fly honeysuckle 51  
frutescent cherry 44  
garden plum 45  
giant arbor-vitae 18  
goat willow 43  
golden chain 50  
golden rain 50  
grand fir 9  
Grecian fir 8  
green alder 37  
guelder rose 52  
hackberry 30  
hawthorn 46, 48  
hazel 27, 28  
heather 55  
hemlock 4, 15  
Hickory 51  
holly 58  
honey locust 57  
honeysuckle 51  
Hop hornbeam 29  
hornbeam 27  
horse chestnut 56  
hydrangea 54  
cherry 44  
cherry laurel 46  
chestnut 27  
Chinese tree of heaven 56  
Japanese cherry 44

Japanese larch 13, 14  
 Japanese maple 33  
 Japanese pagoda tree 50  
 jetbead 49  
 Judas tree 57  
 juniper 17  
 kerria 49  
 labrador tea 55  
 laburnum 49  
 large-leaved linden 35  
 larch 4, 13  
 lawson false cypress 19  
 ligneous grasses 20  
 lime 35  
 linden 35  
 Lodgepole pine 12  
 London plane 56  
 loranthus 56  
 magnolia 57  
 mammoth tree 19  
 manna ash 29  
 maple 33  
 mazzard cherry 44  
 medlar 46  
 milk trefoil 49  
 mistletoe 56  
 mockorange 54  
 mountain ash 46  
 mountain currant 54  
 mulberry 56  
 myricaria 55  
 myrta 58  
 narrow-leaved ash 29, 30  
 Norway maple 33, 34  
 Norway spruce 4  
 oak 23  
 old-fashioned weigela 51  
 oleaster 57  
 olive tree 29  
 osier 44  
 osier dogwood 53  
 pagoda tree 50  
 palms 20  
 paper birch 38  
 pea tree 49  
 pear 46, 48  
 pedunculate oak 23  
 peony 54  
 perfoliate honeysuckle 51  
 piperidges 54  
 plane tree 56  
 plum 45  
 poplar 40  
 privet 29  
 pubescent birch 38, 39  
 pubescent oak 26  
 purple willow 44  
 quince 46  
 red dogwood 53  
 red elder 52  
 red oak 26  
 redwood 19  
 rock red currant 54  
 rose 48, 49  
 rowan 46  
 royal paulownia 58  
 Russian olive 57  
 Sswara cypres 19  
 scorpion senna 49  
 Scotch laburnum 50  
 Scotch pine 10  
 sea buckthorn 57  
 Serbian spruce 6  
 sessile oak 24  
 shizandra 57  
 shrubby trefoil 58  
 Siberian larch 13  
 silver maple 33  
 Sitka spruce 7  
 sloe 45  
 small-leaved linden 35, 36  
 smooth-leaved elm 30, 31  
 snowberry 51  
 Southern pines 12  
 south-European sweet chestnut 27  
 speckled alder 37  
 spindle tree 53  
 spruce 4  
 sugar maple 33  
 sweet chestnut 27  
 sycamore 56  
 sycamore maple 33  
 tamarisk 55  
 tatarian dogwood 53  
 true cedar 16  
 tulip tree 57  
 Turkey oak 25  
 Turkish hazel 28  
 umbrella pine 19  
 viburnum 51 52  
 vine 55  
 violet willow 43  
 virgin's bower 54  
 walnut 50  
 warty-backed spindle tree 53  
 wayfaring tree 52  
 western hemlock 15  
 western larch 13  
 western red cedar 18  
 Weymouth pine 12  
 white cedar 18  
 white fir 10  
 white mulberry 56  
 white pine 12  
 white poplar 40, 41  
 white willow 42  
 whitebeam 46, 47  
 whitethorn 48  
 wild pear 48  
 wild service tree 46, 47

willow 40, 42  
woodbine 55  
wych elm 30, 31  
yew 16  
zelkova 30

## References

- Kolektiv autorů, 1949: Děrevja i kustarniky SSSR I. - III., AN SSSR, Moskva - Leningrad
- Bean, W. J., 1980: Trees & Shrubs Hardy in the British Isles, I. - IV., J. Murray, London
- Farjon, A., 2010: A Handbook of the world's conifers. : Volume 1,2, Brill, Leiden
- Hieke, K., 1978: Praktická dendrologie, SZN, Praha
- Klika, J., 1947: Lesní dřeviny. Lesnická dendrologie. Písek
- Koblížek, J., 2006 : Jehličnaté a listnaté dřeviny našich zahrad a parků, Sursum, Tišnov
- Krüssmann, G., 1972: Handbuch der Nadelgehölze, Paul Parey, Berlin
- Krüssmann, G., 1960: Handbuch der Laubgehölze I. - II., P. Parey, Berlin
- Kubitzki K., ed., 1990: The Families and Genera of Vascular Plants, Vol. I., eds. Kramer K.U et Green P. S. Pteridophytes and Gymnosperms, Springer- Verlag, Berlin,
- Musil, I., Hamerník, J. 2007: jehličnaté dřeviny: přehled nahosemenných i výtrusných dřevin, Lesnická dendrologie 1, Academia, Praha
- Pilát, A., 1953: Listnaté stromy a keře našich zahrad a parků, ČSAV, Praha
- Pilát, A., 1964: Jehličnaté stromy a keře našich zahrad a parků, ČSAV, Praha
- Pokorný, J., 1963: Jehličnany lesů a parků, SZN, Praha
- Rehder, A., 1967: Manual of Cultivated Trees and Shrubs, New York
- Schneider, C., 1906: Illustriertes Handbuch der Laubholzkunde I. - II., Jena
- Úradníček, L., Maděra, P., Koblížek, J. a Tichá, S., 2010: Woody plants of the Czech Republic, Lesnická Práce, Kostelec nad Černými lesy.
- Vidakovic, M., 1991: Conifers morphology and variation, Zagreb