

SCBI Tree Mortality Survey

All Species in Plot

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Chapter 1

Acer negundo

“Box elder” redirects here. For the box elder bug, see *Boisea trivittata*. For other uses, see Box Elder (disambiguation).

Acer negundo is a species of maple native to North America. In Canada it is commonly known as Manitoba maple and occasionally as elf maple. **Box elder**, **boxelder maple**, **ash-leaved maple**, and **maple ash** are its most common names in the United States; in the United Kingdom and Ireland it is also known as **ashleaf maple**.^{*[4]}



Autumn leaf color

1.1 Common names

Indicative of its familiarity to many people over a large geographic range, *A. negundo* has numerous common names.

The names “box elder” and “boxelder maple” are based upon the similarity of its whitish wood to that of **boxwood** and the similarity of its pinnately compound leaves to those of some species of elder.^{*[5]} This is the only North American maple with compound leaves, though several Asian species also have them.^{*[6]}

Other common names are based upon this maple's similarity to **ash**, its preferred environment, its **sugary sap**, a description of its leaves, its **binomial name**, and so on. These names include (but are not limited to) ash-, cut-, or three-leaf (or -leaved) maple; ash maple; sugar ash; Negundo maple; and river maple.^{*[7]} In Canada it is commonly known as Manitoba maple and occasionally as elf maple.^{*[8]} In Russia it is called American maple (Russian: *американский клён*, tr. *amerikansky klyon*) as well as ash-leaf maple (Russian: *клён ясенелистный*, tr. *klyon yasenelistny*), and in Italian *acero americano*.^{*[9]}

Common names may also designate a particular **subspecies**. For example, a common name for *A. negundo* subsp. *interius* may be preceded by “inland” (as in “inland boxelder maple”). A common name for *A. negundo* subsp. *californicum* may be preceded by “California” or “western” .

1.2 Description



Bark of a young Acer negundo.

Acer negundo is a usually fast-growing and fairly short-lived tree that grows up to 10–25 meters (35–80 ft) tall, with a trunk diameter of 30–50 centimeters (12–20 in), rarely up to 1 meter (3.3 ft) diameter. It often has several trunks and can form impenetrable thickets.* [10]

The shoots are green, often with a whitish to pink or violet waxy coating when young. Branches are smooth, somewhat brittle, and tend to retain a fresh green colour rather than forming a bark of dead, protective tissue. The bark on its trunks is pale gray or light brown, deeply cleft into broad ridges, and scaly.* [6]

Unlike most other maples (which usually have simple, palmately lobed leaves), *Acer negundo* has pinnately compound leaves that usually have three to seven leaflets. Simple leaves are also occasionally present; technically, these are single-leaflet compound leaves. Although some other maples (such as *Acer griseum*, *Acer mandshuricum* and the closely related *A. cissifolium*) have trifoliate leaves, only *A. negundo* regularly displays more than three leaflets.

The leaflets are about 5–10 centimeters (2–4 in) long and 3–7 centimeters ($1\frac{1}{4}$ – $2\frac{3}{4}$ in) wide with slightly serrate margins. Leaves have a translucent light green color and turn yellow in the fall.

The flowers are small and appear in early spring on drooping racemes 10–20 centimeters (4–8 in) long. The fruits are paired samaras, each seed slender, 1–2 centimeters ($\frac{1}{2}$ – $\frac{3}{4}$ in) long, with a 2–3 centimeters ($\frac{3}{4}$ – $1\frac{1}{4}$ in) incurved wing; they drop in autumn or they may persist through winter. Seeds are usually both prolific and fertile.

Unlike most other maples, *A. negundo* is fully dioecious and both a male and female tree are needed for either to reproduce.

- Winter buds: Terminal buds acute, an eighth of an inch long. Lateral buds obtuse. The inner scales enlarge when spring growth begins and often become an inch long before they fall.
- Flowers: April, before the leaves, yellow green; staminate flowers in clusters on slender hairy pedicels one and a half to two inches long. Pistillate flowers in narrow drooping racemes.
- Calyx: Yellow green; staminate flowers campanulate, five-lobed, hairy. Pistillate flowers smaller, five-parted; disk rudimentary.
- Corolla: Wanting.
- Stamens: Four to six, exserted; filaments slender, hairy; anthers linear, connective pointed.
- Pistil: Ovary hairy, borne on disk, partly enclosed by calyx, two-celled, wing-margined. Styles separate at base into two stigmatic lobes.
- Fruit: Maple keys, full size in early summer. Borne in drooping racemes, pedicels one to two inches

long. Key an inch and a half to two inches long, nutlets diverging, wings straight or incurved. September. Seed half an inch long. Cotyledons, thin, narrow.* [6]

1.3 Taxonomy

1.3.1 Subspecies



A. negundo leaves and fruits

Acer negundo is often discussed as comprising three subspecies, each of which was originally described as a separate species. These are:

- *A. negundo* subsp. *negundo* is the main variety and the type to which characteristics described in the article most universally apply. Its natural range is from the Atlantic Coast to the Rocky Mountains.* [10]
- *A. negundo* subsp. *interius* has more leaf serration than the main species and a more matte leaf surface. As the name *interius* indicates, its natural range of Saskatchewan to New Mexico is sandwiched between that of the other two subspecies.* [10]
- *A. negundo* subsp. *californicum* has larger leaves than the main species. Leaves also have a velvety texture which is essential to distinguish it from *A. negundo* subsp. *negundo*. It is found in parts of California and Arizona.* [10]

Some authors further subdivide subsp. *negundo* into a number of regional varieties but these intergrade and their maintenance as distinct taxa is disputed by many. Even the differences between recognized subspecies are probably a matter of gradient speciation.

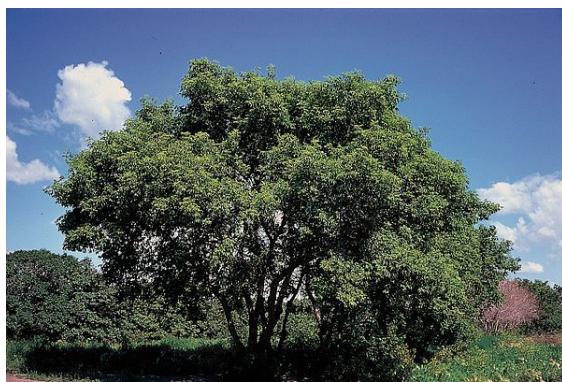
Finally, note that a few botanists treat boxelder maple as its own distinct genus (*Negundo aceroides*) but this is not widely accepted.

1.4 Distribution

As noted, varieties thrive across the United States and Canada. It may also be found as far south as Guatemala.

Although native to North America, it is considered an invasive species in some areas of that continent. It can quickly colonize both cultivated and uncultivated areas and the range is therefore expanding both in North America and elsewhere. In Europe where it was introduced in 1688 as a park tree it is able to spread quickly in places and is considered an invasive species in parts of Central Europe (Germany and the Czech Republic, middle Danube, Vistula river valley in Poland) where it can form mass growth in lowlands, disturbed areas and riparian biomes on calcareous soils. It has also become naturalized in eastern China^{*}[10] and can be found in some of the cooler areas of the Australian continent where it is listed as a pest invasive species.

1.5 Ecology



Boxelder, Manitoba Maple. Tree. ND, USA.

This species prefers bright sunlight. It often grows on flood plains and other disturbed areas with ample water supply, such as riparian habitats. Human influence has greatly favoured this species; it grows around houses and in hedges, as well as on disturbed ground and vacant lots.

Several birds and some squirrels feed on the seeds. The evening grosbeak uses them extensively. The Maple Bug (also known as the Boxelder Bug) lays its eggs on all maples, but prefers this species.

1.6 Cultivation

Although its weak wood, irregular form, and prolific seeding might make it seem like a poor choice for a landscape tree, *A. negundo* is one of the most common maples in cultivation and many interesting cultivars have been developed, including:^{*}[10]

- 'Auratum' – yellowish leaves with smooth undersides
- 'Aureomarginatum' – creamy yellow leaf margins
- 'Baron' – Hardier & seedless variety
- 'Elegans' – distinctively convex leaves
- 'Flamingo' – pink and white variegation (very popular)
- 'Pendulum' – with weeping branches.
- 'Variegatum' – creamy white leaf margins
- 'Violaceum' – younger shoots and branches have bluish colour

1.7 Uses

Although its light, close-grained, soft wood is considered undesirable for most uses, this tree has been considered as a commercial source of wood fiber, for use in fiberboard.

There is some commercial use of the tree for various decorative applications, such as turned items (bowls, stemware, pens). Primarily burl wood and injured wood, where the primary reason is this wood's reaction to injury, where the injured wood develops a red stain.

1.7.1 Use by Native Americans

The Navajo use the wood to make tubes for bellows.^{*}[11] The Cheyenne burn the wood as incense for making spiritual medicines,^{*}[12] and during Sun Dance ceremonies.^{*}[12] They also mix the boiled sap with shavings from the inner sides of animal hides and eat them as candy.^{*}[12]^{*}[13]

The Meskwaki use a decoction of the inner bark as an emetic,^{*}[14] and the Ojibwa use an infusion of the inner bark for the same purpose.^{*}[15] The Chiricahua and Mescalero Apache dry scrapings of the inner bark and keep it as winter food, and they also boil the inner bark until sugar crystallizes out of it.^{*}[16] The Dakota also use the sap to make sugar,^{*}[17] as do the Omaha,^{*}[18]^{*}[19] the Pawnee,^{*}[19] the Ponca,^{*}[19] the Winnebago,^{*}[19] and the indigenous people of Montana, who also freeze the sap and use it as a syrup^{*}[12] The Ojibwa mix the sap with that of the sugar maple and drink it as a beverage.^{*}[20]

The Cheyenne also use the wood to make bowls*[21] and to cook meat.*[12]*[13] The Keres make the twigs into prayer sticks.*[22] The native peoples of Montana also use large trunk burls or knots to make bowls, dishes, drums, and pipe stems.*[12]

The Dakota people and the Omaha people*[19]*[23] make the wood into charcoal, which is used in ceremonial painting and tattooing.*[17]*[19]

The Kiowa burn the wood from the *negundo* subspecies in the altar fire during the peyote ceremony,*[24] and the Sioux boil the sap of this variety in the spring to make sugar.*[25]

The *interius* subspecies is used by Cree to make sugar from the sap,*[26] and the Tewa use the twigs as pipe stems.*[27]

1.8 Archaeological artifacts

Acer negundo was identified in 1959 as the material used in the oldest extant wood flutes from the Americas. These early artifacts, excavated by Earl H. Morris in 1931 in the Prayer Rock district of present-day Northeastern Arizona, have been dated to 620–670 CE.*[28]

The style of these flutes, now known as Anasazi flutes, uses an open tube and a splitting edge at one end. This design pre-dates the earliest extant Native American flute (which use a two-chambered design) by approximately 1,200 years.

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1.11 External links

- "*Acer negundo*". Natural Resources Conservation Service PLANTS Database. USDA.
- Calflora Database: *Acer negundo* (Boxelder)
- *Acer negundo* facts and diagnostic traits
- Interactive Distribution Map of *Acer negundo*
- *Acer negundo* images at bioimages.vanderbilt.edu
- The dictionary definition of Manitoba maple at Wiktionary

Chapter 2

Acer platanoides

Not to be confused with Acer pseudoplatanus.

Acer platanoides (**Norway maple***[2]) is a species of maple native to eastern and central Europe and western Asia, from France east to Russia, north to southern Scandinavia and southeast to northern Iran.*[3]*[4] It is a member of the soapberry and lychee family.

2.1 Description

Acer platanoides is a deciduous tree, growing to 20–30 m (65–100 ft) tall with a trunk up to 1.5 m (5 ft) in diameter, and a broad, rounded crown. The bark is grey-brown and shallowly grooved. Unlike many other maples, mature trees do not tend to develop a shaggy bark. The shoots are green at first, soon becoming pale brown. The winter buds are shiny red-brown.

The leaves are opposite, palmately lobed with five lobes, 7–14 cm (2 3/4–5 1/2 in) long and 8–20 cm or 3 1/4–7 3/4 in (rarely 25 cm or 9 3/4 in) across; the lobes each bear one to three side teeth, and an otherwise smooth margin. The leaf petiole is 8–20 cm (3 1/4–7 3/4 in) long, and secretes a milky juice when broken. The autumn colour is usually yellow, occasionally orange-red.



Flower, close-up

The flowers are in corymbs of 15–30 together, yellow to

yellow-green with five sepals and five petals 3–4 mm (0–1/4 in) long; flowering occurs in early spring before the new leaves emerge. The fruit is a double samara with two winged seeds. The seeds are disc-shaped, strongly flattened, 10–15 mm (3/8–5/8 in) across and 3 mm (1/8 in) thick. The wings are 3–5 cm (1 1/4–2 in) long, widely spread, approaching a 180° angle. It typically produces a large quantity of viable seeds.

Under ideal conditions in its native range, Norway maple may live up to 250 years, but often has a much shorter life expectancy in North America, sometimes only 60 years. Especially when used on streets, it can have insufficient space for its root network and is prone to the roots wrapping around themselves, girdling and killing the tree. Norway maples often cause significant damage and cleanup costs for municipalities and homeowners when branches break off in storms as it is fast-growing and does not have strong wood.*[5]*[6]*[7]*[8]

2.2 Classification and identification



Tree in flower

The Norway maple is a member (and is the type species) of the section *Platanoidea* Pax, characterised by flattened, disc-shaped seeds and the shoots and leaves containing milky sap. Other related species in this section



Norway maple bark



Acer platanoides cv. Schwedleri

include *Acer campestre* (field maple), *Acer cappadocicum* (Cappadocian maple), *Acer lobelii* (Lobel's maple), and *Acer truncatum* (Shandong maple). From the field maple, the Norway maple is distinguished by its larger leaves with pointed, not blunt, lobes, and from the other species by the presence of one or more teeth on all of the lobes.*[6]*[7]

It is also frequently confused with the more distantly related *Acer saccharum* (sugar maple). The sugar maple is easy to differentiate by clear sap in the petiole (Leaf stem; Norway maple has white sap). The tips of the points on Norway maple leaves reduce to a fine “hair”, while the tips of the points on sugar maple leaves are, on close inspection, rounded. On mature trees, sugar maple bark is more shaggy, while Norway maple bark has small, often

criss-crossing grooves. While the shape and angle of leaf lobes vary somewhat within all maple species, the leaf lobes of Norway maple tend to have a more triangular shape, in contrast to the more squarish lobes often seen on sugar maples.

The fruits of Norway maple are paired samaras with widely diverging wings,*[9]*:372 distinguishing them from those of sycamore, *Acer pseudoplatanus* which are at 90 degrees to each other.*[9] Norway maple seeds are flattened, while those of sugar maple are globose. The sugar maple usually has a brighter orange autumn color, where the Norway maple is usually yellow, although some of the red-leaved cultivars appear more orange.

The tree tends to grow out leaves earlier than most maples and holds its leaves somewhat longer in autumn. Seeds begin to be forming in mid-spring and ripen over the course of the summer months, finally dropping in the fall. Unlike some other maples that wait for the soil to warm up, *A. platanoides* seeds require only three months of exposure to sub-40 °F (4.4 °C) temperatures and will sprout in early spring. The heavy seed crop and high germination rate contributes to its invasiveness in North America, where it forms dense monotypic stands that choke out native vegetation. It is one of the few introduced species that can successfully invade and colonize a virgin forest. By comparison, in its native range, Norway maple is rarely a dominant species and instead occurs mostly as a scattered understory tree.*[6]*[7]

2.3 Cultivation and uses

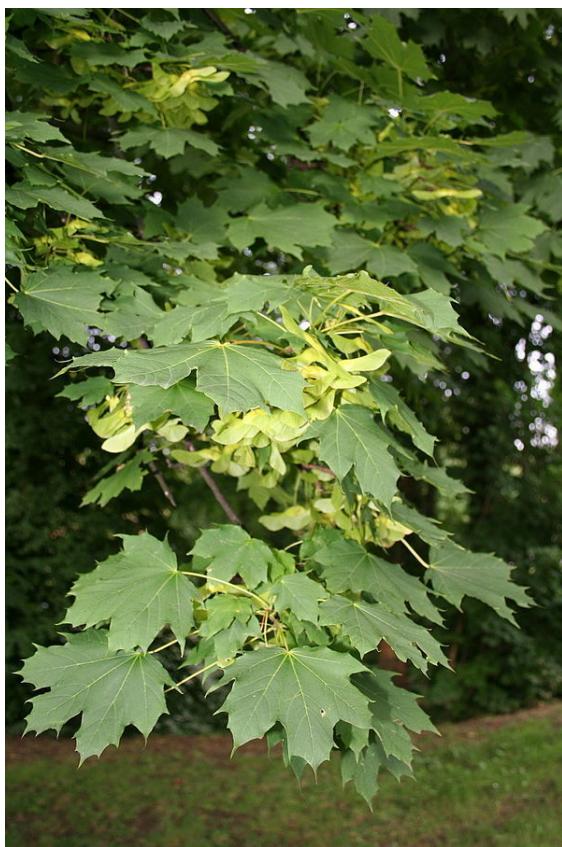


A mature tree in Belgium, with exceptionally rough bark for this species

The wood is hard, yellowish-white to pale reddish, with the heartwood not distinct; it is used for furniture and turnery.*[10] Norway maple sits ambiguously between hard and soft maple with a Janka Hardness of 1,010 lbf (4,510 N). The wood is rated as non-durable to perishable in regard to decay resistance.*[11] In Europe, it is used for furniture, flooring and musical instruments. Many Stradivarius and other older Italian violins are suspected to have been constructed from Norway maple.*[12]



Leaf of 'Schwedleri'.



Foliage and fruit; the fruit are an important characteristic for identification of this species

Norway maple has been widely taken into cultivation in other areas, including western Europe northwest of its native range. It grows north of the Arctic Circle at Tromsø, Norway. In North America, it is planted as a street and shade tree as far north as Anchorage, Alaska,*[13] having been first introduced from Europe in the 18th century. During the 1950s–60s, it became popular as a street tree due to the large-scale loss of American elms from Dutch elm disease.*[14]

It is favored due to its tall trunk and tolerance of poor, compacted soils and urban pollution, conditions that

sugar maple cannot grow in. Because of the Norway maple's invasive nature, the London plane, *Platanus X acerifolia*, is often recommended as a pollution tolerant urban tree for planting where trees cannot be allowed to freely colonise new areas.

It has become a popular species for *bonsai* in Europe and is used for medium to large *bonsai* sizes and a multitude of styles.*[15]

Norway maples are not typically cultivated for maple syrup production due to the lower sugar content of the sap. The sugar content often approaches that of sugar maple and produces a good quality syrup.*[16] When it is plucked from the tree, Norway maple exudes a milky sap from the leaf stem, which distinguishes it from the very similar Sugar maple, *Acer saccharum*.

2.4 Cultivars

Many cultivars have been selected for distinctive leaf shapes or colorations, such as the dark purple of 'Crimson King' and 'Schwedleri', the variegated leaves of 'Drummondii', the light green of 'Emerald Queen', and the deeply divided, feathery leaves of 'Dissectum' and 'Lobbergii'. The purple-foliage cultivars have orange to red autumn colour. 'Columnare' is selected for its narrow upright growth,*[7]*[17] and 'Pendulum' for its weeping habit.

The cultivar 'Crimson King'*[18] has gained the Royal Horticultural Society's Award of Garden Merit.

2.5 As an invasive species in North America



Fruit (samara): note the flat seed capsule and the angle of the "wings"

The roots of Norway maples grow very close to the ground surface, starving other plants of moisture. For example, lawn grass (and even weeds) will usually not grow well beneath a Norway maple, but English Ivy, with

its minimal rooting needs, may thrive. In addition, the dense canopy of Norway maples can inhibit understory growth.*[19] Some have suggested Norway maples may also release chemicals to discourage undergrowth,*[20] although this is controversial.*[19]

A. platanoides has been shown to inhibit the growth of native saplings as a canopy tree or as a sapling.*[19] The Norway maple also suffers less **herbivory** than the sugar maple, allowing it to gain a competitive advantage against the latter species.*[21]

As a result of these characteristics, it is considered invasive in some states,*[22] and has been banned in New Hampshire*[23] and Massachusetts.*[24]*[25] The State of New York has classified it as an invasive plant species.*[26]



Norway maple sapling invading a natural forest in North America

The Norway maple is one of three species Meijer Garden Centers no longer sell; Meijer made this decision due to the tree's invasive nature.*[27] Despite these steps, the species is still available and widely used for urban plantings in many areas.

2.6 Natural enemies

The Norway maple is threatened in a few areas by the **Asian long-horned beetle**, which eats through the trunks, often killing the trees.

A number of species of **Lepidoptera** feed on Norway maple foliage. Norway maple is generally free of serious



Typical yellow fall foliage



Atypical orange-red fall colour; few trees produce such a colour variety

diseases, though can be attacked by the powdery mildew *Uncinula bicornis*, and **verticillium** wilt disease caused by *Verticillium* spp.*[28] "Tar spots" caused by *Rhytisma acerinum* infection are common but largely harmless.*[29]

Aceria pseudoplatani is a acarine mite that causes a 'felt gall' that is found on the underside of leaves of both sycamores (*Acer pseudoplatanus*) and Norway maple (*Acer platanoides*),*[30]

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2.8 Further reading

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- Platt, Karen Gold Fever
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Both books have descriptions of *Acer platanoides* and its cultivars
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2.9 External links

- *Acer platanoides* - information, genetic conservation units and related resources. European Forest Genetic Resources Programme (EUFORGEN)
- Portrait of the Earth: *Acer platanoides* (Norway maple) —with winter images.

Chapter 3

Acer rubrum

Acer rubrum (**red maple**, also known as **swamp**, **water** or **soft maple**) is one of the most common and widespread deciduous trees of eastern and central North America. The U.S. Forest service recognizes it as the most abundant native tree in eastern North America.*[4] The red maple ranges from southeastern Manitoba around the **Lake of the Woods** on the border with Ontario and Minnesota, east to **Newfoundland**, south to Florida, and southwest to eastern Texas. Many of its features, especially its leaves, are quite variable in form. At maturity it often attains a height of around 15 m (50 ft). Its flowers, petioles, twigs and seeds are all red to varying degrees. Among these features, however, it is best known for its brilliant deep scarlet foliage in autumn.

Over most of its range, red maple is adaptable to a very wide range of site conditions, perhaps more so than any other tree in eastern North America. It can be found growing in **swamps**, on poor dry **soils**, and most anywhere in between. It grows well from **sea level** to about 900 m (3,000 ft). Due to its attractive fall foliage and pleasing form, it is often used as a shade tree for landscapes. It is used commercially on a small scale for **maple syrup** production as well as for its medium to high quality lumber. It is also the **State Tree of Rhode Island**. The red maple can be considered weedy or invasive.*[5] It is taking over forests in the eastern US, replacing traditional mainstays like oaks, as well as hickories and pines.*[6]

3.1 Description

Though *A. rubrum* is usually easy to identify, it is highly changeable in morphological characteristics. It is a medium to large sized tree, reaching heights of 18 to 27 metres (60 to 90 ft) and exceptionally over 35 metres (115 feet). The leaves are usually 9 to 11 centimetres (3 ½ to 4 ¼ in) long on a full grown tree. The trunk diameter can range from 46 to 76 cm (18 to 30 in), depending on the growing conditions.*[7] Its spread is about 12 m (40 ft). A 10-year-old sapling will stand about 6 m (20 ft) tall. In forests, the bark will remain free of branches until some distance up the tree. Individuals grown in the open are shorter and thicker with a more rounded crown.*[8] Generally speaking, however, the crown is irregularly ovoid



Typical fall foliage in red maple country.

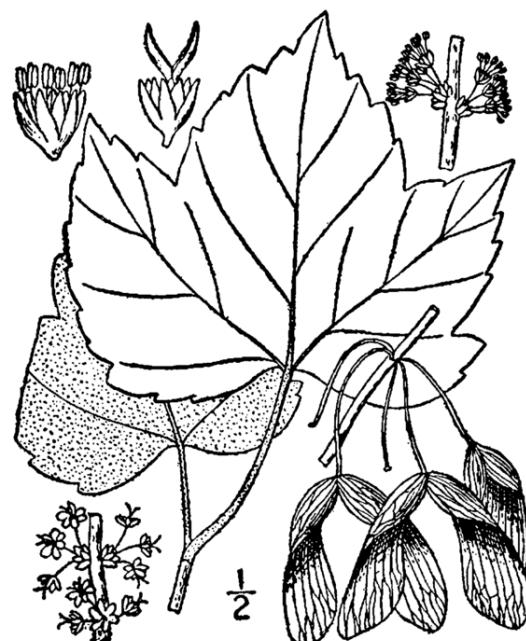
with ascending whip-like curved shoots. The **bark** is a pale grey and smooth when the individual is young. As the tree grows the bark becomes darker and cracks into slightly raised long plates.*[9] The largest known living red maple is located near **Armada, Michigan**, at a height of 38.1 m (125 ft) and a bole circumference, at breast height, of 4.95 m (16 ft 3 in).*[7]

The **leaves** of the red maple offer the easiest way to distinguish it from its relatives. As with nearly all North American maple trees, they are **deciduous** and arranged oppositely on the twig. They are typically 5–10 cm (2–4 in) long and wide with 3–5 **palmate lobes** with a serrated margin. The **sinuses** are typically narrow, but the leaves can exhibit considerable variation.*[8] When 5 lobes are present, the three at the terminal end are larger than the other two near the base. In contrast, the leaves of the related **silver maple**, *A. saccharinum*, are much more deeply lobed, more sharply toothed and characteristically have 5 lobes. The upper side of *A. rubrum*'s leaf is light green and the underside is whitish and can be either **glaucous** or hairy. The leaf stalks are usually red and are up to 10 cm (4 in) long. Furthermore, the leaves can turn a brilliant red in autumn, but can also become yellow or orange on some individuals.

The **twigs** of the red maple are reddish in color and somewhat shiny with small **lenticels**. Dwarf shoots are present on many branches. The buds are usually blunt and green-



Red Maple leaf from specimen in northern Florida



Drawing showing male and female flower, leaf and samara



Immature foliage of *Acer rubrum* (Red Maple)

ish to reddish in color, generally with several loose scales. The lateral buds are slightly stalked, and in addition there may be collateral buds present as well. The buds form in fall and winter and are often visible from a distance due to their reddish tint. The leaf scars on the twig are V-shaped and contain 3 bundle scars.*[8]

The flowers are generally unisexual, with male and female flowers appearing in separate sessile clusters, though

they are sometimes also bisexual. They appear in spring from April to May (though as early as late January in the southern part of its range), usually coming before the leaves. The tree itself is considered Polygamodioecious, meaning some individuals are male, some female, and some monoecious.*[7] Under the proper conditions, the tree can sometimes switch from male to female, male to hermaphroditic, and hermaphroditic to female*[10] The red maple will begin blooming when it is about 8 years old, but it significantly varies between tree to tree: some trees may begin flowering when they are 4 years old. The flowers are red with 5 small petals and a 5-lobed calyx borne in hanging clusters, usually at the twig tips. They are lineal to oblong in shape and are pubescent. The pistillate flowers have one pistil formed from two fused carpels with a glabrous superior ovary and two long styles that protrude beyond the perianth. The staminate flowers contain between 4 and 12 stamens, often with 8.*[11]

The fruit is a samara 15 to 25 millimeters ($\frac{5}{8}$ to 1 in) long that grows in pairs with somewhat divergent wings at an angle of 50 to 60 degrees. They are borne on long slender stems and are variable in color from light brown to reddish.*[8] They ripen from April through early June, before even the leaf development is altogether complete. After they reach maturity, the seeds are dispersed for a 1 to 2 week period from April through July.*[7]

3.2 Distribution and habitat

A. rubrum is one of the most abundant and widespread trees in eastern North America. It can be found from the south of Newfoundland, Nova Scotia and southern

Quebec to the south west of Ontario, extreme south-eastern Manitoba and northern Minnesota; south to Wisconsin, Illinois, Missouri, eastern Oklahoma, and eastern Texas in its western range; and east to Florida. It has the largest continuous range along the North American **Atlantic Coast** of any tree that occurs in Florida. In total it ranges 2,600 km (1,600 mi) from north to south.*[7] The species is native to all regions of the United States east of the 95th meridian. The tree's range ends where the -40°C (-40°F) mean minimum isotherm begins, namely in southeastern Canada. *A. rubrum* is not present in the Prairie Peninsula of the northern Midwest, the coastal prairie in southern Louisiana and southeastern Texas and the swamp prairie of the Florida Everglades.*[7] The absence of red maple in the Prairie Peninsula is perhaps due to the species' intolerance of fire.*[12]

In several other locations, the tree is absent from large areas but still present in a few specific habitats. An example is the **Bluegrass region** of Kentucky, where red maple is not found in the dominant open plains, but is present along streams.*[13] Here the red maple is not present in the bottom land forests of the **Grain Belt**, despite the fact it is common in similar habitats and species associations both to the north and south of this area.*[7]

A. rubrum does very well in a wide range of soil types, with varying textures, moisture, pH, and elevation, probably more so than any other forest tree in North America. *A. rubrum*'s high pH tolerance means that it can grow in a variety of places, and it is widespread along the eastern United States.*[14] It grows on glaciated as well as unglaciated soils derived from the following rocks: granite, gneiss, schist, sandstone, shale, slate, conglomerate, quartzite, and limestone. Chlorosis can occur on very alkaline soils, though otherwise its pH tolerance is quite high. Moist mineral soil is best for germination of seeds.*[12]

The red maple can grow in a variety of moist and dry biomes, from dry ridges and sunny, southwest-facing slopes to peat bogs and swamps. While many types of tree prefer a south or north facing aspect, the red maple does not appear to have a preference.*[7] Its ideal conditions are in moderately well-drained, moist sites at low or intermediate elevations. However, it is nonetheless common in mountainous areas on relatively dry ridges, as well as on both the south and west sides of upper slopes. Furthermore, it is common in swampy areas, along the banks of slow moving streams, as well as on poorly drained flats and depressions. In northern Michigan and New England, the tree is found on the tops of ridges, sandy or rocky upland and otherwise dry soils, as well as in nearly pure stands on moist soils and the edges of swamps. In the far south of its range, it is almost exclusively associated with swamps.*[7] Additionally, Red maple is one of the most drought-tolerant species of maple in the Carolinas.*[15]

Red maple is far more abundant today than when Europeans first arrived in North America, where along with

its cousin Silver Maple, it may have comprised a mere 5% of forest area and was confined mostly to riparian zones.*[7] The density of the tree in many of these areas has increased 6 to 7 fold and this trend seems to be continuing, much of it due to human factors, especially suppression of wildfires which would kill shallow-rooted pioneer species like red maple, but leave mainline forest trees like oaks and hickories untouched.

Additionally, conservation efforts of the red maple have caused a major increase in the population of **white-tailed deer** since the mid-20th century. Deer will readily consume acorns, but leave maple seeds untouched, thus reducing the ability of oaks to regenerate compared to maples.*[16] Because it can grow on a variety of substrates, has a high pH tolerance, and grows in both shade and sun, *A. rubrum* can be called a "super-generalist," and it is predicted to replace historically dominant tree species in the eastern United States such as oaks, hickorys and pines.*[17] Extensive use of red maple in landscaping has also contributed to the surge in the species' numbers as volunteer seedlings proliferate. Finally, disease epidemics have greatly reduced the population of elms and chestnuts in the forests of the US. While mainline forest trees continue to dominate mesic sites with rich soil, more marginal areas are increasingly being dominated by red maple.*[18]

3.3 Ecology

Red maple seldom lives longer than a comparatively brief 150 years.*[7] It reaches maturity in 70 to 80 years. Its ability to thrive in a large number of habitats is largely due to its ability to produce **roots** to suit its site from a young age. In wet locations, red maple seedlings produce short **taproots** with long and developed lateral roots, while on dry sites, they develop long taproots with significantly shorter laterals. The roots are primarily horizontal, however, forming in the upper 25 cm (9.8 in) of the ground. Mature trees have woody roots up to 25 m (82 ft) long. They are very tolerant of flooding, with one study showing that 60 days of flooding caused no leaf damage. At the same time, they are tolerant of drought due to their ability to stop growing under dry conditions by then producing a second growth flush when conditions later improve, even if growth has stopped for 2 weeks.*[7]

A. rubrum is one of the first plants to flower in spring. A crop of seeds is generally produced every year with a bumper crop often occurring every second year. A single tree between 5 and 20 cm (2.0 and 7.9 in) in diameter can produce between 12,000 and 91,000 seeds in a season. A tree 30 cm (0.98 ft) in diameter was shown to produce nearly a million seeds.*[7] Red maple produces one of the smallest seeds of any of the maples.*[15] Fertilization has also been shown to significantly increase the seed yield for up to two years after application. The seeds are epigeal and tend to germinate in early summer soon after



Samaras from a specimen in Milford, New Hampshire

they are released, assuming a small amount of light, moisture, and sufficient temperatures are present. If the seeds are densely shaded, then germination commonly does not occur until the next spring. Most seedlings do not survive in closed forest canopy situations. However, one- to four-year-old seedlings are common under dense canopy and though they eventually die if no light reaches them, they serve as a reservoir, waiting to fill any open area of the canopy above. Trees growing in a Zone 9 or 10 area such as Florida will usually die from cold damage if transferred up north, Canada, Maine, Vermont, New Hampshire and New York, even if the southern trees were planted with northern red maples. Due to their wide range, genetically the trees have adapted to the climatic differences.



Female flowers

Red maple is able to increase its numbers significantly when associate trees are damaged by disease, cutting, or fire. One study found that 6 years after clearcutting a 3.4 hectares (8.4 acres) Oak-Hickory forest containing no red maples, the plot contained more than 2,200 red maple seedlings per hectare (900 per acre) taller than 1.4 m (4.6 ft).^{*[7]} One of its associates, the black cherry (*Prunus serotina*), contains benzoic acid, which has been shown to be a potential allelopathic inhibitor of red maple growth. Red maple is one of the first species to start stem elongation. In one study, stem elongation was one-half com-

pleted in 1 week, after which growth slowed and was 90% completed within only 54 days. In good light and moisture conditions, the seedlings can grow 30 cm (0.98 ft) in their first year and up to 60 cm (2.0 ft) each year for the next few years making it a fast grower.^{*[7]}

The red maple is used as a food source by several forms of wildlife. Elk and white-tailed deer in particular use the current season's growth of red maple as an important source of winter food. Several Lepidoptera (butterflies and moths) utilize the leaves as food; see List of Lepidoptera that feed on maples.



Male flowers

Due to *A. rubrum*'s very wide range, there is significant variation in hardiness, size, form, time of flushing, onset of dormancy, and other traits. Generally speaking, individuals from the north flush the earliest, have the most reddish fall color, set their buds the earliest and take the least winter injury. Seedlings are tallest in the north-central and east-central part of the range. In Florida, at the extreme south of the red maple's range, it is limited exclusively to swamplands. The fruits also vary geographically with northern individuals in areas with brief, frost-free periods producing fruits that are shorter and heavier than their southern counterparts. As a result of the variation there is much genetic potential for breeding programs with a goal of producing red maples for cultivation. This is especially useful for making urban cultivars that require resistance from verticillium wilt, air pollution, and drought.^{*[7]}

Red maple frequently hybridizes with Silver Maple; the hybrid, known as Freeman's Maple *Acer x freemanii*, is intermediate between the parents.

3.3.1 Allergenic potential

The allergenic potential of red maples varies widely based on the cultivar.

The following cultivars are completely male and are highly allergenic, with an OPALS allergy scale rating of 8 or higher:^{*[19]}



Acer × freemanii 'Jeffersred' in Toronto

- 'Autumn Flame' ('Flame')
- 'Autumn Spire'
- 'Columnare' ('Pyramidalis')
- 'Firedance' ('Landsburg')
- 'Karpick'
- 'Northwood'
- 'October Brilliance'
- 'Sun Valley'
- 'Tiliford'

The following cultivars have an OPALS allergy scale rating of 3 or lower; they are completely **female** trees, and have low potential for causing allergies:^{*}[19]

- 'Autumn Glory'
- 'Bowhall'
- 'Davey Red'
- 'Doric'
- 'Embers'
- 'Festival'
- 'October Glory'
- 'Red Skin'
- 'Red Sunset' ('Franksred')

3.3.2 Toxicity

The leaves of red maple, especially when dead or wilted, are extremely **toxic** to horses. The toxin is unknown, but believed to be an **oxidant** because it damages **red blood cells**, causing acute oxidative hemolysis that inhibits the transport of **oxygen**. This not only decreases oxygen delivery to all tissues, but also leads to the production of methemoglobin, which can further damage the kidneys. The ingestion of 700 grams (1.5 pounds) of leaves is considered toxic and 1.4 kilograms (3 pounds) is lethal. Symptoms occur within one or two days after ingestion and can include depression, lethargy, increased rate and depth of breathing, increased heart rate, jaundice, dark brown urine, **colic**, **laminitis**, coma, and death. Treatment is limited and can include the use of **methylene blue** or mineral oil and activated carbon in order to stop further absorption of the toxin into the stomach, as well as **blood transfusions**, fluid support, **diuretics**, and **anti-oxidants** such as **Vitamin C**. About 50% to 75% of affected horses die or are euthanized as a result.^{*}[16]

3.4 Cultivation

Red maple's rapid growth, ease of transplanting, attractive form, and value for wildlife (in the eastern US) has made it one of the most extensively planted trees. In parts of the **Pacific Northwest**, it is one of the most common introduced trees. Its popularity in cultivation stems from its vigorous habit, its attractive and early red flowers, and most importantly, its flaming red fall foliage. The tree was introduced into the **United Kingdom** in 1656 and shortly thereafter entered cultivation. There it is frequently found in many parks and gardens, as well as occasionally in churchyards.^{*}[9]



Mature bark, at Hemingway, South Carolina

Red maple is a good choice of a tree for urban areas when there is ample room for its root system. Forming an association with **Arbuscular Mycorrhizal Fungi** can help *A. rubrum* grow along city streets.^{*}[20] It is more tol-

erant of pollution and road salt than Sugar Maples, although the tree's fall foliage is not as vibrant in this environment. Like several other maples, its low root system can be invasive and it makes a poor choice for plantings near paving. It attracts squirrels, who eat its buds in the early spring, although squirrels prefer the larger buds of the silver maple.*[21]

Red Maple make vibrant and colorful bonsai, and have year around attractive features for display.*[22]



Specimen showing variation of autumn leaf coloration

3.4.1 Cultivars

Numerous cultivars have been selected, often for intensity of fall color, with 'October Glory' and 'Red Sunset' among the most popular. Toward its southern limit, 'Fireburst', 'Florida Flame', and 'Gulf Ember' are preferred. Many cultivars of the Freeman maple are also grown widely. Below is a partial list of cultivars.*[23]*[24]

- '**Armstrong**' – Columnar to fastigate in shape with silvery bark and modest orange to red fall foliage
- '**Autumn Blaze**' – Rounded oval form with leaves that resemble the silver maple. The fall color is orange red and persists longer than usual
- '**Autumn Flame**' – A fast grower with exceptional bright red fall color developing early. The leaves are also smaller than the species.
- '**Autumn Radiance**' – Dense oval crown with an orange-red fall color

- '**Autumn Spire**' – Broad columnar crown; red fall color; very hardy
- '**Bowhall**' – Conical to upright in form with a yellow-red fall color
- '**Burgundy Bell**' – Compact rounded uniform shape with long lasting, burgundy fall leaves
- '**Columnare**' – An old cultivar growing to 20 metres (66 feet) with a narrow columnar to pyramidal form with dark green leaves turning orange and deep red in fall
- '**Gerling**' – A compact, slow growing selection, this individual only reaches 10 metres (33 feet) and has orange-red fall foliage
- '**Northwood**' – Branches are at a 45 degree angle to the trunk, forming a rounded oval crown. Though the foliage is deep green in summer, its orange-red fall color is not as impressive as other cultivars.
- '**October Brilliance**' – This selection is slow to leaf in spring, but has a tight crown and deep red fall color
- '**October Glory**' – Has a rounded oval crown with late developing intense red fall foliage. Along with 'Red Sunset', it is the most popular selection due to the dependable fall color and vigorous growth. This cultivar has gained the Royal Horticultural Society's Award of Garden Merit.*[25]
- '**Redpointe**' – Superior in alkaline soil, strong central leader, red fall color
- '**Red Sunset**' – The other very popular choice, this selection does well in heat due to its drought tolerance and has an upright habit. It has very attractive orange-red fall color and is also a rapid and vigorous grower.
- '**Scarlet Sentinel**' – A columnar to oval selection with 5-lobed leaves resembling the silver maple. The fall color is yellow-orange to orange-red and the tree is a fast grower.
- '**Schlesingeri**' – A tree with a broad crown and early, long lasting fall color that a deep red to reddish purple. Growth is also quite rapid.
- '**Shade King**' – This fast growing cultivar has an upright-oval form with deep green summer leaves that turn red to orange in fall.
- '**V.J. Drake**' – This selection is notable because the edges of the leaves first turn a deep red before the color progresses into the center.



A bottle of maple syrup

3.5 Other uses

In the lumber industry *Acer rubrum* is considered a soft maple. The wood is close grained and as such it is similar to that of *A. saccharum*, but its texture is softer, less dense, and has a poorer figure and machining qualities. High grades of wood from the red maple can nonetheless be substituted for hard maple, particularly when it comes to making furniture. As a soft maple, the wood tends to shrink more during the drying process than with the hard maples.

Red maple is also used for the production of **maple syrup**, though the hard maples *Acer saccharum* (sugar maple) and *Acer nigrum* (black maple) are more commonly utilized. One study compared the sap and syrup from the sugar maple with those of the red maple, as well as those of the *Acer saccharinum* (silver maple), *Acer negundo* (boxelder), and *Acer platanoides* (Norway maple), and all were found to be equal in sweetness, flavor, and quality.

However, the buds of red maple and other soft maples emerge much earlier in the spring than the sugar maple, and after sprouting chemical makeup of the sap changes, imparting an undesirable flavor to the syrup. This being the case, red maple can only be tapped for syrup before the buds emerge, making the season very short.*[7]

Red maple is a medium quality firewood,*[26] possessing less heat energy, nominally 5.4 MJ/m^3 (18.7 million BTU (mbtu) per cord), than other hardwoods such as Ash: 7 MJ/m^3 (24 mbtu/cord), Oak: 7 MJ/m^3 (24 mbtu/cord), or Birch: 5.8 MJ/m^3 (20 mbtu/cord).

3.6 See also

- List of plants poisonous to equines
- List of foods made from maple

3.7 References

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3.8 External links

- NRCS: United States Department of Agriculture Plants Profile and map: *Acer rubrum*
- *Acer rubrum* images from Vanderbilt University
- Portrait of the Earth, Winter ID photos

Chapter 4

Ailanthus altissima

“Tree of heaven” redirects here. For the TV show, see [Tree of Heaven \(TV series\)](#).

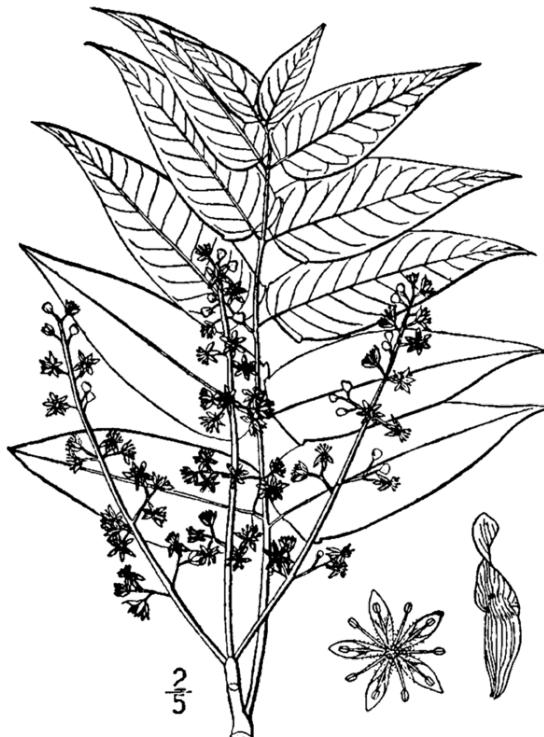
Ailanthus altissima /er'lænθəs æl'tɪsɪmə/, *[2] commonly known as **tree of heaven**, **ailanthus**, or in Standard Chinese as **chouchun** (Chinese: 臭椿; pinyin: chòuchūn; literally: “foul smelling tree”), is a deciduous tree in the Simaroubaceae family. It is native to both northeast and central China, as well as Taiwan. Unlike other members of the genus *Ailanthus*, it is found in temperate climates rather than the tropics. The tree grows rapidly and is capable of reaching heights of 15 metres (49 ft) in 25 years. However, the species is also short lived and rarely lives more than 50 years, though its remarkable suckering ability makes it possible for this tree to clone itself indefinitely and live considerably longer *[3] (since they are linked to the mother tree and thus partly fed by it, the suckers are less vulnerable than the seedlings and can grow faster).

In China, the tree of heaven has a long and rich history. It was mentioned in the oldest extant Chinese dictionary and listed in countless Chinese medical texts for its purported ability to cure ailments ranging from mental illness to baldness. The roots, leaves and bark are still used today in **traditional Chinese medicine**, primarily as an astringent. The tree has been grown extensively both in China and abroad as a host plant for the **ailanthus silk-moth**, a moth involved in **silk** production. Ailanthus has become a part of western culture as well, with the tree serving as the central metaphor and subject matter of the best-selling American novel *A Tree Grows in Brooklyn* by Betty Smith.

The tree was first brought from China to Europe in the 1740s and to the United States in 1784. It was one of the first trees brought west during a time when **chinoiserie** was dominating European arts, and was initially hailed as a beautiful garden specimen. However, enthusiasm soon waned after gardeners became familiar with its suckering habits and its foul smelling odour. Despite this, it was used extensively as a street tree during much of the 19th century. Outside Europe and the United States the plant has been spread to many other areas beyond its native range. In a number of these, it has become an **invasive species** due to its ability both to colonise disturbed ar-

eas quickly and to suppress competition with allelopathic chemicals. It is considered a noxious weed in Australia, the United States, New Zealand and many countries of central, eastern and southern Europe. The tree also resprouts vigorously when cut, making its eradication difficult and time-consuming. In many urban areas, it has acquired the derisive nicknames of “ghetto palm”, “stink tree”, and “tree of Hell” .

4.1 Description



Botanical drawing of the leaves, flowers and samaras from Britton and Brown's 1913 Illustrated flora of the northern states and Canada

A. altissima is a medium-sized tree that reaches heights between 17 and 27 metres (56 and 89 ft) with a diameter at breast height of about 1 metre (39 inches).*[4] The **bark** is smooth and light grey, often becoming some-

what rougher with light tan fissures as the tree ages. The twigs are stout, smooth to lightly pubescent, and reddish or chestnut in colour. They have lenticels as well as heart-shaped leaf scars (i.e. a scar left on the twig after a leaf falls) with many bundle scars (i.e. small marks where the veins of the leaf once connected to the tree) around the edges. The buds are finely pubescent, dome shaped, and partially hidden behind the petiole, though they are completely visible in the dormant season at the sinuses of the leaf scars.* [5] The branches are light to dark gray in colour, smooth, lustrous, and containing raised lenticels that become fissures with age. The ends of the branches become pendulous. All parts of the plant have a distinguishing strong odour that is often likened to peanuts, cashews,* [6] or rotting cashews.* [7]

The leaves are large, odd- or even-pinnately compound, and arranged alternately on the stem. They range in size from 30 to 90 cm (0.98 to 2.95 ft) in length and contain 10–41 leaflets organised in pairs, with the largest leaves found on vigorous young sprouts. When they emerge in the spring, the leaves are bronze then quickly turn from medium to dark green as they grow.* [8] The rachis is light to reddish-green with a swollen base. The leaflets are ovate-lanceolate with entire margins, somewhat asymmetric and occasionally not directly opposite to each other. Each leaflet is 5 to 18 cm (2.0 to 7.1 in) long and 2.5 to 5 cm (0.98 to 1.97 in) wide. They have a long tapering end while the bases have two to four teeth, each containing one or more glands at the tip.* [5] The leaflets' upper sides are dark green in colour with light green veins, while the undersides are a more whitish green. The petioles are 5 to 12 mm (0.20 to 0.47 in) long.* [6] The lobed bases and glands distinguish it from similar sumac species.



Immature seeds on a female tree.

The flowers are small and appear in large panicles up to 50 cm (20 in) in length at the end of new shoots. The individual flowers are yellowish green to reddish in colour, each with five petals and sepals.* [4]* [6] The sepals are cup-shaped, lobed and united while the petals are valvate (i.e. they meet at the edges without overlapping), white and hairy towards the inside.* [5]* [9]* [10] They appear from



Tree of Heaven Re-sprouting even after herbicide use to restore Red Butte Creek in Salt Lake City. By removing invasive species like the tree of heaven which overcrowd native trees, the local ecosystem functions much better.

mid-April in the south of its range to July in the north. *A. altissima* is dioecious, with male and female flowers being borne on different individuals. Male trees produce three to four times as many flowers as the females, making the male flowers more conspicuous. Furthermore, the male plants emit a foul-smelling odour while flowering to attract pollinating insects. Female flowers contain ten (or rarely five through abortion) sterile stamens (stamenoides) with heart-shaped anthers. The pistil is made up of five free carpels (i.e. they are not fused), each containing a single ovule. Their styles are united and slender with star-shaped stigmas.* [5]* [9] The male flowers are similar in appearance, but they of course lack a pistil and the stamens do function, each being topped with a globular anther and a glandular green disc.* [5] The fruits grow in clusters; a fruit cluster may contain hundreds of seeds.* [11] The seeds borne on the female trees are 5 mm in diameter and each is encapsulated in a samara that is 2.5 cm (0.98 in) long and 1 cm (0.39 in) broad, appearing July through August, but can persist on the tree until the next spring. The samara is large and twisted at the tips, making it spin as it falls, assisting wind dispersal,* [4]* [6] and aiding buoyancy for long-distance dispersal through hydrochory.* [12] The females can produce huge amounts of seeds, normally around 30,000 per kilogram (14,000/lb) of tree,* [4] and fecundity can be estimated non-destructively through measurements of dbh.* [12]

4.2 Taxonomy

The first scientific descriptions of the tree of heaven were made shortly after it was introduced to Europe by the French Jesuit Pierre Nicholas d’Incarville. D’Incarville had sent seeds from Peking via Siberia to his botanist friend Bernard de Jussieu in the 1740s. The seeds sent by d’Incarville were thought to be from the economically important and similar looking Chinese varnish tree (*Toxicodendron vernicifluum*), which he had observed in the lower Yangtze region, rather than the tree of heaven.

D'Icarville attached a note indicating this, which caused much taxonomic confusion over the next few decades. In 1751, Jussieu planted a few seeds in France and sent others on to Philip Miller, the superintendent at the Chelsea Physic Garden, and to Philip C. Webb, the owner of an exotic plant garden in Busbridge, England.* [5]

Confusion in naming began when the tree was described by all three men with three different names. In Paris, Linnaeus gave the plant the name *Rhus succedanea*, while it was known commonly as *grand vernis du Japon*. In London the specimens were named by Miller as *Toxicodendron altissima* and in Busbridge it was dubbed in the old classification system as *Rhus Sinese foliis alatis*. There are extant records from the 1750s of disputes over the proper name between Philip Miller and John Ellis, curator of Webb's garden in Busbridge. Rather than the issue being resolved, more names soon appeared for the plant: Jakob Friedrich Ehrhart observed a specimen in Utrecht in 1782 and named it *Rhus cacodendron*.* [5]

Light was shed on the taxonomic status of ailanthus in 1788 when René Louiche Desfontaines observed the samaras of the Paris specimens, which were still labelled *Rhus succedanea*, and came to the conclusion that the plant was not a sumac. He published an article with an illustrated description and gave it the name *Ailanthus glandulosa*, placing it in the same genus as the tropical species then known as *A. integrifolia* (white siris, now *A. triphysa*). The name is derived from the Amboinese word *ailanto*, meaning “heaven-tree” or “tree reaching for the sky”.* [5]* [13] The specific *glandulosa*, referring to the glands on the leaves, persisted until as late as 1957, but it was ultimately made invalid as a later homonym at the species level.* [5] The current species name comes from Walter T. Swingle who was employed by the United States Department of Plant Industry. He decided to transfer Miller's older specific name into the genus of Desfontaines, resulting in the accepted name *Ailanthus altissima*.* [14] *Altissima* is Latin for “tallest”,* [15] and refers to the sizes the tree can reach. The plant is sometimes incorrectly cited with the specific epithet in the masculine (*glandulosus* or *altissimus*), which is incorrect since botanical, like Classical Latin, treats most tree names as feminine.

There are three varieties of *A. altissima*:

- *A. altissima* var. *altissima*, which is the type variety and is native to mainland China.
- *A. altissima* var. *tanakai*, which is endemic to northern Taiwan highlands. It differs from the type in having yellowish bark, odd-pinnate leaves that are also shorter on average at 45 to 60 cm (18 to 24 in) long with only 13–25 scythe-like leaflets.* [16]* [17]* [18] It is listed as endangered in the IUCN Red List of threatened species due to loss of habitat for building and industrial plantations.* [19]

- *A. altissima* var. *sutchuenensis*, which differs in having red branchlets.* [16]* [17]

4.3 Distribution and habitat

A. altissima is native to northern and central China, Taiwan* [20] and northern Korea.* [21] In Taiwan it is present as var. *takanai*.* [19] In China it is native to every province except Gansu, Heilongjiang, Hainan, Jilin, Ningxia, Qinghai, Xinjiang, and Tibet.* [16]

The tree prefers moist and loamy soils, but is adaptable to a very wide range of soil conditions and pH values. It is drought-hardy, but not tolerant of flooding. It also does not tolerate deep shade.* [4] In China it is often found in limestone-rich areas.* [17] The tree of heaven is found within a wide range of climatic conditions.* [4] In its native range it is found at high altitudes in Taiwan* [19] as well as lower ones in mainland China.* [5] In the U.S. it is found in arid regions bordering the Great Plains, very wet regions in the southern Appalachians, cold areas of the lower Rocky Mountains and throughout much of the California Central Valley. Prolonged cold and snow cover cause dieback, though the trees re-sprout from the roots.* [4]



Ailanthus altissima growing in Australia.

4.3.1 As an exotic plant

The earliest introductions of *A. altissima* to countries outside of its native range were to the southern areas of Korea as well as to Japan. It is possible that the tree is native to these areas, but it is generally agreed that the tree was a very early introduction.* [22] Within China itself it has also been naturalised beyond its native range in areas such as Qinghai, Ningxia and Xinjiang.* [17]

In 1784, not long after Jussieu had sent seeds to England, some were forwarded to the United States by William Hamilton, a gardener in Philadelphia. In both Europe and America it quickly became a favoured ornamental, especially as a street tree, and by 1840 it

was available in most nurseries.* [5]*[13] The tree was separately brought to California in the 1890s by Chinese immigrants who came during the California Gold Rush. It has escaped cultivation in all areas where it was introduced, but most extensively in the United States.* [20] It has naturalised across much of Europe, including Germany,*[23] Austria, Switzerland, the Czech Republic, the Pannonian region (i.e. southeastern Central Europe around the Danube river basin from Austria, Slovakia and Hungary south to the Balkan ranges) and most countries of the Mediterranean Basin.*[21] In Montenegro*[24] and Albania*[25]*[26] *A. altissima* is widespread in both rural and urban areas and while in the first it was introduced as an ornamental plant, it very soon invaded native ecosystems with disastrous results and became an invasive species.*[24] Ailanthus has also been introduced to Argentina,*[20] Australia (where it is a declared weed in New South Wales and Victoria),*[27] New Zealand (where it is listed under the National Pest Plant Accord and is classed an “unwanted organism”),*[28] the Middle East and in some countries in South Asia such as Pakistan.*[29] In South Africa it is listed as an invasive species which must be controlled, or removed and destroyed.*[30]

In North America, *A. altissima* is present from Massachusetts in the east, west to southern Ontario, southwest to Iowa, south to Texas, and east to the north of Florida. On the west coast it is found from New Mexico west to California and north to Washington.*[4]*[20] In the east of its range it grows most extensively in disturbed areas of cities, where it was long ago present as a planted street tree.*[5]*[20] It also grows along roads and railways. For example, a 2003 study in North Carolina found the tree of heaven was present on 1.7% of all highway and railroad edges in the state and had been expanding its range at the rate of 4.76% counties per year.*[31] Similarly, another study conducted in southwestern Virginia determined that the tree of heaven is thriving along approximately 30% of the state's interstate highway system length or mileage.*[32] It sometimes enters undisturbed areas as well and competes with native plants.*[20] In western North America it is most common in mountainous areas around old dwellings and abandoned mining operations.*[33]*[34]

4.4 Ecology

Ailanthus is an opportunistic plant that thrives in full sun and disturbed areas. It spreads aggressively both by seeds and vegetatively by root sprouts, re-sprouting rapidly after being cut.*[4] It is considered a shade-intolerant tree and cannot compete in low-light situations,*[35] though it is sometimes found competing with hardwoods, but such competition rather indicates it was present at the time the stand was established.*[4] On the other hand, a study in an old-growth hemlock-hardwood forest in New York



A female bearing a heavy load of seeds in Valladolid, Spain

found that *Ailanthus* was capable of competing successfully with native trees in canopy gaps where only 2 to 15% of full sun was available. The same study characterised the tree as using a “gap-obligate” strategy in order to reach the forest canopy, meaning it grows rapidly during a very short period rather than growing slowly over a long period.*[36] It is a short lived tree in any location and rarely lives more than 50 years.*[4] *Ailanthus* is among the most pollution-tolerant of tree species, including sulfur dioxide, which it absorbs in its leaves. It can withstand cement dust and fumes from coal tar operations, as well as resist ozone exposure relatively well. Furthermore, high concentrations of mercury have been found built up in tissues of the plant.*[20]

Ailanthus has been used to re-vegetate areas where acid mine drainage has occurred and it has been shown to tolerate pH levels as low as 4.1 (approximately that of tomato juice). It can withstand very low phosphorus levels and high salinity levels. The drought-tolerance of the tree is strong due to its ability to effectively store water in its root system.*[20] It is frequently found in areas where few trees can survive. The roots are also aggressive enough to cause damage to subterranean sewers and pipes.*[5] Along highways it often forms dense thickets in which few other tree species are present, largely due to the toxins it produces to prevent competition.*[20]



Female tree growing in Chicago, Illinois

Ailanthus produces an allelopathic chemical called ailanthone, which inhibits the growth of other plants.*[37] The inhibitors are strongest in the bark and roots, but are also present in the leaves, wood and seeds of the plant. One study showed that a crude extract of the root bark inhibited 50% of a sample of garden cress (*Lepidium sativum*) seeds from germinating. The same study tested the extract as an herbicide on garden cress, redroot pigweed (*Amaranthus retroflexus*), velvetleaf (*Abutilon theophrasti*), yellow bristlegrass (*Setaria pumila*), barnyard grass (*Echinochloa crusgalli*), pea (*Pisum sativum* cv. Sugar Snap) and maize (*Zea mays* cv. Silver Queen). It proved able to kill nearly 100% of seedlings with the exception of velvetleaf, which showed some resistance.*[38] Another experiment showed a water extract of the chemical was either lethal or highly damaging to 11 North American hardwoods and 34 conifers, with the white ash (*Fraxinus americana*) being the only plant not adversely affected.*[39] The chemical does not, however, affect the tree of heaven's own seedlings, indicating that *A. altissima* has a defence mechanism to prevent autotoxicity.*[37] Resistance in various plant species has been shown to increase with exposure. Populations without prior exposure to the chemicals are most susceptible to them. Seeds produced from exposed plants have also been shown to be more resistant than their unexposed counterparts.*[40]



Leaves in autumn

The tree of heaven is a very rapidly growing tree, possibly the fastest growing tree in North America.*[41] Growth of one to two metres (3.3 to 6.6 ft) per year for the first four years is considered normal. Shade considerably hampers growth rates. Older trees, while growing much slower, still do so faster than other trees. Studies found that Californian trees grew faster than their East Coast counterparts, and American trees in general grew faster than Chinese ones.*[41]

In northern Europe the tree of heaven was not considered naturalised in cities until after the Second World War. This has been attributed to the tree's ability to colonise areas of rubble of destroyed buildings where most other plants would not grow.*[21] In addition, the

warmer microclimate in cities offers a more suitable habitat than the surrounding rural areas (it is thought that the tree requires a mean annual temperature of 8 degrees Celsius to grow well, which limits its spread to more northern and higher altitude areas). For example, one study in Germany found the tree of heaven growing in 92% of densely populated areas of Berlin, 25% of its suburbs and only 3% of areas outside the city altogether.*[21] In other areas of Europe this is not the case as climates are mild enough for the tree to flourish. It has colonised natural areas in Hungary, for example, and is considered a threat to biodiversity at that country's Aggtelek National Park.*[21]

Several species of Lepidoptera utilise the leaves of ailanthus as food, including the Indian moon moth (*Actias selene*) and the common grass yellow (*Eurema hecabe*). In North America the tree is the host plant for the ailanthus webworm (*Atteva aurea*), though this ermine moth is native to Central and South America and originally used other members of the mostly tropical Simaroubaceae as its hosts.*[42] In its native range *A. altissima* is associated with at least 32 species of arthropods and 13 species of fungi.*[17]

Due to the tree of heaven's weedy habit, landowners and other organisations often resort to various methods of control in order to keep its populations in check. For example, the city of Basel in Switzerland has an eradication program for the tree.*[21] It can be very difficult to eradicate, however. Means of eradication can be physical, thermal, managerial, biological or chemical. A combination of several of these can be most effective, though they must of course be compatible. All have some positive and negative aspects, but the most effective regimen is generally a mixture of chemical and physical control. It involves the application of foliar or basal herbicides in order to kill existing trees, while either hand pulling or mowing seedlings in order to prevent new growth.*[43]*[note 1]

4.5 Uses



A male ailanthus silkmoth from the Texas A&M University insect collection

In addition to its use as an ornamental plant, the tree of heaven is also used for its wood, medicinal properties, and as a host plant to feed silkworms of the moth *Samia cynthia*, which produces silk that is stronger and cheaper than mulberry silk, although with inferior gloss and texture. It is also unable to take dye. This type of silk is known under various names: "pongee", "eri silk" and "Shantung silk", the last name being derived from Shandong Province in China where this silk is often produced. Its production is particularly well known in the Yantai region of that province. The moth has also been introduced in the United States.*[5]

The pale yellow, close-grained and satiny wood of ailanthus has been used in cabinet work.*[44] It is flexible and well suited to the manufacture of kitchen steamers, which are important in Chinese cuisine for cooking mantou, pastries and rice. Zhejiang Province in eastern China is most famous for producing these steamers.*[5] It is also considered a good source of firewood across much of its range as it moderately hard and heavy, yet readily available.*[45] The wood is also used to make charcoal for culinary purposes.*[46] There are problems with using the wood as lumber, however. Because the trees exhibit rapid growth for the first few years, the trunk has uneven texture between the inner and outer wood, which can cause the wood to twist or crack during drying. Techniques have been developed for drying the wood so as to prevent this cracking, allowing it to be commercially harvested. Although the live tree tends to have very flexible wood, the wood is quite hard once properly dried.*[47]

4.5.1 Cultivation

Tree of heaven is a popular ornamental tree in China and valued for its tolerance of difficult growing conditions.*[17] It was once very popular in cultivation in both Europe and North America, but this popularity dropped, especially in the United States, due to the disagreeable odor of its blossoms and the weediness of its habit. The problem of odor was previously avoided by only selling pistillate plants since only males produce the smell, but a higher seed production also results.*[13] Michael Dirr, a noted American horticulturalist and professor at the University of Georgia, reported meeting, in 1982, a grower who could not find any buyers. He further writes (his emphasis):

For most landscaping conditions, it has no value as there are too many trees of superior quality; for impossible conditions this tree has a place; selection could be made for good habit, strong wood and better foliage which would make the tree more satisfactory; I once talked with an architect who tried to buy *Ailanthus* for use along polluted highways but could not find an adequate supply [...]

—Michael A. Dirr, *Manual of Woody Land-*

*scape Plants**[48]

In Europe, however, the tree is still used in the garden to some degree as its habit is generally not as invasive as it is in America. In the United Kingdom it is especially common in London squares, streets, and parks, though it is also frequently found in gardens of southern England and East Anglia. It becomes rare in the north, occurring only infrequently in southern Scotland. It is also rare in Ireland.*[49] In Germany the tree is commonly planted in gardens.*[23] The tree has furthermore become unpopular in cultivation in the west because it is short-lived and that the trunk soon becomes hollow, making trees more than two feet in diameter unstable in high winds.*[44]

A few cultivars exist, but they are not often sold outside of China and probably not at all in North America:

- 'Hongye' – The name is Chinese and means “red leaves”. As the name implies it has attractive vivid red foliage*[50]
- 'Thousand Leaders'*[50]
- 'Metro' – A male cultivar with a tighter crown than usual and a less weedy habit*[51]
- 'Erythrocarpa' – The fruits are a striking red*[51]
- 'Pendulifolia' – Leaves are much longer and hang elegantly*[51]

4.5.2 Medicinal

Nearly every part of *A. altissima* has some application in Chinese traditional medicine. One of the oldest recipes, recorded in a work from 732 AD, is used for treating mental illness. It involved chopped root material, young boys' urine and douchi. After sitting for a day the liquid was strained out and given to the patient over the course of several days.*[5]

Another source from 684 AD, during the Tang dynasty and recorded in Li Shizhen's *Compendium of Materia Medica*, states that when the leaves are taken internally, they make one incoherent and sleepy, while when used externally they can be effectively used to treat boils, abscesses and itches. Yet another recipe recorded by Li uses the leaves to treat baldness. This formula calls for young leaves of ailanthus, catalpa and peach tree to be crushed together and the resulting liquid applied to the scalp to stimulate hair growth.*[5]

The dried bark, however, is still an official drug and is listed in the modern Chinese *materia medica* as *chun bai pi* (Chinese: 椿白皮; pinyin: chūnbáipí), meaning “white bark of spring”. Modern works treat it in detail, discussing chemical constituents, how to identify the product and its pharmaceutical uses. It is prepared by

felling the tree in fall or spring, stripping the bark and then scraping off the hardest, outermost portion, which is then sun-dried, soaked in water, partially re-dried in a basket and finally cut into strips. The bark is said to have cooling and astringent properties and is primarily used to treat dysentery, intestinal hemorrhage, menorrhagia and spermatorrhea. It is only prescribed in amounts between 4 and 10 grams, so as not to poison the patients. Li's Compendium has 18 recipes that call for the bark. Asian and European chemists have found some justification for its medical use as it contains a long list of active chemicals that include quassin and saponin, while ailanthone, the allelopathic chemical in the tree of heaven, is a known antimalarial agent.*[52] It is available in most shops dealing in Chinese traditional medicine.*[5] A tincture of the root-bark has been used successfully in treating cardiac palpitation, asthma and epilepsy.*[9]

The samaras are also used in modern Chinese medicine under the name *feng yan cao* (simplified Chinese: 凤眼草; traditional Chinese: 鳳眼草; pinyin: fèngyǎncǎo), meaning “herbal phoenix eye”. They are used as a hemostatic agent, spermatorrhea and for treating patients with blood in their feces or urine. It was clinically shown to be able to treat trichomoniasis, a vaginal infection caused by the protozoan *Trichomonas vaginalis*.*[5] In the West, an extract of the bark sold under the synonym *A. glandulosa* is sometimes used as an herbal remedy for various ailments including cancer.*[53]

Anecdotal evidence suggests that the plant may be mildly toxic. The noxious odours have been associated with nausea and headaches, as well as with contact dermatitis reported in both humans and sheep, who also developed weakness and paralysis. It contains a quinone irritant, 2,6-dimethoxybenzoquinone, as well as active quassinooids (ailanthone itself being one) which may account for these effects, but they have, however, proved difficult or impossible to reproduce in humans and goats. In one trial a tincture from the blossom and foliage caused nausea, vomiting and muscular relaxation.*[52]

Ailanthus altissima has potent anti-anaphylactic and anti-inflammatory properties.*[54]

4.6 Culture

4.6.1 China

In addition to the tree of heaven's various uses, it has also been a part of Chinese culture for many centuries and has more recently attained a similar status in the west. Within the oldest extant Chinese dictionary, the *Erya*, written in the 3rd century BC, the tree of heaven is mentioned second among a list of trees. It was mentioned again in a *materia medica* compiled during the Tang dynasty in 656 AD. Each work favoured a different character, however, and there is still some debate in

the Chinese botanical community as to which character should be used. The current name, *chouchun* (Chinese: 臭椿; pinyin: chòuchūn), means “stinking spring”, and is a relatively new appellation. People living near the lower Yellow River know it by the name *chunshu* (simplified Chinese: 椿树; traditional Chinese: 椿樹; pinyin: chūnshù), meaning “spring tree”. The name stems from the fact that *A. altissima* is one of the last trees to come out of dormancy, and as such its leaves coming out would indicate that winter was truly over.*[5]

In Chinese literature, ailanthus is often used for two rather extreme metaphors, with a mature tree representing a father and a stump being a spoiled child. This manifests itself occasionally when expressing best wishes to a friend's father and mother in a letter, where one can write “wishing your ailanthus and daylily are strong and happy”, with ailanthus metaphorically referring to the father and daylily to the mother. Furthermore, one can scold a child by calling him a “good-for-nothing ailanthus stump sprout”, meaning the child is irresponsible. This derives from the literature of Zhuangzi, a Taoist philosopher, who referred to a tree that had developed from a sprout at the stump and was thus unsuitable for carpentry due to its irregular shape. Later scholars associated this tree with ailanthus and applied the metaphor to children who, like stump sprouts of the tree, will not develop into a worthwhile human being if they don't follow rules or traditions.*[55]

4.6.2 United States

The 1943 book *A Tree Grows in Brooklyn* by Betty Smith uses the tree of heaven as its central metaphor, using it as an analogy for the ability to thrive in a difficult environment. At that time as well as now, ailanthus was common in neglected urban areas.*[13]*[56] She writes:

There's a tree that grows in Brooklyn.
Some people call it the Tree of Heaven. No
matter where its seed falls, it makes a tree
which struggles to reach the sky. It grows in
boarded up lots and out of neglected rubbish
heaps. It grows up out of cellar gratings. It
is the only tree that grows out of cement. It
grows lushly...survives without sun, water,
and seemingly earth. It would be considered
beautiful except that there are too many of it.
— *A Tree Grows in Brooklyn*, Introduction

In William Faulkner's novel, *Sanctuary*, a “heaven-tree” stands outside the Jefferson jail, where Lee Goodwin and a “negro murderer” are incarcerated. The tree is associated with the black prisoner's despair in the face of his impending execution and the spirituals that he sings in chorus with other black people who keep a sort of vigil in the street below:

...they sang spirituals while white people slowed and stopped in the leafed darkness that was almost summer, to listen to those who were sure to die and him who was already dead singing about heaven and being tired; or perhaps in the interval between songs a rich, sourceless voice coming out of the high darkness where the ragged shadow of the heaven-tree which snooded the street lamp at the corner fretted and mourned: “Fo days mo! Den dey ghy stroy de bes ba'yon singer in nawth Mississippi!”* [57]

Upon the barred and slitted wall the splotched shadow of the heaven-tree shuddered and pulsed monstrously in scarce any wind; rich and sad, the singing fell behind.* [58]

Ailanthus is also sometimes counter-nicknamed “tree from hell” due to its prolific invasiveness and the difficulty in eradicating it.* [56]* [59] In certain parts of the United States, the species has been nicknamed the “ghetto palm” because of its propensity for growing in the inhospitable conditions of urban areas, or on abandoned and poorly maintained properties, such as in war-torn Afghanistan.* [60]* [61]

Until March 26, 2008, a 60-foot (18 m)-tall member of the species was a prominent “centerpiece” of the sculpture garden at the **Noguchi Museum** in the Astoria section in the borough of **Queens** in **New York City**. The tree had been spared by the sculptor **Isamu Noguchi** when in 1975 he bought the building which would become the museum and cleaned up its back lot. The tree was the only one he left in the yard, and the staff would eat lunch with Noguchi under it. “[I]n a sense, the sculpture garden was designed around the tree”, said a former aide to Noguchi, Bonnie Rychlak, who later became the museum curator. By 2008, the old tree was found to be dying and in danger of crashing into the building, which was about to undergo a major renovation. The museum hired the Detroit Tree of Heaven Woodshop, an artists’ collective, to use the wood to create benches, sculptures and other amenities in and around the building. The tree’s rings were counted, revealing its age to be 75, and museum officials hoped it would regenerate from a sucker.* [62]

4.6.3 Europe

Ingo Vetter, a German artist and professor of fine arts at Umeå University in Sweden, was influenced by the idea of the “ghetto palm” and installed a living ailanthus tree taken from Detroit for an international art show called *Shrinking Cities* at the Kunst-Werke Institute for Contemporary Art in Berlin in 2004.* [60]* [61]

4.7 Notes

- [1] For a more thorough discussion, see the entry for *Ailanthus altissima* in the Wikimanual of Gardening at Wikibooks.

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4.9 External links

- USDA Plants profile for *Ailanthus altissima* (tree of heaven)
- U.S. Forest Service Fire Effects Information System: *Ailanthus altissima*
- United States National Agricultural Library—National Invasive Species Information Center: species profile of *Ailanthus altissima* (Tree of Heaven)
- National Park Service, Plant Conservation Alliance, Alien Plant Working Group: Tree of Heaven (*Ailanthus altissima*) report
- Calflora Database: *Ailanthus altissima* (Tree of Heaven, Ailanthus) —introduced invasive species.
- Cal-IPC/California Invasive Plant Council: plant profile of *Ailanthus altissima*
- *Ailanthus altissima* in the CalPhotos Photo Database, University of California, Berkeley

Chapter 5

Amelanchier arborea

Amelanchier arborea (downy serviceberry^{*[1]} or common serviceberry^{*[2]}), is native to eastern North America from the Gulf Coast north to Thunder Bay in Ontario and Lake St. John in Quebec, and west to Texas and Minnesota.^{*[1]}

Amelanchier arborea is generally 5–12 metres (16–39 ft) tall. Occasionally, it can grow up to 20 metres (66 ft) tall and reach into the overstory. The trunk can be up to 15 cm diameter (rarely to 40 centimetres (16 in) diameter). The bark is smooth and gray.^{*[3]*[4]}

The buds are slender with a pointed tip, and usually more than two scales visible. The leaves are ovate or elliptical, 4–8 centimetres (1.6–3.1 in) (rarely 10 centimetres (3.9 in)) long and 2.5–4 centimetres (0.98–1.57 in) wide, with pointed tips and finely serrated margins. A characteristic useful for identification is that the young leaves emerge downy on the underside. The fall color is variable, from orange-yellow to pinkish or reddish.^{*[3]*[4]}



Flower details

It has perfect flowers that are 15–25 millimetres (0.59–0.98 in) diameter, with 5 petals, emerging during bud-break in early spring. The petals are white. Flowers are produced on pendulous racemes 3–5 centimetres (1.2–2.0 in) long with 4–10 flowers on each raceme. The flowers are pollinated by bees. The fruit is a reddish-purple pome, resembling a small apple in shape. They ripen in summer and are very popular with birds.^{*[3]*[4]*[5]}

It also commonly hybridizes with other species of *Amelanchier*,^{*[4]} the hybrid *Amelanchier × grandiflora* being one example,^{*[6]} and identification can be very difficult as a result.

5.1 Cultivation

This species tolerates varying light levels, but is at its best in full sun. It requires good drainage and air circulation and should be watered during drought. It is often confused with other species in the nursery trade. Propagation is by seed, divisions and grafting.

The fruit is drier than some other serviceberries, and it is harvested locally for pies and jams; they were also used by Native Americans to make bread.

5.2 References

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- [6] "*Amelanchier × grandiflora*". Missouri Botanical Garden. Retrieved February 13, 2015.

5.3 External links

- *Amelanchier arborea* information from Plants for a Future database

Chapter 6

Asimina triloba

This article is about the common pawpaw of eastern North America. For the unrelated tropical papaya fruit often called 'papaw' or 'pawpaw', see *Carica papaya*. For other uses, see Paw Paw (disambiguation).

Asimina triloba, the **papaw**,^{*[1]} **paw paw**, **paw-paw**, or **common pawpaw**, is a small deciduous tree native to the eastern United States, producing a large, yellowish-green to brown fruit. It belongs to the genus *Asimina* in the same plant family (the Annonaceae) as the custard-apple, cherimoya, sweetsop, ylang-ylang and soursop.

The pawpaw is a patch-forming (clonal) understory tree found in well-drained, deep, fertile bottom-land and hilly upland habitat, with large, simple leaves. Pawpaw fruits are the largest edible fruit indigenous to the United States (not counting gourds, which are typically considered vegetables rather than fruit for culinary purposes, although in botany they are classified as fruit).^{*[2]}

Pawpaw fruits have a sweet, custardish flavor somewhat similar to banana, mango, and cantaloupe, and are commonly eaten raw.

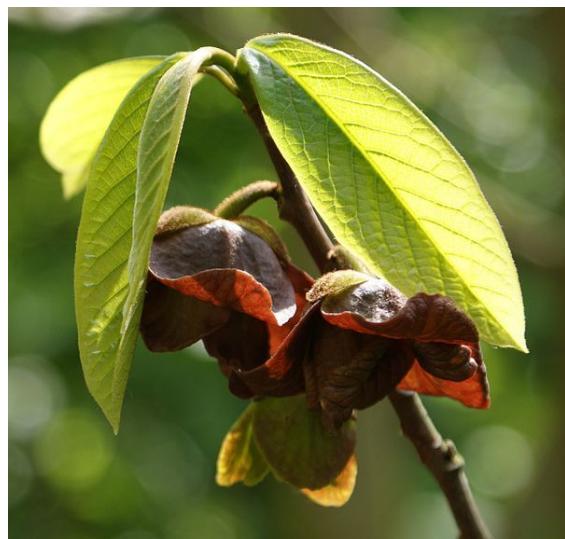
6.1 Names

This plant's scientific name is *Asimina triloba*. The genus name *Asimina* is adapted from the Native American (probably Miami-Illinois^{*[3]}) name *assimin* or *ras-simin*^{*[4]} through the French colonial *asiminier*.^{*[5]} The epithet *triloba* in the species' scientific name refers to the flowers' three-lobed calices and doubly three-lobed corollas,^{*[4]} the shape not unlike a tricorne hat.

The common name of this species is variously spelled **pawpaw**, **paw paw**, **paw-paw**, and **papaw**. It probably derives from the Spanish *papaya*, an American tropical fruit (*Carica papaya*) sometimes also called "paw-paw",^{*[6]*[7]} perhaps because of the superficial similarity of their fruits. (In some parts of the world, such as Australia, New Zealand and South Africa, the name Paw Paw is commonly used for a variety of Papaya.) *Asimina triloba* has had numerous local common names including: *wild banana*, *prairie banana*, *Indiana banana*,

Hoosier banana, *West Virginia banana*, *Kansas banana*, *Kentucky banana*, *Michigan banana*, *Missouri banana*, *the poor man's banana*, *Ozark banana*, and *banango*.

6.2 Description



Flowers

Asimina triloba is a large shrub or small tree growing to a height of 35 feet (11 m) (rarely to 45 feet or 14 m) with a trunks 8-12 inches (20–30 cm) or more in diameter. The large leaves of pawpaw trees are clustered symmetrically at the ends of the branches, giving a distinctive imbricated appearance to the tree's foliage.^{*[4]*[8]}

The **leaves** of the species are simple, alternate and spirally arranged, entire, deciduous, obovate-lanceolate, 10-12 inches (25–30 cm) long, 4-5 inches (10–13 cm) broad, and wedge-shaped at the base, with an acute apex and an entire margin, with the midrib and primary veins prominent. The **petioles** are short and stout, with a prominent adaxial groove. **Stipules** are lacking. The expanding leaves are conduplicate, green, covered with rusty tomentum beneath, and hairy above; when fully grown they are smooth, dark green above, and paler beneath. When bruised, the leaves have a disagreeable odor similar to a

green bell pepper. In autumn the leaves are a rusty yellow, which make spotting pawpaw groves possible from a long distance.*[2]*[4]*[8]

Pawpaw flowers are perfect, about 1-2 inches (3–5 cm) across, rich red-purple or maroon when mature, with three sepals and six petals. They are borne singly on stout, hairy, axillary peduncles. The flowers are produced in early spring at the same time as or slightly before the new leaves appear, and have a faint fetid or yeasty smell.*[2]*[4]*[8]*[9]



Fruit

The fruit of the pawpaw is a large, yellowish-green to brown berry, 2–6 in (5–16 cm) long and 1–3 in (3–7 cm) broad, weighing from 0.7–18 oz (20–500 g), containing several brown/black seeds 1/2 to 1 in (15–25 mm) in diameter embedded in the soft, edible fruit pulp. The conspicuous fruits begin developing after the plants flower; they are initially green, maturing by September or October to yellow or brown. When mature, the heavy fruits bend the weak branches down.*[2]*[4]*[8]

Other characteristics:

- Calyx: Sepals three, valvate in bud, ovate, acuminate, pale green, downy.*[4]*[8]
- Corolla: Petals six, in two rows, imbricate in the bud. Inner row acute, erect, nectariferous. Outer row broadly ovate, reflexed at maturity. Petals at first are green, then brown, and finally become dull purple or maroon and conspicuously veiny.*[4]*[8]
- Stamens: Indefinite, densely packed on the globular receptacle. Filaments short; anthers extrorse, two-celled, opening longitudinally.*[8]
- Pistils: Several, on the summit of the receptacle,

projecting from the mass of stamens. Ovary one-celled; stigma sessile; ovules many.*[8]

- Branchlets: light brown, tinged with red, marked by shallow grooves.*[8]
- Winter buds: Small, of two kinds, the leaf buds pointed and closely appressed to the twigs, and the flower buds round, brown, and fuzzy.*[4]
- Bark: Light gray, sometimes blotched with lighter gray spots, sometimes covered with small excrescences, divided by shallow fissures. Inner bark tough, fibrous. The bark with a very disagreeable odor when bruised.*[4]*[8]
- Wood: Pale, greenish yellow, sapwood lighter; light, soft, coarse-grained and spongy. Sp. gr., 0.3969; weight of cu ft 24.74 lb.*[4]*[8]

6.3 Range and ecology



Bark

Asimina triloba, the pawpaw, is native to the Eastern, Southern, and Midwestern United States and adjacent Ontario, Canada, from New York west to southeastern Nebraska, and south to northern Florida and eastern Texas.*[2]*[10]*[11]

The tree commonly grows in floodplains and shady, rich bottomlands, where it often forms a dense, clonally

spreading undergrowth in the forest, often appearing as a patch or thicket of individual small slender trees. Pawpaws are not the first to colonize a disturbed site (arriving roughly four years after a clearcut), but may become dominant and slow the establishment of oaks and hickories. Although shade-tolerant, pawpaws do not persist in undisturbed old growth forest. Pawpaws spread locally primarily by root suckers; sexual reproduction by seed does also occur, but at a fairly low rate.* [12]

Pawpaw flowers are insect-pollinated, but fruit production is sometimes limited as few if any pollinators are attracted to the flower's faint, or sometimes non-existent scent.* [13] The flowers produce an odor similar to that of rotting meat to attract blowflies or carrion beetles for cross pollination. Other insects that are attracted to pawpaw flowers include scavenging fruit flies, carrion flies and beetles. Because of irregular fruit production, some believe pawpaw plants are self-incompatible, requiring cross-pollination between trees of different clones (patches).* [13]

The fruits of the pawpaw are eaten by a variety of mammals, including raccoons, gray foxes, opossums, squirrels, and black bears.* [12]

The disagreeable-smelling leaves, twigs, and bark of pawpaws contain natural insecticides known as acetogenins.* [14] Pawpaw leaves and twigs are seldom consumed by rabbits, deer, or goats,* [15] or by many insects.* [2] However, mules have been seen eating pawpaw leaves in Maryland.* [16]

Larvae of the zebra swallowtail (*Protographium marcellus*), a butterfly, feed exclusively on young leaves of *Asimina triloba* and various other pawpaw (*Asimina*) species, but never occur in great numbers on the plants.* [15] Chemicals in the pawpaw leaves confer protection from predation throughout the butterfly's life, as trace amounts of acetogenins remain present, making them unpalatable to birds and other predators.* [17]

6.4 Conservation status

On a global (range-wide) scale, the common pawpaw (*Asimina triloba*) has a NatureServe global conservation rank of G5 (very common).

In the United States, the species has a NatureServe national conservation rank of N5 (very common), but is considered a threatened species in New York, and an endangered species in New Jersey.

In Canada, where the species is found only in portions of southern Ontario, it has a NatureServe national conservation rank of N3 (vulnerable), and a NatureServe sub-national conservation rank of S3 (vulnerable) in Ontario. The Ontario Ministry of Natural Resources has given the species a general status of "Sensitive", and its populations there are monitored.

In areas in which deer populations are dense, pawpaws appear to be becoming more abundant locally, since the deer avoid them but consume seedlings of most other woody plants.* [16]

6.5 History

A candidate for the natural distribution of the common pawpaw (*Asimina triloba*) in North America, prior to the Ice Ages and lasting until roughly 10,000 years ago, were extant but now extinct megafauna.* [18] Such animals became extinct during the Quaternary extinction event, and with the arrival of humans and subsequent extinction of such megafauna for distributing *Asimina triloba*, the probable distribution of these large fruit bearing plants was by humans.* [18]

The earliest documented mention of pawpaws is in the 1541 report of the Spanish de Soto expedition, who found Native Americans cultivating it east of the Mississippi River.* [19] The Lewis and Clark Expedition consumed pawpaws during their travels.* [19] Chilled pawpaw fruit was a favorite dessert of George Washington,* [9]* [19] and Thomas Jefferson planted it at Monticello, his home in Virginia.* [19]

6.6 Cultivation

In cultivation, lack of successful pollination is the most common cause of poor fruiting. Cross-pollination of at least two different genetic varieties of the plant is recommended,* [2] and growers often resort to hand pollination or to use of pollinator attractants such as spraying fish emulsion or hanging chicken necks or other meat near the open flowers to attract pollinators. While pawpaws are larval hosts for the zebra swallowtail butterfly, these caterpillars are usually present only at low density, and not detrimental to the foliage of the trees.* [15]

Pawpaws have never been cultivated for their fruits on the scale of apples (*Malus domestica*) or peaches (*Prunus persica*), primarily because pawpaw fruits ripen to the point of fermentation soon after they are picked, and only frozen fruit will store or ship well. Other methods of preservation include dehydration, production of jams or jellies, and pressure canning (using the numerical values for bananas).

In recent years, cultivation of pawpaws for fruit production has attracted renewed interest, particularly among organic growers, as a native fruit with few to no pests, successfully grown without pesticides. The commercial cultivation and harvesting of pawpaws is strong in southeastern Ohio* [20] and also being explored in Kentucky* [2] and Maryland,* [16] as well as various areas outside the species' native range, including California,* [15] the Pacific Northwest.,* [15] and Massachusetts* [21]

The pawpaw is also gaining in popularity among landscapers and backyard gardeners because of the tree's distinctive growth habit, the appeal of its fresh fruit, and its relatively low maintenance needs once established. However, only container-grown pawpaws should be transplanted; use of bare-rooted pawpaws is not recommended, since their fragile root hairs tend to break off unless a cluster of moist soil is retained on the root mass.*[9]

6.6.1 Propagation

Trees are easily grown from seed. Germination is hypogean and cotyledons remain within the seed coat. Strictly speaking, hypogean means the cotyledons stay in the soil, acting as a food store for the seedling until the plumule emerges from the soil on the epicotyl or true stem. However, pawpaw seeds have occasionally been observed to emerge from the ground and form the true stem and plumule above ground. Desirable kinds (cultivars) of pawpaw are propagated by chip budding or whip grafting.

Seeds will lose viability if they dehydrate to 5% moisture.*[22] The seeds need to be stratified, achieved by storage for 9 weeks at 5 degrees C, losing their viability if stored for 3 years or more. Some seeds survive if stored for 2 years.*[22]

In one study, propagation using cuttings was not successful.*[22]

6.6.2 Habitat restoration

Pawpaws are sometimes included in ecological restoration plantings since this tree grows well in wet soil and has a strong tendency to form well-rooted colonial thickets. The pawpaw is particularly valued for establishing fast-growing vegetation in areas where frequent flooding might produce erosion, since their root systems help hold streambanks steady.

6.7 Uses

6.7.1 Fruits

As described by horticulturist Barbara Damrosch, the fruit of the pawpaw "looks a bit like mango, but with pale yellow, custardy, spoonable flesh and black, easy-to-remove seeds."*[21] Wild-collected pawpaw fruits, ripe in late August to mid-September, have long been a favorite treat throughout the tree's extensive native range in eastern North America, and on occasion are sold locally at farmers' markets.*[2]*[21] Pawpaw fruits have a sweet, custardish flavor somewhat similar to banana, mango, and cantaloupe,*[2]*[4]*[23] vary-



Asimina triloba is often called wild banana or prairie banana because of its banana-like creamy texture and flavor.

ing significantly by source or cultivar,*[2] with more protein than most fruits.*[2] Nineteenth-century American agronomist E. Lewis Sturtevant described pawpaws as

... a natural custard, too luscious for the relish of most people*[16]

Ohio botanist William B. Werthner noted that

The fruit ... has a tangy wild-wood flavor peculiarly its own. It is sweet, yet rather cloying to the taste and a wee bit puckery – only a boy can eat more than one at a time.*[4]

Fresh fruits of the pawpaw are commonly eaten raw, either chilled or at room temperature. However, they can be kept only 2–3 days at room temperature, or about a week if refrigerated.*[9] The easily bruised pawpaw fruits do not ship well unless frozen.*[2]*[21] Where pawpaws grow, the fruit pulp is also often used locally in baked dessert recipes, with pawpaw often substituted with volumetric equivalency in many banana-based recipes. Pawpaws may also be blended into ice cream* [9] or included in pancakes.*[9]

Due to its potential for allergic reaction causing contact dermatitis and possible presence of pesticides,*[24] pawpaw consumption may be harmful to humans.*[25]*[26]

6.7.2 Nutrition

According to a report from the Kentucky State University Pawpaw Program (right table), raw pawpaw (with skin) in a 100 gram amount provides 80 Calories and is a rich source (20% or more of the Daily Value, DV) of vitamin C (22% DV), magnesium (32% DV), iron (54% DV) and manganese (124% DV). The fruit also contains a moderate amount (10–19% DV) of vitamin A (11% DV).



Zebra swallowtail butterflies (*Eurytides marcellus*) with pawpaw foliage

6.7.3 Phytochemicals

Phytochemical extracts of the leaves and fruit contain acetogenins, including the neurotoxin, annonacin.*[26] The seeds and bark contain the chemical asimitrin*[27] and other acetogenins, including asimin, asiminacin and asiminecin.*[26]*[28]

6.7.4 Effect on insects

Due to the presence of acetogenins, the leaves, twigs, and bark of pawpaw trees can be used to make an organic insecticide.*[14] The one notable exception is the zebra swallowtail butterfly (*Eurytides marcellus*), whose larvae feed on the leaves of various species of *Asimina*, conferring protection from predation throughout the butterfly's life, as trace amounts of acetogenins remain present, making them unpalatable to birds and other predators.*[17]

6.7.5 Historical uses

The tough, fibrous inner bark of the pawpaw was used by Native Americans and settlers in the Midwest for making ropes, fishing nets, mats,*[4]*[16] and for stringing fish.*[5]

Pawpaw logs have been used for split-rail fences in Arkansas.*[4]

The hard, brown, shiny lima-bean-sized seeds were sometimes carried as pocket pieces in Ohio.*[4]

6.8 Cultural significance

6.8.1 Old song

A traditional American folk song portrays wild harvesting of pawpaws; Arty Schrone of the Georgia Department of Agriculture gives these lyrics:*[9]

Where, oh where is dear little Nellie?

Where, oh where is dear little Nellie?

Where, oh where is dear little Nellie?

Way down yonder in the pawpaw patch

Pickin' up pawpaws, puttin' 'em in your pocket

Pickin' up pawpaws, puttin' 'em in your pocket

Pickin' up pawpaws, puttin' 'em in your pocket

Way down yonder in the pawpaw patch

He notes that “picking up pawpaws” refers to gathering the ripe, fallen fruit from beneath the trees, and that the “pocket” in the song is that of an apron or similar tie-on pocket, not a modern pants or blue jeans pocket, into which pawpaws would hardly fit.*[9] A “pawpaw patch” refers to the plant's characteristic patch-forming clonal growth habit.

6.8.2 Place names

The pawpaw (*Asimina triloba*) is the basis for various place and school names in the United States, almost all using the older spelling variant “paw paw” .

6.8.3 Art

Nineteenth-century naturalist and painter John James Audubon included pawpaw foliage and fruits in the background of his illustration of the yellow-billed cuckoo (*Coccyzus americanus*) in his classic work, *The Birds of America* (1827–1838).

Pawpaw fruits and a pawpaw leaf are featured in the painting *Still Life with Pawpaws* (c. 1870–1875) by Edward Edmondson, Jr. (1830–1884), at the Dayton Art Institute in Dayton, Ohio.

6.8.4 Other

- The Paw Paw Formation, an Early Cretaceous geological formation in Texas where the *Pawpawsaurus* (pawpaw lizard), an herbivorous Cretaceous dinosaur, was found in Texas.*[29]
- The Paw Paw Tunnel in Maryland on the historic Chesapeake and Ohio Canal, a 3118-foot (950-m) canal tunnel completed in 1850 bypassing the six-mile-long Paw Paw Bends in the Potomac River near

- the town of Paw Paw, West Virginia, all ultimately named after the pawpaw tree.*[23]
- The Paw Paw Railroad (1857–1887), which constructed and operated a 4-mile (6.4 km) rail line between Lawton and Paw Paw, in Van Buren County, Michigan.*[30]
 - *Paw Paws* (or *Paw Paw Bears*), a 1985–1986 television cartoon series.*[31]
 - The pawpaw (*Asimina triloba*) was designated as Ohio's state native fruit in 2009.*[32]
 - Since 1999, The Ohio Pawpaw Growers' Association has sponsored an annual Ohio Pawpaw Festival at Lake Snowden, near Albany, Ohio.*[33]
 - Since 2012, Delaware's Alapocas Run State Park has hosted an annual Pawpaw Folk Festival featuring tastings of the fruit.*[34]

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6.10 External links

- The Pawpaw: Foraging For America's Forgotten Fruit

Chapter 7

Carpinus caroliniana

“Blue beech” redirects here. For Japanese blue beech, see *Fagus japonica*.

Carpinus caroliniana (American hornbeam) is a small hardwood tree in the genus *Carpinus*. American hornbeam is also known as **blue-beech**, **ironwood**, and **musclewood**. It is native to eastern North America, from Minnesota and southern Ontario east to Maine, and south to eastern Texas and northern Florida. It also grows in Canada (southwest Quebec and southeast Ontario).^{*[2]}^{*[3]}

7.1 Description



Bark

American hornbeam is a small tree reaching heights of 10–15 meters (35–50 ft), rarely 20 meters (65 ft), and often has a fluted and crooked trunk. The bark is smooth and greenish-grey, becoming shallowly fissured in all old trees. The leaves are alternate, 3–12 centimeters ($1\frac{1}{4}$ – $4\frac{3}{4}$ in) long, with prominent veins giving a distinctive corrugated texture, and a serrated margin. The male and female catkins appear in spring at the same time as the leaves. The fruit is a small 7–8-millimeter ($\frac{9}{32}$ – $\frac{5}{16}$ -inch) long nut, partially surrounded by a three- to seven-pointed leafy involucrum 2–3 centimeters ($\frac{3}{4}$ – $1\frac{1}{4}$ in) long; it matures in autumn. The seeds often do not germinate till the spring of the second year after maturing.

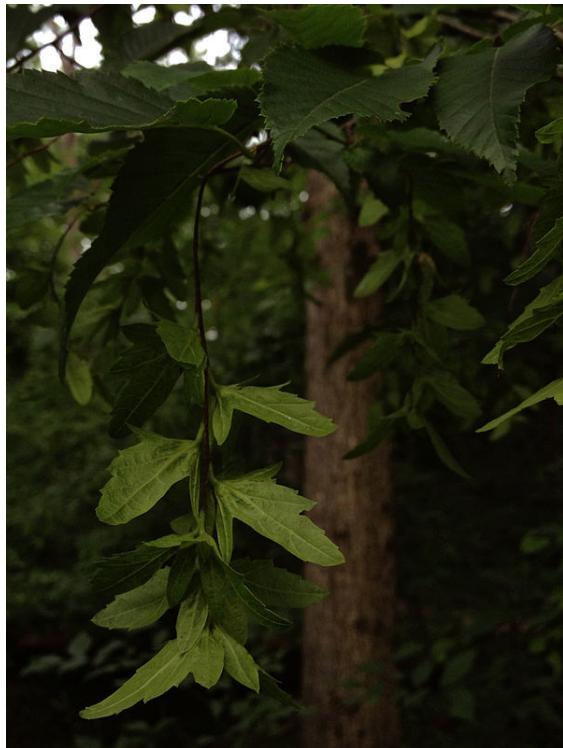
- Bark: On old trees near the base, furrowed. Young trees and branches smooth, dark bluish gray, sometimes furrowed, light and dark gray. Branchlets at first pale green, changing to reddish brown, ultimately dull gray.
- Wood: Light brown, sapwood nearly white; heavy, hard, close-grained, very strong. Used for levers, handles of tools. Specific gravity, 0.7286; weight 45.41 pounds (20.60 kg).
- Winter buds: Ovate, acute, chestnut brown, $\frac{1}{8}$ inch (3 mm) long. Inner scales enlarge when spring growth begins. No terminal bud is formed.
- Leaves: Alternate, two to four inches long, ovate-oblong, rounded, wedge-shaped, or rarely subcordate and often unequal at base, sharply and doubly serrate, acute or acuminate. They come out of the bud pale bronze green and hairy; when full grown they are dull deep green above, paler beneath; feather-veined, midrib and veins very prominent on under side. In autumn bright red, deep scarlet and orange. Petioles short, slender, hairy. Stipules caducous.
- Flowers: April. Monoecious, without petals, the staminate spike naked in pendulous catkins (aments). The staminate ament buds are axillary and form in the autumn. During the winter they resemble leaf-buds, only twice as large. They begin to lengthen very early in the spring, and when full grown are about $1\frac{1}{2}$ inches (4 cm) long. The staminate flower is composed of three to twenty stamens crowded on a hairy torus, adnate to the base of a broadly ovate, acute boot-shaped scale, green below the middle, bright red at apex. The pistillate aments are one-half to three-fourths of an inch long with ovate, acute, hairy, green scales and bright scarlet styles.
- Fruit: Clusters of involucres, hanging from the ends of leafy branches. Each involucre slightly encloses a small oval nut. The involucres are short stalked, usually three-lobed, though one lobe is often wanting; halberd-shaped, coarsely serrated on one margin, or entire.^{*[4]}

7.2 Subdivisions

There are two subspecies, which intergrade extensively where they meet:

- *Carpinus caroliniana* subsp. *caroliniana*. Atlantic coastal plain north to Delaware, and lower Mississippi Valley west to eastern Texas. Leaves mostly smaller, 3–9 cm ($1\frac{1}{4}$ – $3\frac{1}{2}$ in) long, and relatively broader, 3–6 cm ($1\frac{1}{4}$ – $2\frac{1}{4}$ in) broad.
- *Carpinus caroliniana* subsp. *virginiana*. Appalachian Mountains and west to Minnesota and south to Arkansas. Leaves mostly larger, 8–12 cm ($3\frac{1}{4}$ – $4\frac{3}{4}$ in) long, and relatively narrower, 3.5–6 cm ($1\frac{3}{8}$ – $2\frac{3}{8}$ in) broad.

7.3 Ecology



Fruit

It is a shade-loving tree, which prefers moderate soil fertility and moisture. It has a shallow, wide-spreading root system. The leaves are eaten by the caterpillars of some Lepidoptera, for example the Io moth (*Automeris io*).

Common along the borders of streams and swamps, loves a deep moist soil. Varies from shrub to small tree, and ranges throughout the United States east of the Rocky Mountains.

7.4 Uses

The wood is heavy and hard, and is used for tool handles, longbows, walking sticks, walking canes and golf clubs.

7.5 References

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Chapter 8

Carya cordiformis

Carya cordiformis, the **bitternut hickory**,*^[1] also called bitternut or swamp hickory, is a large pecan hickory with commercial stands located mostly north of the other pecan hickories. Bitternut hickory is cut and sold in mixture with the true hickories. It is the shortest-lived of the hickories, living to about 200 years.*^[2]

8.1 Description



Twig of a bitternut

It is a large deciduous tree, growing up to 35 m (115 ft) tall (exceptionally to 47 m or 154 ft), with a trunk up to 1 m (3 ft 3 in) diameter. The leaves are 15–30 cm (6–12 in) long, pinnate, with 7–11 leaflets, each leaflet lanceolate, 7–13 cm (2 3/4–5 in) long, with the apical leaflets the

largest but only slightly so. The flowers are small wind-pollinated catkins, produced in spring. The fruit is a very bitter nut, 2–3 cm (3/4–1 1/4 in) long with a green four-valved cover which splits off at maturity in the fall, and a hard, bony shell. Another identifying characteristic is its bright sulfur-yellow winter bud.

It is closely related to the **pecan**, sharing similar leaf shape and being classified in the same section of the genus *Carya* sect. *Apocarya*, but unlike the pecan, it does not have edible nuts. It is most readily distinguished from the pecan by the smaller number of leaflets, with many leaves having only 7 leaflets (rarely fewer than 9, and often 11–13, in the pecan). Hybrids with the pecan are known, and named *Carya × brownii*. A hybrid between the shagbark hickory (*C. ovata*) is also recognized, and is known as Laney's hickory (*Carya ×laneyi*).*^[3]

8.2 Habitat

Bitternut hickory grows in moist mountain valleys along streambanks and in swamps. Although it is usually found on wet bottom lands, it grows on dry sites and also grows well on poor soils low in nutrients. The species is not included as a titled species in the Society of American Foresters forest cover types because it does not grow in sufficient numbers.

8.3 Range

Bitternut hickory grows throughout the eastern United States from southwestern New Hampshire, Vermont, Maine, and southern Quebec; west to southern Ontario, central Michigan, and northern Minnesota; south to eastern Texas; and east to northwestern Florida and Georgia. It is most common, however, from southern New England west to Iowa and from southern Michigan south to Kentucky. It is probably the most abundant and most uniformly distributed of all the hickories.



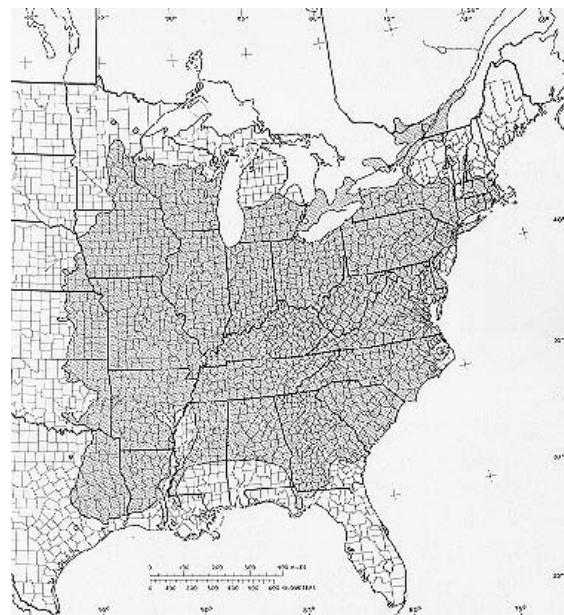
Bitternut leaf



Branch of a bitternut hickory with developing nuts

8.4 Uses

Bitternut is used for lumber and pulpwood. Because bitternut hickory wood is hard and durable, it is used for furniture, paneling, dowels, tool handles and ladders. Like other hickories, the wood is used for smoking meat, and by Native Americans for making bows. Bitternut hickory seeds and its bark are eaten by wildlife.



US range map of *Carya cordiformis*

8.5 References

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8.6 External links

- Media related to *Carya cordiformis* (category) at Wikimedia Commons
- Data related to *Carya cordiformis* at Wikispecies
- *Carya cordiformis* images at [bioimages.vanderbilt.edu*](http://bioimages.vanderbilt.edu/)
- Ontario Tree Atlas: Bitternut Hickory (*Carya Cordiformis*)

Chapter 9

Carya glabra

Carya glabra, the **pignut hickory**, is a common, but not abundant species of hickory in the oak-hickory forest association in the Eastern United States and Canada. Other common names are **pignut**, **sweet pignut**, **coast pignut hickory**, **smoothbark hickory**, **swamp hickory**, and **broom hickory**. The pear-shaped nut ripens in September and October and is an important part of the diet of many wild animals. The **wood** is used for a variety of products, including fuel for home heating.

9.1 Habitat

9.1.1 Native range

The range of pignut hickory covers nearly all of eastern United States (11). The species grows in central Florida and westward through Louisiana and along the Gulf Coast to Alabama through Mississippi. It extends through parts of East Texas to Louisiana, Arkansas, Missouri and extreme southeastern Iowa. Its range further includes Massachusetts and the southwest corner of New Hampshire westward through southern Vermont to central Lower Peninsula of Michigan and Illinois.

The best development of this species is in the lower Ohio River Basin. It prevails over other species of hickory in the Appalachian forests. Pignut makes up much of the hickory harvested in Kentucky, West Virginia, the Cumberland Mountains of Tennessee, and the hill country of the Ohio Valley.

Pignut hickory is also found in Canada in southern Ontario. It does however have a limited range and is restricted to the Niagara Peninsula, southern Halton Region, the Hamilton area along western Lake Ontario, and southward along the northern shore of Lake Erie and pockets of extreme southwestern Ontario.

9.1.2 Climate

Pignut hickory grows in a **humid climate** with an average annual **precipitation** of 760 to 2,030 mm (30 to 80 in) of which 510 to 1,020 mm (20 to 40 in) is **rain** during the growing season. Average **snowfall** varies from little

to none in the South to 2,540 mm (100 in) or more in the mountains of **West Virginia**, southeastern **New York**, and southern **Vermont** (25).

Within the range of pignut hickory, **average annual temperatures** vary from 7 °C (45 °F) in the north to 21 °C (70 °F) in Florida. Average January temperature varies from -4° to 16 °C (25° to 60 °F) and average July temperature varies from 21° to 27 °C (70° to 80 °F). Extremes of 46° and -30 °C (115° and -22 °F) have been recorded within the range. The **growing season** varies by **latitude** and **elevation** from 140 to 300 days.

Mean annual **relative humidity** ranges from 70 to 80 percent with small monthly differences; daytime relative humidity often falls below 50% while nighttime humidity approaches 100%.

Mean annual **hours of sunshine** range from 2,200 to 3,000. Average January sunshine varies from 100 to 200 hours, and July sunshine from 260 to 340 hours. Mean daily solar radiation ranges from 12.57 to 18.86 million J m⁻² (300 to 450 **langleys**). In January daily radiation varies from 6.28 to 12.57 million J m⁻² (150 to 300 langleys), and in July from 20.95 to 23.04 million J m⁻² (500 to 550 langleys).

According to one classification of climate (20), the range of pignut hickory south of the **Ohio River**, except for a small area in Florida, is designated as **humid, mesothermal**. That part of the range lying north of the **Ohio River** is designated **humid, mesothermal**. Part of the species range in peninsular Florida is classed as **subhumid, mesothermal**. **Mountains** in Pennsylvania, West Virginia, North Carolina, and Tennessee are classed as **wet, microthermal**, and mountains in South Carolina and Georgia are classed as **wet, mesothermal**. Throughout its range, precipitation is rated adequate during all seasons.

9.1.3 Soils and topography

Pignut hickory frequently grows on dry ridgetops and sideslopes throughout its range but it is also common on moist sites, particularly in the mountains and **Piedmont**. In the **Great Smoky Mountains** pignut hickory has been observed on dry sandy soils at low elevations. Whit-

taker (27) placed pignut in a submesic class and charted it as ranging up to 1480 m (4,850 ft)-the hickory with the greatest elevational range in the Great Smoky Mountains. In southwest Virginia, south-facing upper slopes from 975 to 1050 m (3,200 to 3,445 ft) of Beanfield Mountain are dominated by pignut hickory, northern red oak (*Quercus rubra*), and white oak (*Q. alba*). This site is the most xeric habitat on the mountain because of high insolation, 70 percent slopes, and medium- to coarse-textured soils derived from Clinch sandstone. Mid-elevation slopes from 800 to 975 m (2,625 to 3,200 ft) are dominated by chestnut oak (*Q. prinus*), northern red oak, and pignut hickory and coincide with three shale formations (12).

The range of pignut hickory encompasses 7 orders, 12 suborders, and 22 great groups of soils (24,25). About two-thirds of the species range is dominated by Ultisols, which are low in bases and have subsurface horizons of clay accumulation. They are usually moist but are dry during part of the warm season. Uadults is the dominant suborder and Hapludults and Paleudults are the dominant great groups. These soils are derived from a variety of parent materials-sedimentary and metamorphic rocks, glacial till, and in places varying thickness of loess-which vary in age from Precambrian to Quaternary.

A wide range of soil fertility exists as evidenced by soil orders-Alfisols and Mollisols which are medium to high in base saturation to Ultisols which are low in base saturation (24). Pignut hickory responds to increases in soil nitrogen similarly to American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and blackgum (*Nyssa sylvatica*) (15). These species are rated as intermediate in nitrogen deficiency tolerance and consequently are able to grow with lower levels of nitrogen than are required by “nitrogen-demanding” white ash (*Fraxinus americana*), yellow-poplar (*Liriodendron tulipifera*), and American basswood (*Tilia americana*). Hickories are considered “soil improvers” because their leaves have a relatively high calcium content.

9.1.4 Associated forest cover

Hickories are consistently present in the broad eastern upland climax forest association commonly called oak-hickory, but they are not generally abundant (18). Locally, hickories may make up to 20 to 30 percent of stand basal area, particularly in slope and cove forests below the escarpment of the Cumberland Plateau (23) and in second-growth forests in the Cumberland Mountains, especially on benches (14). It has been hypothesized that hickory will replace chestnut (*Castanea dentata*) killed by the blight (*Cryphonectria parasitica*) in the Appalachian Highlands (10,12). On Beanfield Mountain in Giles County, Virginia, the former chestnut-oak complex has changed to an oak-hickory association over a period of 50 years. This association is dominated by pignut hickory with an importance value of 41.0 (maxi-

mum value = 300), northern red oak (36.0), and chestnut oak (25.0). White oak, red maple (*Acer rubrum*), and sugar maple are subdominant species.

Pignut hickory is an associated species in 20 of the 90 forest cover types listed by the Society of American Foresters for the eastern United States (6):

9.1.5 Northern forest region

53 White Pine-Chestnut Oak

9.1.6 Central forest region

- 40 Post Oak-Blackjack Oak
- 44 Chestnut Oak
- 45 Pitch Pine
- 46 Eastern Redcedar
- 52 White Oak-Black Oak-Northern Red Oak
- 53 White Oak
- 55 Northern Red Oak
- 57 Yellow-Poplar-Tulip tree
- 59 Yellow-Poplar-White Oak-Northern Red Oak
- 64 Sassafras-Persimmon
- 110 Black Oak

9.1.7 Southern forest region

- 75 Shortleaf Pine
- 76 Shortleaf Pine-Oak
- 78 Virginia Pine-Oak
- 79 Virginia Pine
- 80 Loblolly Pine-Shortleaf Pine
- 81 Loblolly Pine
- 82 Loblolly Pine-Hardwood
- 83 Longleaf Pine-Slash Pine

Because the range of pignut hickory is so extensive, it is not feasible to list the associated trees, shrubs, herbs, and grasses, which vary according to elevation, topographic conditions, edaphic features, and geographic locality.

9.2 Life history

9.2.1 Reproduction and early growth

Flowering and fruiting- Hickories are monoecious and flower in the spring (3). The staminate catkins of pignut hickory are 8 to 18 cm (3 to 7 in) long and develop from axils of leaves of the previous season or from inner scales of the terminal buds at the base of the current growth. The pistillate flowers appear in spikes about 6 mm (0.25 in) long on peduncles terminating in shoots of the current year. Flowers open from the middle of March in the



Pignut hickory nuts

southeast part of the range to early June in New England. The catkins usually emerge before the pistillate flowers.

The fruit of hickory is pear shaped and enclosed in a thin husk developed from the floral involucrume. The fruit ripens in September and October, and seeds are dispersed from September through December. Husks are green until maturity; they turn brown to brownish-black as they ripen. The husks become dry at maturity and split away from the nut into four valves along sutures. Husks of pignut hickory split only to the middle or slightly beyond and generally cling to the nut, which is unribbed, with a thick shell.

9.2.2 Seed production and dissemination

Pignut hickory begins to bear seed in quantity in 30 years, with optimum production between 75 and 200 years (16). The maximum age for seed production is about 300 years. Good seed crops occur every year or two with light crops in other years; frost can seriously hinder seed production (22). Usually less than half of the seeds are sound (2,3), but 50 to 75 percent of these will germinate. The hickory shuckworm (*Laspeyresia caryana*) can seriously reduce germination. Pignut seed, averaging 440/kg (200/lb), is lighter than the seed of other hickory species. The nuts are disseminated mainly by gravity, but the range of seed-ing is extended by squirrels and chipmunks.

9.2.3 Seedling development

Hickories exhibit embryo dormancy which is overcome naturally by overwintering in the duff and litter or artificially by stratification in a moist medium at 1° to 4 °C (33° to 40 °F) for 30 to 150 days. In forest tree nurseries unstratified hickory nuts are sown in the fall and stratified nuts are sown in the spring. Hickories are hypogeously germinating plants, and the nuts seldom remain viable in the forest floor for more than one winter (22).

Seedling growth of hickories is slow. The following height growth of pignut hickory seedlings was reported

in the Ohio Valley in the open or under light shade, on red clay soil (2):

9.2.4 Vegetative reproduction

Hickories sprout readily from stumps and roots. Stump sprouting is not as prolific as in other deciduous trees species but the sprouts that are produced are vigorous and grow fairly rapidly in height. Root sprouts also are vigorous and probably more numerous than stump sprouts in cut-over areas. Small stumps sprout more frequently than large ones. Sprouts that originate at or below ground level and from small stumps are less likely to develop heartwood decay. Pignut hickory is difficult to reproduce from cuttings.

9.2.5 Sapling and pole stages to maturity

Growth and yield- Pignut hickory often grows 24 to 27 m (80 to 90 ft) tall and occasionally reaches 37 m (120 ft), with d.b.h. of 91 to 122 cm (36 to 48 in). The bole is often forked. Height and diameter by age are shown in table 1 for selected locations. Diameter growth of pignut hickory (along with chestnut oak, white oak, sweet birch (*Betula lenta*), and American beech is rated slow. Since hickories constitute 15 percent or less of the basal area of oak-hickory forest types, most growth and yield information is written in terms of oak rather than oak-hickory. Yields of mixed oak stands (5,7,19) and of hickory stands (2) have been reported. Tree volume tables are available (2,19).

¹Second growth. ²Virgin forest.

9.2.6 Rooting habit

Pignut hickory tends to develop a pronounced taproot with few laterals and is rated as windfirm (21). The taproot develops early, which may explain the slow growth of seedling shoots. Taproots may develop in compact and stony soils.

9.2.7 Reaction to competition

The hickories as a group are classed as intermediate in shade tolerance; however, pignut hickory has been classed as intolerant in the Northeast and tolerant in the Southeast. In much of the area covered by mixed oak forests, shade-tolerant hardwoods (including the hickories) are climax, and the trend of succession toward this climax is very strong. Although most silvicultural systems when applied to oak types will maintain a hardwood forest, the cutting methods used affects the rapidity with which other species may replace the oaks and hickories (17,18,26).

9.3 Damaging agents

Pignut hickory is easily damaged by fire, which causes stem degrade or loss of volume, or both. Internal discolorations called mineral streak are common and are one major reason why so few standing hickories meet trade specifications. Streaks result from yellow-bellied sapsucker pecking, pin knots, worm holes, and mechanical injuries. Hickories strongly resist ice damage and seldom develop epicormic branches.

The Index of Plant Diseases in the United States lists 133 fungi and 10 other causes of diseases on *Carya* species (4,9). Most of the fungi are saprophytes, but a few are damaging to foliage, produce cankers, or cause trunk or root rots.

The most common disease of pignut hickory from Pennsylvania southward is a trunk rot caused by *Porina spiculosa*. Cankers vary in size and appearance depending on their age. A common form develops around a branch wound and resembles a swollen, nearly healed wound. On large trees these may become prominent burl-like bodies having several vertical or irregular folds in the callus covering. A single trunk canker near the base is a sign that the butt log is badly infected, and multiple cankers are evidence that the entire tree may be a cull.

Major leaf diseases are anthracnose (*Gnomonia caryae*) and mildew (*Microstroma juglandis*). The former causes brown spots with definite margins on the undersides of the leaf. These may coalesce and cause widespread blotching. Mildew invades the leaves and twigs and may form witches' brooms by stimulating bud formation. Although locally prevalent, mildew offers no problem in the management of hickory.

The stem canker (*Nectria galligena*) produces depressed areas with concentric bark rings that develop on the trunk and branches. Affected trees are sometimes eliminated through breakage or competition and sometimes live to reach merchantable size with cull section at the canker. No special control measures are required, but cankered trees should be harvested in stand improvement operations.

A gall-forming fungus species of *Phomopsis* can produce warty excrescences ranging from small twig galls to very large trunk burls on northern hickories and oaks. Little information is available on root diseases of hickory.

More than 100 insects have been reported to infest hickory trees and wood products, but only a few cause death or severe damage (1). The hickory bark beetle (*Scolytus quadrispinosus*) is the most important insect enemy of hickory, and also one of the most important insect pests of hardwoods in the Eastern United States. During drought periods in the Southeast, outbreaks often develop and large tracts of timber are killed. At other times, damage may be confined to the killing of a single tree or to portions of the tops of trees. The foliage of heavily

infested trees turns red within a few weeks after attack, and the trees soon die. There is one generation per year in northern areas and normally two broods per year in the South. Control consists of felling infested trees and destroying the bark during winter months or storing infested logs in ponds.

Logs and dying trees of several hardwood species including pignut hickory are attacked by the ambrosia beetle (*Platypus quadridentatus*) throughout the South and north to West Virginia and North Carolina. The false powderpost beetle (*Xylobiops basilaris*) attacks recently felled or dying trees, logs, or limbs with bark in the Eastern and Southern States. Hickory, persimmon (*Diospyros virginiana*), and pecan (*C. illinoiensis*) are most frequently infested, but other hardwoods also are attacked. Healthy trees growing in proximity to heavily infested trees are occasionally attacked but almost always without success. Hickory and persimmon wood (useful in the manufacture of small products such as shuttle blocks, mallets, and mauls) is sometimes seriously damaged.

Hickory is one of several host species of the twig girdler (*Oncideres cingulata*). Infested trees and seedlings are not only damaged severely but become ragged and unattractive. A few of the more common species of gall-producing insects attacking hickory are *Phylloxera caryaecaulis*, *Caryomyia holotricha*, *C. sanguinolenta*, and *C. tubicola*.

9.4 Special uses

Hickories provide food to many kinds of wildlife (8,13). The nuts are relished by several species of squirrel and represent an estimated 10 to 25 percent of their diet. Nuts and flowers are eaten by the wild turkey and several species of songbirds. Nuts and bark are eaten by black bears, foxes, rabbits, and raccoons. Small mammals eat the nuts and leaves; 5 to 10 percent of the diet of eastern chipmunks is hickory nuts. White-tailed deer occasionally browse hickory leaves, twigs, and nuts.

The kernel of hickory seeds is exceptionally high in crude fat, up to 70 to 80 percent in some species. Crude protein, phosphorus, and calcium contents are generally moderate to low. Crude fiber is very low.

Pignut hickory makes up a small percentage of the biomass in low-quality upland hardwood stands that are prime candidates for clearcutting for chips or fuelwood as the first step toward rehabilitation to more productive stands. Hickory has a relatively high heating value and is used extensively as a home heating fuel.

Pignut hickory is an important shade tree in wooded suburban areas over most of the range but is seldom planted as an ornamental tree because of its size and difficulty of transplanting, although it has spectacular orangey-red fall colors.

9.5 Genetics

Carya glabra var. *megacarpa* (Sarg.) Sarg., coast pignut hickory, was once recognized as a distinct variety but is now considered to be a synonym of *C. glabra* (Mill.) Sweet. *C. leiodermis* Sarg., swamp hickory, has also been added as a synonym of *C. glabra* (11).

Carya glabra (Mill.) Sweet var. *glabra* distinguishes the (typical) pignut hickory from red hickory (*C. glabra* var. *odorata* (Marsh.) Little). The taxonomic position of red hickory is controversial. The binomial *C. ovalis* (Wangenh.) Sarg. was published in 1913 for a segregate of *C. glabra*. It was reduced to a synonym of *C. glabra* in Little's 1953 checklist but was elevated to a variety in the 1979 edition (11). The principal difference is in the husk of the fruit, opening late and only partly, or remaining closed in *C. glabra* but promptly splitting to the base in *C. ovalis*. However, many trees are intermediate in this trait, and the recorded ranges are almost the same. The leaves of *C. ovalis* have mostly seven leaflets; those of *C. glabra* have mostly five leaflets. The two can be distinguished with certainty only in November. Since the two ranges seem to overlap, the distributions have been mapped together as a *Carya glabra*-*ovalis* complex (11).

Carya ovalis has also been treated as an interspecific hybrid between *C. glabra* and *C. ovata*. *C. ovalis* was accepted as a polymorphic species especially variable in the size and shape of its nuts and possibly a hybrid. The relationships may be more complex after a long and reticulate phylogeny, according to detailed chemical analyses of hickory nut oils.

One hybrid, *C. x demareei* Palmer (*C. glabra* x *cordiformis*) was described in 1937 from northeastern Arkansas.

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Chapter 10

Carya ovalis

Carya ovalis, the **red hickory** or **sweet pignut hickory**, is a fairly uncommon but widespread hickory native to eastern North America. It is typically found growing in dry, well drained sandy upland ridges and sloped woodlands from southern Ontario, Canada, and in the United States east to New Hampshire, south to northern Florida west to eastern Texas and north-west to Nebraska.*[1] This species was formerly treated as a variety or northern ecotype of the pignut hickory *C. glabra*, described as *Carya glabra* var. *odorata*. This discrepancy has not yet been completely resolved, and some sources and authors still consider red hickory as a variety or synonym of pignut hickory.*[2] However both trees are quite morphologically distinct.

10.1 Description

The red hickory is generally encountered as a medium-sized tree, capable of growing to 30 m (100 ft) in height.*[3] The single trunk is straight and often continues for the entire height of the tree, although sometimes splits into several large limbs once the canopy has been breached. The branches are strong, stout and long, ascending in the upper crown and drooping in the lower crown; the branches around mid-height are more or less horizontal. This creates a broad, thick, column-shaped form that casts dense shade. Individuals have been known to live from 100–250 years of age.



the thin shelled nuts of red hickory

The leaves are pinnately compound, typically producing 5-9 leaflets (7 being the most common). The terminal leaflet is often the largest, with the auxiliary leaflets decreasing in size from the tip to the base of the rachis. Leaflets are broadest above or at their median length, with finely serrated margins. They are dark green and smooth or glaucous above and paler and finely pubescent underneath. The rachis of the leaves are usually bright red or purple in color, a distinctive feature of red hickory that helps to separate it from pignut hickory.*[4]



The bark of a mature red hickory

The bark of mature trees is grey, composed of tight, flat-topped intersecting ridges that can appear quite blocky but are generally strap-like. Occasionally, the ridges may separate from the trunk in peeling strips, loose at both ends, a trait characteristic of Shagbark and Shellbark

Hickories. Young, vigorously growing trees are more prone to producing peeling bark than mature individuals.

Like all hickories, the fruit is a small round or slightly elliptical **nut**, born singly or in groups of 2-3 on the ends of bearing branches. When immature, the nut is encased in a thin, green **husk** with 4 distinct seams. Upon maturity (late September to mid-October) the husk changes from being green, fleshy and flexible to dark brown and very brittle. The seams then split from the base upwards and may or may not completely separate from the ripe nut. The nut itself is smooth, tan to beige in color and has 4 shallow ridges from the seams. The inner **kernel** is very oily and varies in flavor from bitter and unpalatable to mildly sweet. For such a small nut, the shell is thick and the kernel difficult to extract. These nuts are relished by countless wildlife species, including many **rodents** and **birds**, as well as raccoons and wild turkeys.

The flowers emerge in the spring at the same times as the developing leaves (early to late May). The male flowers are long, green, inconspicuous drooping **catkins** that develop between the base of the petiole and the developing twig. The female flowers are bizarre looking, with a tuft of sticky green tissue emerging from a swollen base. These develop individually or in groups at the end of a new twig, after the expanding leaves. All hickories are self-infertile and **monoecious**.

10.2 References

- [1] USDA Germplasm Resources Information Network: *Carya ovalis*
- [2] Flora of North America: *Carya glabra*
- [3] Plants For A Future: *Carya ovalis*
- [4] Ohio Trees Bulletin 700-00: *Carya* – Hickory

Chapter 11

Carya tomentosa

Carya tomentosa, (mockernut hickory, mockernut, white hickory, whiteheart hickory, hognut, bullnut) is a tree in the Juglandaceae or walnut family. The most abundant of the hickories, common in the eastern half of the US, it is long lived, sometimes reaching the age of 500 years. A straight-growing hickory, a high percentage of its wood is used for products where strength, hardness, and flexibility are needed. The wood makes an excellent fuelwood, as well.

The species' name comes from the Latin word *tomentum*, meaning "covered with dense short hairs," referring to the underside of the leaves which help identify the species. Also called the white hickory due to the light color of the wood, the common name mockernut comes from the large, thick-shelled fruit with very small kernels of meat inside.* [2]

11.1 Habitat

11.1.1 Native range

Mockernut hickory, a true hickory, grows from Massachusetts and New York west to southern Ontario, southern Michigan, and northern Illinois; then to southeastern Iowa, Missouri, and eastern Kansas, south to eastern Texas and east to northern Florida. This species is not present in New Hampshire and Vermont as previously mapped by Little.* [3] Mockernut hickory is most abundant southward through Virginia, North Carolina and Florida where it is the most common of the hickories. It is also abundant in the lower Mississippi Valley and grows largest in the lower Ohio River Basin and in Missouri and Arkansas.* [4]* [5]

11.1.2 Climate

The climate where mockernut hickory grows is usually humid. Within its range the mean annual precipitation measures from 890 millimetres (35 in) in the north to 2,030 millimetres (80 in) in the south. During the growing season (April through September), annual precipitation varies from 510 to 890 mm (20 to 35 in). About

200 centimetres (79 in) of annual snowfall is common in the northern part of the range, but it seldom snows in the southern portion.

Annual temperatures range from 10° to 21 °C (50° to 70 °F). Temperatures range from 21° to 27° C (70° to 80 °F) in July and from -7° to 16 °C (20° to 60 °F) in January. Temperature extremes are well above 38 °C (100 °F) and below -18 °C (0 °F). The growing season is approximately 160 days in the northern part of the range and up to 320 days in the southern part of the range.* [6]* [7]

11.1.3 Soils and topography

In the north, mockernut hickory is found on drier soils of ridges and hillsides and less frequently on moist woodlands and alluvial bottoms.* [5] The species grows and develops best on deep, fertile soils.* [4]* [8] In the Cumberland Mountains and hills of southern Indiana, it grows on dry sites such as south and west slopes or dry ridges mockernut grows in Alabama and Mississippi on sandy soils with shortleaf pine (*Pinus echinata*) and loblolly pine (*P. taeda*). However, most of the merchantable mockernut grows on moderately fertile upland soils.* [5]

Mockernut hickory grows primarily on Ultisols occurring on an estimated 65 percent of its range, including much of the southern to northeastern United States.* [9] These soils are low in nutrients and usually moist, but during the warm season, they are dry part of the time. Along the mid-Atlantic and in the southern and western range, mockernut hickory grows on a variety of soils on slopes of 25 percent or less, including combinations of fine to coarse loams, clays, and well-drained quartz sands. On slopes steeper than 25 percent, mockernut often grows on coarse loams.

Mockernut grows on Inceptisols in an estimated 15 percent of its range. These clayey soils are moderate to high in nutrients and are primarily in the Appalachians on gentle to moderate slopes where water is available to plants during the growing season. In the northern Appalachians on slopes of 25 percent or less, mockernut hickory grows on poorly drained loams with a fragipan. In the central and southern Appalachians on slopes 25 percent or less, mockernut hickory grows on fine loams. On steeper

slopes it grows on coarse loams.* [9]

In the northwestern part of the range, mockernut grows on mollisols. These soils have a deep, fertile surface horizon greater than 25 centimetres (9.8 in) thick. Mollisols characteristically form under grass in climates with moderate to high seasonal precipitation.

Mockernut grows on a variety of soils including wet, fine loams, sandy textured soils that often have been burned, plowed, and pastured. **Alfisols** are also present in these areas and contain a medium to high supply of nutrients. Water is available to plants more than half the year or more than 3 consecutive months during the growing season. On slopes 25 percent or less, mockernut grows on wet to moist, fine loam soils with a high carbonate content.* [9]

11.2 Associated forest cover

Mockernut hickory is associated with the eastern **Oak-hickory** forest and the **beech-maple** forest. The species does not exist in sufficient amounts to be included as a title species in the Society of American Foresters forest cover types. Nevertheless, it is identified as an associated species in eight cover types. Three of the upland oak types and the bottom land type are subclimax to **climax**. The types are:

Central Forest Region (upland oaks)-Post Oak-Blackjack Oak (Type 40), White Oak-Black Oak-Northern Red Oak (Type 52), White Oak (Type 53), Black Oak (Type 110).

Southern Forest Region (southern yellow pines) Shortleaf Pine (Type 75), Loblolly Pine-Shortleaf Pine (Type 80); (oak-pine type) Loblolly Pine-Hardwood (Type 82); (bottom-land type) Swamp Chestnut Oak-Cherrybark Oak (Type 91).

11.2.1 In the central forest upland oak types, mockernut is commonly associated with

- pignut hickory (*Carya glabra*)
- shagbark hickory (*C. ovata*)
- bitternut hickory (*C. cordiformis*)
- black oak (*Quercus velutina*)
- scarlet oak (*Q. coccinea*)
- post oak (*Q. stellata*)
- bur oak (*Q. macrocarpa*)
- blackgum (*Nyssa sylvatica*)
- yellow-poplar (*Liriodendron tulipifera*)

- maples (*Acer spp.*)
- white ash (*Fraxinus americana*)
- eastern white pine (*Pinus strobus*)
- eastern hemlock (*Tsuga canadensis*)

Common understory vegetation includes

- flowering dogwood (*Cornus Florida*)
- sumac (*Rhus spp.*)
- sassafras (*Sassafras albidum*)
- sourwood (*Oxydendrum arboreum*)
- downy serviceberry (*Amelanchier spp.*)
- redbud (*Cercis canadensis*)
- eastern hop hornbeam (*Ostrya virginiana*)
- American hornbeam (*Carpinus caroliniana*)

Mockernut is also associated with

- wild grapes (*Vitis spp.*)
- rosebay rhododendron (*Rhododendron maximum*)
- mountain-laurel (*Kalmia latifolia*)
- greenbriers (*Smilax spp.*)
- blueberries (*Vaccinium spp.*)
- witch-hazel (*Hamamelis virginiana*)
- spicebush (*Lindera benzoin*)
- New Jersey tea (*Ceanothus americanus*)
- wild hydrangea (*Hydrangea arborescens*)
- tick-trefoil (*Desmodium spp.*)
- bluestem (*Andropogon spp.*)
- poverty oatgrass (*Danthonia spicata*)
- sedges (*Carex spp.*)
- pussytoes (*Antennaria spp.*)
- goldenrod (*Solidago spp.*)
- asters (*Aster* or other genera, depending on the classification).

11.2.2 In the southern forest, mockernut grows with

- shortleaf pine
- loblolly pine
- pignut hickory
- gums
- oaks
- sourwood
- winged elm (*Ulmus alata*)
- flowering dogwood
- redbud
- sourwood
- persimmon (*Diospyros virginiana*)
- eastern redcedar (*Juniperus virginiana*)
- sumacs
- hawthorns (*Crataegus* spp.)
- blueberries
- honeysuckle (*Lonicera* spp.)
- mountain-laurel
- viburnums
- greenbriers
- grapes

In the Loblolly Pine-Hardwood Type in the southern forest, mockernut commonly grows in the upland and drier sites with

- white oak (*Quercus alba*)
- post oak
- northern red oak (*Q. rubra*)
- southern red oak (*Q. falcata*)
- scarlet oak
- shagbark and pignut hickories
- blackgum
- flowering dogwood
- hawthorn
- sourwood
- greenbrier
- grape
- honeysuckle
- blueberry

In the southern bottom lands, mockernut occurs in the Swamp Chestnut Oak-Cherrybark Oak Type along with

- green ash (*Fraxinus pennsylvanica*)
- white ash
- shagbark
- Shellbark hickory (*Carya laciniosa*)
- bitternut hickories
- white oak
- Delta post oak (*Quercus stellata* var. *paludosa*)
- Shumard oak (*Q. shumardii*)
- blackgum.

Understory trees include

- American pawpaw (*Asimina triloba*)
- flowering dogwood
- painted buckeye (*Aesculus sylvatica*)
- American hornbeam
- devils-walking stick (*Aralia spinosa*)
- redbud
- American holly (*Ilex opaca*)
- Dwarf palmetto (*Sabal minor*)
- Coastal plain willow (*Salix caroliniana*)

11.3 Life history

11.3.1 Reproduction and early growth

Flowering and fruiting

Mockernut hickory is monoecious - male and female flowers are produced on the same tree. Mockernut male flowers are catkins about 10 to 13 cm (3.9 to 5.1 in) long and may be produced on branches from axils of leaves of the previous season or from the inner scales of the terminal buds at the base of the current growth. The female flowers appear in short spikes on peduncles terminating in shoots of the current year. Flowers bloom in the spring from April to May, depending on latitude and weather. Usually the male flowers emerge before the female flowers. Hickories produce very large amounts of pollen that is dispersed by the wind.

Fruits are solitary or paired and globose, ripening in September and October, and are about 2.5 to 9.0 cm

(0.98 to 3.54 in) long with a short necklike base. The fruit has a thick, four-ribbed husk 3 to 4 mm (0.12 to 0.16 in) thick that usually splits from the middle to the base. The nut is distinctly four-angled with a reddish-brown, very hard shell 5 to 6 mm (0.20 to 0.24 in) thick containing a small edible kernel.

Seed production and dissemination

The seed is dispersed from September through December. Mockernut hickory requires a minimum of 25 years to reach commercial seed-bearing age. Optimum seed production occurs from 40 to 125 years, and the maximum age listed for commercial seed production is 200 years.

Good seed crops occur every 2 to 3 years with light seed crops in intervening years. Approximately 50 to 75 percent of fresh seed will germinate. Fourteen mockernut hickory trees in southeastern Ohio produced an average annual crop of 6,285 nuts for 6 years; about 39 percent were sound, 48 percent aborted, and 13 percent had insect damage. Hickory shuckworm (*Laspeyresia caryana*) is probably a major factor in reducing germination.

Mockernut hickory produces one of the heaviest seeds of the hickory species; cleaned seeds range from 70 to 250 seeds/kg (32 to 113/lb). Seed is disseminated mainly by gravity and wildlife, particularly squirrels. Birds also help disperse seed. Wildlife such as squirrels and chipmunks often bury the seed at some distance from the seed-bearing tree.

Seedling development

Hickory seeds show embryo dormancy that can be overcome by stratification in a moist medium at 1° to 4 °C (33° to 40 °F) for 30 to 150 days. When stored for a year or more, seed may require stratification for only 30 to 60 days. Hickory nuts seldom remain viable in the ground for more than 1 year. Hickory species normally require a moderately moist seedbed for satisfactory seed germination, and mockernut hickory seems to reproduce best in moist duff. Germination is hypogeal.

Mockernut seedlings are not fast-growing. The height growth of mockernut seedlings observed in the Ohio Valley in the open or under light shade on red clay soil was as follows:

Vegetative reproduction

True hickories sprout prolifically from stumps after cutting and fire. As the stumps increase in size, the number of stumps that produce sprouts decreases; age is probably directly correlated to stump size and sprouting. Coppice management is a possibility with true hickories. True hickories are difficult to reproduce from cuttings. Mad-

den discussed the techniques for selecting, packing, and storing hickory propagation wood. Reed indicated that the most tested hickory species for root stock for pecan hickory grafts were mockernut and water hickory (*Carya aquatica*).

However, mockernut root stock grew slowly and reduced the growth of pecan tops. Also, this graft seldom produced a tree that bore well or yielded large nuts.

11.3.2 Sapling and pole stages to maturity

Growth and yield

Mockernut hickory is a large, true hickory with a dense crown. This species occasionally grows to about 30 m (98 ft) tall and 91 cm (36 in) in d.b.h., but heights and diameters usually range from about 15 and 46 to 61 cm (5.9 and 18.1 to 24.0 in), respectively.

The relation of height to age is as follows:

The current annual growth of mockernut hickory on dry sites is estimated at about 1.0 m³/ha (15 ft³/acre). In fully stocked stands on moderately fertile soil 2.1 m³ /ha (30 ft³/acre) is estimated, though annual growth rates of 3.1 m³/ha (44 ft³/acre) were reported in Ohio (26). Greenwood and bark weights for commercial-size mockernut trees from mixed hardwoods in Georgia are available for total tree and saw-log stems to a 4-inch top for trees 5 to 22 inches d.b.h..

Available growth data and other research information is summarized for hickory species, not for individual species. Trimble compared growth rates of various Appalachian hardwoods including a hickory species category Dominant-codominant hickory trees 38 to 51 cm (15 to 20 in) in d.b.h. on good oak sites grew slowly compared to northern red oak, yellow-poplar, black cherry (*Prunus serotina*), and sugar maple (*Acer saccharum*). Hickories were in the white oak, sweet birch (*Betula lenta*), and American beech (*Fagus grandifolia*) growth-rate category. Dominant-codominant hickory trees grew about 3 mm (0.12 in) d.b.h. per year compared to 5 mm (0.20 in) for the moderate-growth species (black cherry) and 6 mm (0.24 in) for the faster-growing species (yellow-poplar and red oak). Equations are available for predicting merchantable gross volumes from hickory stump diameters in Ohio. Also, procedures are described for predicting diameters and heights and for developing volume tables to any merchantable top diameter for hickory species in southern Illinois and West Virginia. Generally, epicormic branching is not a problem with hickory species, but a few branches do occur.

Rooting habit

True hickories such as mockernut develop a long taproot with few laterals. The species is windfirm. Early root

growth is primarily into the taproot, which typically reaches a depth of 30 to 91 cm (12 to 36 in) during the first year. Small laterals originate along the taproot, but many die back during the fall. During the second year, the taproot may reach a depth of 122 centimetres (48 in), and the laterals grow rapidly. After 5 years, the root system attains its maximum depth, and the horizontal spread of the roots is about double that of the crown. By age 10, the height is 4 times the depth of the taproot.

Reaction to competition

At certain times during its life, mockernut hickory may be variously classified as **tolerant** to intolerant. Overall it is classified as intolerant of shade. It recovers rapidly from suppression and is probably a climax species on moist sites.

Silvicultural practices for managing the oak-hickory type have been summarized. Establishing the seedling origin of hickory trees is difficult because of seed predators. Although infrequent bumper seed crops usually provide some seedlings, seedling survival is poor under a dense canopy. Because of prolific sprouting ability, hickory reproduction can survive browsing, breakage, drought, and fire. Top dieback and resprouting may occur several times, each successive shoot reaching a larger size and developing a stronger root system than its predecessors. By this process, hickory reproduction gradually accumulates and grows under moderately dense canopies, especially on sites dry enough to restrict reproduction of more tolerant but more fire or drought-sensitive species.

Wherever adequate hickory advance reproduction occurs, **clearcutting** results in new sapling stands containing some hickories. It is difficult to attain reproduction if advance hickory regeneration is inadequate, however; then clearcutting will eliminate hickories except for stump sprouts. In theory, light thinnings or **shelterwood** cuts can be used to create advance hickory regeneration, but this has not been demonstrated.

Damaging agents

Mockernut hickory is extremely sensitive to fire because of the low insulating capacity of the hard, flinty bark. Mockernut is not subject to severe loss from disease. The main fungus of hickory is *Poria spiculosa*, a trunk rot. This fungus kills the bark, which produces a canker, causes heart rot and decay, and can seriously degrade the tree. Mineral streaks and **sapsucker**-induced streaks also degrade the lumber. In general, the hard, strong, and durable wood of hickories makes them relatively resistant to decay fungi. Most fungi cause little, if any, decay in small, young trees.

Common foliage diseases include leaf mildew and witches' broom (*Microstroma juglandis*), leaf blotch (*Mycosphaerella dendroides*), and pecan scab

(*Cladosporium effusum*). Mockernut hickory is host to anthracnose (*Gnomonia caryae*).

Nuts of all hickory species are susceptible to attack by the hickory nut weevil (*Curculio caryaef*). Another weevil (*Conotrachelus aratus*) attacks young shoots and leaf petioles. The *Curculio* species are the most damaging and can destroy 65 percent of the hickory nut crop. Hickory shuckworms also damage nuts.

The bark beetle (*Scolytus quadrispinosus*) attacks mockernut hickory, especially in drought years and where hickory species are growing rapidly. The hickory spiral borer (*Argilus arcuatus torquatus*) and the pecan carpenterworm (*Cossula magnifica*) are also serious insect enemies of mockernut. The hickory bark beetle probably destroys more sawtimber-size mockernut trees than any other insect. The hickory spiral borer kills many seedlings and young trees, and the pecan carpenterworm degrades both trees and logs. The twig girdler (*Oncideres cingulata*) attacks both small and large trees; it seriously deforms trees by sawing branches. Sometimes these girdlers cut hickory seedlings near ground level.

Two casebearers (*Acrobasis caryivorella* and *A. juglandis*) feed on buds and leaves; later they bore into succulent hickory shoots. Larvae of *A. caryivorella* may destroy entire nut sets. The living-hickory borer (*Goes pulcher*) feeds on hickory boles and branches throughout the East. Borers commonly found on dying or dead hickory trees or cut logs include:

- the banded hickory borer (*Knnulliana cincta*)
- a long-horned beetle (*Saperda discoidea*)
- the apple twig borer (*Amphicerus bicaudatus*)
- the flatheaded ambrosia beetle (*Platypus compositus*)
- the redheaded ash borer (*Neoclytus acuminatus*)
- the false powderpost beetle (*Scobicia bidentata*)

Severe damage to hickory lumber and manufactured hickory products is caused by powderpost beetles (*Lycus* spp. and *Polycanion stoutii*). Gall insects (*Caryomyia* spp.) commonly infest leaves. The fruit-tree leafroller (*Archips argyrospila*) and the hickory leafroller (*Argyrotaenia juglandana*) are the most common leaf feeders. The giant bark aphid (*Longistigma caryae*) is common on hickory bark. This aphid usually feeds on twigs and can cause branch mortality. The European fruit lecanium (*Parthenolecanium corni*) is common on hickories.

Mockernut is not easily injured by ice glaze or snow, but young seedlings are very susceptible to frost damage. Many birds and animals feed on the nuts of mockernut hickory. This feeding combined with insect and disease problems eliminates the annual nut production, except during bumper seed crop years.

11.4 Special uses



Closeup of Bark

Mockernuts are preferred mast for wildlife, particularly squirrels, which eat green nuts. Black bears, foxes, rabbits, beavers, and white-footed mice feed on the nuts, and sometimes the bark. The white-tailed deer browse on foliage and twigs and also feed on nuts. Hickory nuts are a minor source of food for ducks, quail, and turkey.

Mockernut hickory nuts are consumed by many species of birds and other animals, including wood duck, red-bellied woodpecker, red fox, squirrels, beaver, eastern cottontail, eastern chipmunk, turkey, white-tailed deer, white-footed mice, and others. Many insect pests eat hickory leaves and bark. Mockernut hickories also provide cavities for animals to live in, such as woodpeckers, black rat snakes, raccoons, Carolina chickadees, and more. They are also good nesting trees, providing cover for birds with their thick foliage. Animals help disperse seeds so that new hickories can grow elsewhere. Chipmunks, squirrels, and birds do this best. Some fungi grow on mockernut hickory roots, sharing nutrients from the soil.*[10]

True hickories provide a very large portion of the high-grade hickory used by industry. Mockernut is used for lumber, pulpwood, charcoal, and other fuelwood products. Hickory species are preferred species for fuelwood consumption. Mockernut has the second highest heating value among the species of hickories. It can be used for veneer, but the low supply of logs of veneer quality is a limiting factor.

Mockernut hickory is used for tool handles requiring high

shock resistance. It is used for ladder rungs, athletic goods, agricultural implements, dowels, gymnasium apparatus, poles, shafts, well pumps, and furniture. Lower grade lumber is used for pallets, blocking, and so on. Hickory sawdust, chips, and some solid wood are often used by packing companies to smoke meats, and mockernut is the preferred wood for smoking hams. Though mockernut kernels are edible, because of their size they are rarely eaten by humans.

Mockernut hickory is used for smoking meats such as ham.*[2]

11.5 Genetics

The mockernut is a 64 chromosome species and therefore very rarely if ever crosses with 32 chromosome species such as pecan or shellbark hickory. There is no published information concerning population or other genetic studies of this species.

Hickories are noted for their variability, and many natural hybrids are known among North American species. Hickories usually can be crossed successfully within the genus. Geneticists recognize that mockernut hickory hybridizes naturally with: *C. illinoensis* (*Carya x schneckii* Sarg.) and *C. ovata* (*Carya x collina* Laughlin).

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Chapter 12

American chestnut

The **American chestnut** (*Castanea dentata*) is a large, monoecious deciduous tree of the beech family native to eastern North America.* [1] Before the species was devastated by the **chestnut blight**, a fungal disease, it was one of the most important forest trees throughout its range, and was considered the finest chestnut tree in the world.* [2] It is estimated that between 3 and 4 billion American chestnut trees were destroyed in the first half of the 20th century by blight after its initial discovery in 1904.* [3]*[4]*[5] Very few mature specimens of the tree exist within its historical range, although many small shoots of the former live trees remain. There are hundreds of large (2 to 5 ft diameter) American chestnuts outside its historical range, some in areas where less virulent strains of the pathogen are more common, such as the 600 to 800 large trees in northern Lower Michigan.*[6]*[7]



Young tree in natural habitat

petiole length and nut size. *C. dentata* was once one of the most common trees in the **Northeastern United States**. In **Pennsylvania** alone, it is estimated to have comprised 25–30% of all hardwoods. The tree's huge population was due to a combination of rapid growth and a large annual seed crop in comparison to oaks which do not reliably produce sizable numbers of acorns every year. Nut production begins when *C. dentata* is 7–8 years old.

C. dentata can be best identified by the larger and more widely spaced saw-teeth on the edges of its leaves, as indicated by the scientific name *dentata*, Latin for “toothed”. The leaves, which are 14–20 cm (5.5–8 in) long and 7–10 cm (3–4 in) broad, also tend to average slightly shorter and broader than those of the sweet chestnut. The blight-resistant Chinese chestnut is now the most commonly planted chestnut species in the US, while the European chestnut is the source of commercial nuts in recent decades. It can be distinguished from the American chestnut by its hairy twig tips which are in contrast to the hairless twigs of the American chestnut. The chestnuts are in the beech family along with **beech** and **oak**, but are not closely related to the horse-chestnut, which is in the family Sapindaceae.

The chestnut is monoecious, producing many small, pale green (nearly white) male flowers found tightly occurring along 6 to 8 inch long catkins. The female parts are found near base of the catkins (near twig) and appear in late spring to early summer. Like all members of the



American chestnut male (pollen) catkins

Castanea dentata is a rapidly growing deciduous hardwood tree, historically reaching up to 30 metres (98 ft) in height, and 3 metres (9.8 ft) in diameter. It ranged from **Maine** and **southern Ontario** to **Mississippi**, and from the **Atlantic coast** to the **Appalachian Mountains** and the **Ohio Valley**. It has several related chestnut species, such as the European **sweet chestnut**, **Chinese chestnut**, and **Japanese chestnut**, which are distinguishable from the American species by a few morphological traits, such as leaf shape,

Fagaceae family, American chestnut is self-incompatible and requires two trees for pollination, which can be any member of the *Castanea* genus.

The American chestnut is a prolific bearer of nuts, usually with three nuts enclosed in each spiny, green burr, and lined in tan velvet. The nuts develop through late summer, with the burrs opening and falling to the ground near the first fall frost.

The American chestnut was a very important tree for wildlife, providing much of the fall mast for species such as white-tailed deer and wild turkey and, formerly, the passenger pigeon. Black bears were also known to eat the nuts to fatten up for the winter. The American chestnut also contains more nitrogen, phosphorus, potassium and magnesium in its leaves when compared to other trees that share its habitat. This means they return more nutrients to the soil which helps with the growth of other plants, animals, and microorganisms.*[8]

12.2 Chestnut blight

Main article: Chestnut blight

Once an important hardwood timber tree, the American



American chestnut field trial sapling from the American Chestnut Cooperators Foundation

chestnut is highly susceptible to chestnut blight, caused by an Asian bark fungus (*Cryphonectria parasitica*, formerly *Endothia parasitica*) accidentally introduced into North America on imported Asiatic chestnut trees. The disease was first noticed on American chestnut trees in what was

then the New York Zoological Park, now known as the Bronx Zoo, in 1904, by chief forester Hermann Merkel. Merkel estimated that by 1906 blight had infected 98 percent of the chestnut trees in the Bronx alone.*[9] While Chinese chestnut evolved with the blight and developed a strong resistance, the American chestnut had little resistance. The airborne bark fungus spread 50 mi (80 km) a year and in a few decades girdled and killed up to three billion American chestnut trees. Salvage logging during the early years of the blight may have unwittingly destroyed trees which had high levels of resistance to this disease and thus aggravated the calamity.*[4] New shoots often sprout from the roots when the main stem dies, so the species has not yet become extinct. However, the stump sprouts rarely reach more than 6 m (20 ft) in height before blight infection returns.

12.2.1 Reduced population

The total number of chestnut trees in eastern North America was estimated at over three billion, and 25% of the trees in the Appalachian Mountains were American chestnut. The number of large surviving trees over 60 cm (24 in) in diameter within its former range is probably fewer than 100. American chestnuts were also common part of the forest canopy in southeast Michigan.*[10]

Although large trees are currently rare east of the Mississippi River, it exists in pockets in the blight-free West, where the habitat was agreeable for planting: settlers took seeds for American chestnut with them in the 19th century. Huge planted chestnut trees can be found in Sherwood, Oregon, as the Mediterranean climate of the West Coast discourages the fungus, which relies on hot, humid summer weather. American chestnut thrives as far north as Revelstoke, British Columbia.

At present, it is believed that survival of *C. dentata* for more than a decade in its native range is almost impossible. The fungus uses various oak trees as a host,*[11] and while the oak itself is unaffected, American chestnuts nearby will succumb to the blight in approximately a year or more.*[12] In addition, the hundreds of chestnut stumps and “living stools” dotting eastern woodlands may still contain active pathogens.

12.3 Attempts at revitalization

Several organizations are attempting to breed blight-resistant chestnut trees. The American Chestnut Cooperators Foundation breeds surviving American chestnuts, which have shown some native resistance to blight, and the Canadian Chestnut Council is an organization attempting to reintroduce the trees in Canada, primarily in Ontario. A technique called backcrossing is being used by The American Chestnut Foundation in an attempt to restore the American chestnut to its original habitat.

12.3.1 Intercrossing Surviving American Chestnuts



Large Surviving Blight Resistant American Chestnut in its natural range. Surviving trees passing resistance tests are utilized in ACCF's All American Breeding program. Courtesy American Chestnut Cooperators Foundation, www.accf-online.org.

American Chestnut Cooperators Foundation (ACCF) is not using Oriental genes for blight resistance, but intercrossing among American chestnuts selected for native resistance to the blight, a breeding strategy described by the ACCF as “All-American intercrosses.” John Rush Elkins, a research chemist and professor emeritus of chemistry at Concord University, and Gary Griffin, professor of plant pathology at Virginia Tech, think there may be several different characteristics which favor blight resistance. Both Elkins and Griffin have written extensively about the American chestnut.*[13] They believe that by making intercrosses among resistant American chestnuts from many locations, they will continue to improve upon the levels of blight resistance to make an American chestnut that can compete in the forest. Griffin, who has been involved with American chestnut restoration for many years,*[13] developed a scale for assessing levels of blight resistance, which made it possible to make selections scientifically. He inoculated five-year-old chestnuts with a standard lethal strain of the blight fungus and measured growth of the cankers. Chestnuts with no resistance to blight make rapid-growing, sunken

cankers that are deep and kill tissue right to the wood. Resistant chestnuts make slow-growing, swollen cankers that are superficial: live tissue can be recovered under these cankers. The level of blight resistance is judged by periodic measurement of cankers. Grafts from large survivors of the blight epidemic were evaluated following inoculations, and controlled crosses among resistant American chestnut trees were made beginning in 1980. The first “All-American intercrosses” were planted in Virginia Tech’s Martin American Chestnut Planting in Giles County, Virginia, and in Beckley, West Virginia. They were inoculated in 1990 and evaluated in 1991 and 1992. Nine of the trees showed resistance equal to their parents, and four of these had resistance comparable to hybrids in the same test.*[13]*[14]*[15]*[16] Many ACCF chestnuts have expressed blight resistance equal to or greater than an original blight survivor but so far, only a handful have demonstrated superior, durable blight control. Time will tell if the progeny of these best chestnuts exhibit durable blight resistance in different stress environments.*[17]

12.3.2 Backcrossing

Backcrossing as a treatment for blight was first proposed by Dr. Charles R. Burnham of the University of Minnesota in 1970s.*[3]*[5]*[18] Dr. Burnham, a Professor Emeritus in agronomy and plant genetics who was considered one of the pioneers of maize genetics,*[19] realized that experiments conducted by the USDA to cross-breed American chestnuts with European and Asian chestnuts erroneously assumed that a large number of genes were responsible for blight resistance, while it is currently believed the number of responsible genes is low. The USDA abandoned their cross-breeding program and destroyed local plantings around 1960 after failing to produce a blight-resistant hybrid.*[20] Burnham’s recognition of the USDA’s error led to him joining with others to create The American Chestnut Foundation in 1983, with the sole purpose of breeding a blight-resistant American chestnut.*[18] The American Chestnut Foundation is backcrossing blight-resistant Chinese chestnut into American chestnut trees, to recover the American growth characteristics and genetic makeup, and then finally intercrossing the advanced backcross generations to eliminate genes for susceptibility to blight.*[21] The first backcrossed American chestnut tree, called “Clapper”, survived blight for 25 years, and grafts of the tree have been used by The American Chestnut Foundation since 1983.*[20] The Pennsylvania chapter of The American Chestnut Foundation, which seeks to restore the American chestnut to the forests of the Mid-Atlantic states, has planted over 22,000 trees.*[22]

The Surface Mining Control and Reclamation Act of 1977 requires owners of abandoned coal mines to cover at least 80 percent of their land with vegetation. While many companies planted invasive grasses, others began

funding research on planting trees, because they can be more cost-effective, and yield better results.* [23] Keith Gilland began planting American chestnut trees in old strip mines in 2008 as a student at Miami University, and to date has planted over 5,000 trees.* [23] In 2005, a hybrid tree with mostly American genes was planted on the lawn of the White House.* [24] A tree planted in 2005 in the tree library outside the USDA building was still very healthy seven years later; it contains 98% American chestnut DNA and 2% Chinese chestnut DNA. This tree contains enough Chinese chestnut DNA that encodes for systemic resistance genes to resist the blight. This is essential for restoring the American chestnut trees into the Northeast.* [25] The Northern Nut Growers Association (NNGA) has also been active in pursuing viable hybrids.* [26] From 1962 to 1990, Alfred Szego and other members of the NNGA developed hybrids with Chinese varieties which showed limited resistance.

12.3.3 Transgenic blight-resistant American chestnut

Researchers at the State University of New York College of Environmental Science and Forestry (SUNY ESF), have developed fully blight-resistant transgenic American chestnuts.* [27] This was done by inserting a specific gene from wheat, oxalate oxidase, into the American chestnut genome.* [28] The oxalate oxidase enzyme is an extremely common fungal defense in plants, and is found in strawberries, bananas, oats, barley, and other cereals. Oxalate oxidase breaks down the oxalic acid which the fungus secretes in the cambium to lower the pH and subsequently kill plant tissues. The chestnut trees which contain this resistance gene can be infected by the chestnut blight, but the tree is not girdled by the resulting canker and heals around the wound. This lets the fungus fulfill its normal lifecycle without the death of the tree. The blight resistance gene is passed down to the tree's offspring to provide subsequent generations with full blight resistance.* [29] In 2015, the researchers are working towards applying for government permission to make these trees available to the public in the next five years.* [30] These trees could be the first genetically modified forest trees released in the wild in the United States.* [31]* [32]

12.3.4 Hypovirulence

Hypovirus is the only genus in the family Hypoviridae. Members of this genus infect fungal pathogens and reduce their ability to cause disease (hypovirulence).* [33] In particular, the virus infects *Cryphonectria parasitica*, the fungus that causes Chestnut blight, which has enabled infected trees to recover from the blight. The use of hypovirulence to control blight originated in Europe where the fungal virus spread naturally through populations of European chestnuts. The reduced ability of the fungus to

cause disease allowed the European chestnut to regenerate, creating large stands of trees. Hypovirulence has also been found in North America, but has not spread effectively.* [34] The “Arner Tree” of Southern Ontario, is one of the best examples of naturally occurring hypovirulence. It is a mature American chestnut that has recovered from severe infections of chestnut blight. The cankers have healed over and the tree continues to grow vigorously. Scientists have discovered that the chestnut blight remaining on the tree is hypovirulent, although isolates taken from the tree do not have the fungal viruses found in other isolates.* [35] Trees inoculated with isolates taken from the Arner tree have shown moderate canker control.* [36]

12.4 Surviving specimens

- About 2,500 chestnut trees are growing on 60 acres near West Salem, Wisconsin, which is the world's largest remaining stand of American chestnut. These trees are the descendants of those planted by Martin Hicks, an early settler in the area. In the late 1800s, Hicks planted fewer than a dozen chestnuts. Planted outside the natural range of chestnut, these trees escaped the initial onslaught of chestnut blight, but in 1987, scientists found blight in the stand. Scientists are working to try to save the trees.* [37]
- Two of the largest surviving American chestnut trees are in Jackson County, Tennessee. One, the state champion, has a diameter of 61 cm (24 in) and a height of 23 m (75 ft), and the other tree is nearly as large. One of them has been pollinated with hybrid pollen by members of The American Chestnut Foundation; the progeny will have mostly American chestnut genes and some will be blight resistant.
- On May 18, 2006, a biologist with the Georgia Department of Natural Resources spotted a stand of several trees near Warm Springs, Georgia. One of the trees is approximately 20–30 years old and 13 m (43 ft) tall and is the southernmost American chestnut tree known to be flowering and producing nuts.* [38]* [39]
- Another large tree was found in Talladega National Forest, Alabama, in June 2005.* [40]
- In the summer of 2007, a stand of trees was discovered near the northeastern Ohio town of Braceville.* [41]* [42] The stand encompasses four large flowering trees, the largest of which is about 23 m (75 ft) tall, sited among hundreds of smaller trees that have not begun to flower, located in and around a sandstone quarry. A combination of factors may account for the survival of these relatively



American chestnut leaves, late spring



A shoot with fall foliage taken in November in North Georgia

large trees, including low levels of blight susceptibility, hypovirulence, and good site conditions. In particular, some stands may have avoided exposure due to being located at a higher altitude than blighted trees in the neighboring area; the fungal spores are not carried to higher altitudes as easily.* [41]

- In March 2008, officials of the Ohio Department of Natural Resources announced a rare adult American chestnut tree had been discovered in a marsh near Lake Erie. The officials admitted they had known about the tree for seven years, but had kept its existence a secret. The exact location of the tree is still being held secret, both because of the risk of infecting the tree and because an eagle has nested in its branches. They described the tree as being 89 feet (27 m) tall and having a circumference of 5 feet (1.5 m). The American Chestnut Foundation was also only recently told about the tree's existence.* [43]
- Members of the Kentucky chapter of the American Chestnut Foundation have been pollinating a tree found on a farm in Adair County, and a specimen found on Henderson Ridge in Elliott County. The Adair County tree is over one hundred years old.* [44]* [45]
- In June 2007, a mature American chestnut was discovered in Farmington, New Hampshire.* [46]
- In rural Missaukee County, Michigan, a blight-free grove of American chestnut trees approximately

0.33 acres (0.13 ha) in size with the largest tree measuring 128 in (330 cm) in circumference (40 in (100 cm) diameter) has been located. It is believed to be the result of nuts planted by early settlers in the area. The American Chestnut Council, located in the local town of Cadillac, Michigan, has verified its identity and existence. Efforts have been initiated to protect the property from logging and development.

- In Lansing, Michigan, Fenner Nature Center is home to a grove of blight-free American chestnuts descended from the aforementioned grove in Missaukee County.* [47]
- American chestnuts have been located on Beaver Island, a large island in northern Lake Michigan.* [48]
- Hundreds of healthy American chestnuts have been found in the proposed Chestnut Ridge Wilderness Area in the Allegheny National Forest in northwestern Pennsylvania.* [49] Many of these trees are large, measuring more than 60 ft (18 m) in height. These trees will be protected from logging if the wilderness area, proposed by Friends of Allegheny Wilderness, is passed into law.
- The Montreal Botanical Garden has the American chestnut among its collection of trees and ornamental shrubs.* [50]
- Three of Portland, Oregon's heritage trees are American chestnuts, along with three Spanish (European) chestnuts.* [51]

- At least two American chestnuts live on the side of Skitchewaug Trail in Springfield, Vermont.*[52]
- Around 300 to 500 trees were spotted in the George Washington National Forest near Augusta County, Virginia, in 2014. Over one dozen trees were at least 12 inches in diameter with several measuring nearly 24 inches in diameter. Only one of the larger trees was a seed and pollen producer with numerous pods and pollen strands laying on ground. The site did, however, have a high presence of chestnut blight, although the seed producing tree and several other large ones were relatively blight-free with minimal to no damage.
- Two trees were planted 1985 in Nova Scotia, at Dalhousie University, Sexton Campus and are thriving. The donated trees were from saplings grown in Europe, away from the blight. They have 16" diameter trunks and are approximately 40 feet high.
- A single mature American chestnut can be found on the front lawn of the McPhail house heritage site in Sault Ste Marie, Ontario, planted by former mayor John Alexander McPhail in the 1920s. Well north of the natural range of the chestnut, it has avoided the blight.*[53]
- There is one American chestnut in Pennsylvania in the county of Columbia in the township of South Centre. It is a hardy, nut producing tree that has been producing for nearly 30 years.
- The great majority of chestnut trees in the United States are derived from Dunstan chestnuts, developed in Greensboro, N.C. in the 1960s.*[54]

12.5 Uses

12.5.1 Food and medicine

The nuts were once an important economic resource in North America, being sold on the streets of towns and cities, as they sometimes still are during the Christmas season (usually said to be “roasting on an open fire” because their smell is readily identifiable many blocks away). Chestnuts are edible raw or roasted, though typically preferred roasted. Nuts of the European sweet chestnut are now sold instead in many stores. One must peel the brown skin to access the yellowish-white edible portion. The unrelated horse-chestnut's seeds are poisonous without extensive preparation. Native Americans used various parts of the American chestnut to treat ailments such as whooping cough, heart conditions and chafed skin.*[1]

12.5.2 Furniture and other wood products

The January 1888 issue of *Orchard and Garden* mentions the American chestnut as being “superior in quality to any found in Europe.” * [55] The wood is straight-grained, strong, and easy to saw and split, and it lacks the radial end grain found on most other hardwoods. The tree was particularly valuable commercially since it grew at a faster rate than oaks. Being rich in tannins, the wood was highly resistant to decay and therefore used for a variety of purposes, including furniture, split-rail fences, shingles, home construction, flooring, piers, plywood, paper pulp, and telephone poles. Tannins were also extracted from the bark for tanning leather.*[1] Although larger trees are no longer available for milling, much chestnut wood has been reclaimed from historic barns to be refashioned into furniture and other items.*[56]

“Wormy” chestnut refers to a defective grade of wood that has insect damage, having been sown from long-dead, blight-killed trees. This “wormy” wood has since become fashionable for its rustic character.*[56]*[57]*[58] The American chestnut is not considered a particularly good patio shade tree because its droppings are prolific and a considerable nuisance. Catkins in the spring, spiny nut pods in the fall, and leaves in the early winter can all be a problem. These characteristics are more or less common to all shade trees, but perhaps not to the same degree as with the chestnut. The spiny seed pods are a particular nuisance when scattered over an area frequented by people.

12.6 See also

- American Chestnut Cooperators Foundation
- The American Chestnut Foundation
- Central and southern Appalachian montane oak forest

12.7 References

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12.8 External links

- American Chestnut Habitat
- Flora of North America
- RangeMap: American chestnut
- The American Chestnut Foundation
- American Chestnut Cooperators Foundation
- Canadian Chestnut Council
- American Chestnut Research and Restoration Center, SUNY-ESF
- *Castanea dentata* images at bioimages.vanderbilt.edu
- <http://www.ohenrymag.com/the-nutty-professor/>

Chapter 13

Celtis occidentalis

Celtis occidentalis, commonly known as the **common hackberry**, is a large deciduous tree native to North America. It is also known as the **nettletree**, **sugarberry**, **beaverwood**, **northern hackberry**, and **American hackberry**.^{*[2]} It is a moderately long-lived^{*[2]} hardwood^{*[2]} with a light-colored wood, yellowish gray to light brown with yellow streaks.^{*[3]}

The common hackberry is easily distinguished from elms and *some* other hackberries by its cork-like bark with wart-like protuberances. The remarkable bark pattern is even more pronounced in younger trees, with the irregularly-spaced ridges resembling long geologic palisades of sedimentary [layered] rock formations when viewed edge-wise [cross-section]. Coins as large as USA quarters can easily be laid flat against the valleys, which may be as deep as an adult human finger.

The leaves are distinctly asymmetrical and coarse-textured. It produces small fruits that turn orange-red to dark purple in the **autumn**, often staying on the trees for several months. The common hackberry is easily confused with the **sugarberry** (*Celtis laevigata*) and is most easily distinguished by range and habitat. The common hackberry also has wider leaves that are coarser above than the sugarberry.

13.1 Description

The common hackberry is a medium-sized tree, 9 to 15 metres (30 to 50 ft) in height,^{*[2]} with a slender trunk. In the best conditions in the southern **Mississippi Valley** area, it can grow to 40 metres (130 ft). It has a handsome round-topped head and pendulous branches. It prefers rich moist soil, but will grow on gravelly or rocky hill-sides. The roots are fibrous and it grows rapidly.^{*[4]} In the western part of its range, trees may still grow up to 29 m (95 ft).^{*[2]} The maximum age attained by hackberry is probably between 150 and 200 years in ideal conditions.^{*[2]}

The **bark** is light brown or silvery gray, broken on the surface into thick appressed scales and sometimes roughened with excrescences; the pattern is very distinctive.^{*[4]}



Hackberry tree on the campus of the University of Chicago



• The bark of the same tree on the campus of the University of Chicago



• The ridges on the bark of a tree at the Jevremovac Botanical Garden in Serbia



- Closeup of the ridges on the bark of a street tree in Serbia

The branchlets are slender, and their color transitions from light green to red brown and finally to dark red-brown. The winter buds are axillary, ovate, acute, somewhat flattened, one-fourth of an inch long, light brown. The bud scales enlarge with the growing shoot, and the innermost become stipules. No terminal bud is formed.

The leaves are alternately arranged on the branchlets, ovate to ovate-lanceolate, often slightly falcate,^{*[4]} 5–12 cm (2–4 ¾ in) long by 3–9 cm (1 ¼–3 ½ in),^{*[5]} very oblique at the base, with an pointed tip. The margin is serrate (toothed), except at the base which is mostly entire (smooth). The leaf has three nerves, the midrib and primary veins prominent. The leaves come out of the bud conduplicate with slightly involute margins, pale yellow green, downy; when full grown are thin, bright green, rough above, paler green beneath. In autumn they turn to a light yellow. Petioles slender, slightly grooved, hairy. Stipules varying in form, caducous.^{*[4]}



- A leaf



- Yellow leaves of a tree in autumn at the Jevremonac Botanical Garden

The flowers are greenish and appear in May, soon after the leaves. They are polygamo-monecious, meaning that there are three kinds: staminate (male), pistillate (female), perfect (both female and male). They are born on slender drooping pedicels.^{*[4]}

The calyx is light yellow green, five-lobed, divided nearly to the base; lobes linear, acute, more or less cut at the apex, often tipped with hairs, imbricate in bud. There is no corolla.^{*[4]}

There are five stamens, which are hypogynous; the filaments are white, smooth, slightly flattened and gradually narrowed from base to apex; in the bud incurved, bringing the anthers face to face, as flower opens they abruptly straighten; anthers extrorse, oblong, two-celled; cells opening longitudinally.^{*[4]}

The pistil has a two-lobed style and one-celled superior ovary containing solitary ovules. The fruit is a fleshy, oblong drupe, $\frac{1}{4}$ to $\frac{3}{8}$ in (0.64 to 0.95 cm) long, tipped with the remnants of style, dark purple when ripe. It is borne on a slender stem and ripens in September and October. It remains on the branches during winter.^{*[4]} The endocarp contains significant amounts of biogenic carbonate that is nearly pure aragonite.^{*[6]}

13.2 Distribution and habitat

The common hackberry is native to North America from southern Ontario and Quebec, through parts of New England, south to North Carolina-(Appalachia), west to northern Oklahoma, and north to South Dakota. Hackberry's range overlaps with the sugarberry (*Celtis laevigata*), making it difficult to establish the exact range of either species in the South. Although there is little actual overlap, in the western part of its range the common hackberry is sometimes confused with the smaller netleaf hackberry (*Celtis reticulata*), which has a similar bark. Hackberry grows in many different habitats, although it prefers bottomlands and soils high in limestone. Its shade tolerance is greatly dependent on conditions. In favorable conditions its seedlings will persist under a closed canopy, but in less favorable conditions it can be considered shade intolerant.

13.3 Ecology



Fruits

Hackberry is highly susceptible to fire damage. The leaves are eaten by four gall-producing insects of the *Pachypsylla* genus, which do not cause serious damage

to the tree. A number of insects and fungi cause rapid decay of dead branches or roots of the tree.

The small berries, hackberries, are eaten by a number of birds and mammals. Most seeds are dispersed by animals, but some seeds are also dispersed by water.

The tree serves as a butterfly larval host particularly the hackberry emperor.* [7]

13.4 Cultivation and uses



One of the streets with 'bodoš' in Sombor, Serbia

Hackberry's wood is light yellow; heavy, soft, coarse-grained, not strong. It rots easily, making the wood undesirable commercially, although it is occasionally used for fencing and cheap furniture. Specific gravity, 0.7287; weight of cu. ft., 45.41 lb (20.60 kg).

Hackberry is only occasionally used as a street or landscape tree, although its tolerance for urban conditions makes it well suited to this role. Ridjica and Sombor in Serbia (where it is called бођош / *bodoš* [bodzof] in Sombor, галагуња / *galagunja* [galaguña] in Subotica, and кошћела / *košćela* [koftcela] in the rest of the country) and Bratislava, the capital of Slovakia, are known for the extensive use of hackberry (in the latter case along with closely related but Eurasian *Celtis australis*) as a street tree.

The tree's pea-sized berries are edible, ripening in early September. Unlike most fruits, the berries are remarkably high in calories from fat, carbohydrate and protein, and these calories are easily digestible without any cooking or preparation.* [8] Omaha Native Americans ate the berries casually, while the Dakota used them as a flavor for meat, pounding them fine, seeds and all. The Pawnee also pounded the berries fine, added a little fat, and mixed them with parched corn.* [9]

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13.6 Further reading

- Gucker, Corey L. (2011). “*Celtis occidentalis*”. *Fire Effects Information System (FEIS)*. U.S. Department of Agriculture (USDA), Forest Service (USFS), Rocky Mountain Research Station, Fire Sciences Laboratory – via <http://www.fs.fed.us/database/feis/>.

13.7 External links

- Media related to *Celtis occidentalis* (category) at Wikimedia Commons
- Data related to *Celtis occidentalis* at Wikispecies

- *Celtis occidentalis* images at bioimages.vanderbilt.edu
- *Celtis occidentalis* in the CalPhotos Photo Database, University of California, Berkeley

Chapter 14

Cercis canadensis

***Cercis canadensis* (eastern redbud)** is a large deciduous shrub or small tree, native to eastern North America from southern Ontario, Canada south to northern Florida but which can thrive as far west as California. It is the state tree of Oklahoma.



University of Maryland Arboretum & Botanical Garden with the Memorial Chapel (University of Maryland) in the background



Eastern redbud blossoms

14.1 Description

It typically grows to 6–9 m (20–30 ft) tall with an 8–10 m (26–33 ft) spread. It generally has a short, often twisted trunk and spreading branches. A 10-year-old tree will



Detail of buds

generally be around 5 m (16 ft) tall. The bark is dark in color, smooth, later scaly with ridges somewhat apparent, sometimes with maroon patches. The twigs are slender and zigzag, nearly black in color, spotted with lighter lenticels. The winter buds are tiny, rounded and dark red to chestnut in color. The leaves are alternate, simple, and heart shaped with an entire margin, 7–12 cm (3–4.5 in) long and wide, thin and papery, and may be slightly hairy below.

The flowers are showy, light to dark magenta pink in color, 1.5 cm ($\frac{1}{2}$ in) long, appearing in clusters from Spring to early Summer, on bare stems before the leaves, sometimes on the trunk itself. The flowers are pollinated by long-tongued bees such as blueberry bees and carpenter bees. Short-tongued bees apparently cannot reach the nectaries. The fruit are flattened, dry, brown, pea-like pods, 5–10 cm (2–4 in) long that contain flat, elliptical, brown seeds 6 mm ($\frac{1}{4}$ in) long, maturing in August to October.

In some parts of southern Appalachia, green twigs from the eastern redbud are used as seasoning for wild game such as venison and opossum. Because of this, in these mountain areas the eastern redbud is sometimes known as the spicewood tree.

In the wild, eastern redbud is a frequent native under-story tree in mixed forests and hedgerows. It is also much planted as a landscape ornamental plant. The leaves are eaten by the caterpillars of some Lepidoptera, for exam-

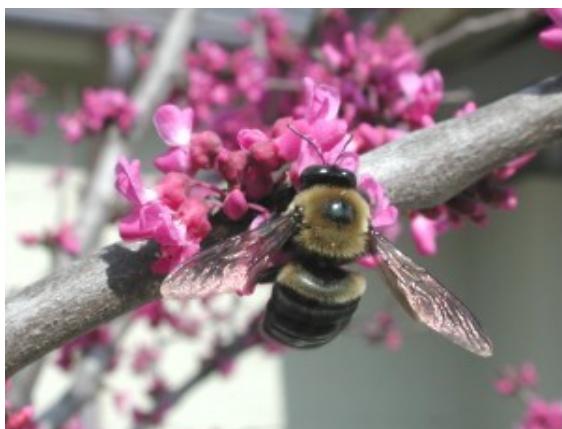
ple the Io moth (*Automeris io*).



Cercis canadensis 'Forest Pansy' leaves.



C. canadensis Leaf



Carpenter bee (*Xylocopa virginica*) on redbud flowers.



Cardinalis cardinalis male feeding female, in a white-flowered *C. canadensis*

In the United States, this tree is difficult to grow further west into arid areas west of western Kansas and Colorado, as there is not sufficient annual precipitation. Its far northern range of growth is the lower Midwest, Ohio Valley, to the south of Boston. There has been success with growing the tree in Columbus, Wisconsin, which has become known as the "Columbus Strain" and a seed source for nurseries.

- Bark: Red brown, with deep fissures and scaly surface. Branchlets at first lustrous brown, later become darker.
- Wood: Dark reddish brown; heavy, hard, coarse-grained, not strong. Sp. gr., 0.6363; weight of cu. ft. 39.65 lbs.
- Winter buds: Chestnut brown, obtuse, one-eighth inch long.
- Leaves: Alternate, simple, heart-shaped or broadly ovate, two to five inches long, five to seven-nerved, chordate or truncate at the base, entire, acute. They come out of the bud folded along the line of the midrib, tawny green; when they are full grown they become smooth, dark green above, paler beneath. In autumn they turn bright clear yellow. Petioles slender, terete, enlarged at the base. Stipules caducous.
- Flowers: April, May, before and with the leaves, papilionaceous. Perfect, rose color, borne four to eight together, in fascicles which appear at the axils of the leaves or along the branch and sometimes on the trunk itself.
- Calyx: Dark red, campanulate, oblique, five-toothed, imbricate in bud.
- Corolla: Papilionaceous, petals five, nearly equal, pink or rose color, upper petal the smallest, enclosed in the bud by the wings, and encircled by the broader keel petals.
- Stamens: Ten, inserted in two rows on a thin disk, free, the inner row rather shorter than the others.

- Pistil: Ovary superior, inserted obliquely in the bottom of the calyx tube, stipitate; style fleshy, in-curved, tipped with an obtuse stigma.
- Fruit: Legume, slightly stipitate, unequally oblong, acute at each end. Compressed, tipped with the remnants of the style, straight on upper and curved on the lower edge. Two and a half to three inches long, rose color, full grown by midsummer, falls in early winter. Seeds ten to twelve, chestnut brown, one-fourth of an inch long -can be made to germinate by first dipping in boiled (99C) water (very hot) for a minute and then sowing in a pot (do not boil the seeds); cotyledons oval, flat.* [2]

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14.6 External links

- *Cercis canadensis* Large format diagnostic photographs and information. Morton Arboretum acc. 380-88-6
- *Cercis canadensis* images at bioimages.vanderbilt.edu
- NCRS: USDA Plants Profile: *Cercis canadensis*

14.2 Cultivation

C. canadensis is grown in parks and gardens, with several cultivars being available. The cultivar 'Forest Pansy', with purple leaves, has gained the Royal Horticultural Society's Award of Garden Merit.* [3]

14.3 Edibility

Native Americans consumed redbud flowers raw or boiled, and ate roasted seeds. Analysis of nutritional components in edible parts of eastern redbud reported that:

- the flower extract contains anthocyanins,
- green developing seeds contained proanthocyanidin, and
- linolenic, alpha-linolenic, oleic and palmitic acids are present in seeds.* [4]

14.4 See also

- List of early spring flowers
- List of late spring flowers

14.5 References

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Chapter 15

Cornus alternifolia

Cornus alternifolia is a species of flowering plant in the dogwood family Cornaceae, native to eastern North America, from Newfoundland west to southern Manitoba and Minnesota, and south to northern Florida and Mississippi. It is rare in the southern United States.^{*[1]} It is commonly known as **green osier**,^{*[2]} **alternate-leaved dogwood**,^{*[3]} and **pagoda dogwood**.^{*[2]*[4]}

15.1 Description



Flowers

It is a small deciduous tree growing to 25 feet (8 m) (rarely 30 feet (9 m)) tall, with a trunk up to 6 inches (152 mm) in diameter. The branches develop characteristic horizontal layers separated by gaps, with a flat-topped crown. Its **leaves** are elliptic to ovate and grow to 2–5 inches (51–127 mm) long and 1–2 inches (25–51 mm) broad, arranged alternately on the stems, not in opposite pairs typical of the majority of *Cornus* species. The leaves are most often arranged in crowded clusters around the ends of the twigs and appear almost whorled. The upper sides of the leaves are smooth and green, while the undersides are hairy and a bluish color. The **bark** is colored gray to brown, becoming ridged as it ages. Small cream colored **flowers** are produced, with four small petals. The flow-

ers are grouped into cymes, with the inflorescences 2–5 inches (51–127 mm) across. It bears berries with a blackish blue color.

- **Bark:** Dark reddish brown, with shallow ridges. Branchlets at first pale reddish green, later dark green.
- **Wood:** Reddish brown, sapwood pale; heavy, hard, close-grained. Sp. gr., 0.6696; weight of cu. ft., 41–73 lbs.
- **Winter buds:** Light chestnut brown, acute. Inner scales enlarge with the growing shoot and become half an inch long before they fall.



Fruits

- **Leaves:** Alternate, rarely opposite, often clustered at the ends of the branch, simple, three to five inches long, two to three wide, oval or ovate, wedge-shaped or rounded at base; margin is wavy toothed, slightly reflexed, apex acuminate. They come out of the bud involute, reddish green above, coated with silvery white tomentum beneath, when full grown are bright green above, pale, downy, almost white beneath. Feather-veined, midrib broad, yellowish, prominent beneath, with about six pairs of primary veins. In autumn they turn yellow, or yellow and scarlet. Petioles slender, grooved, hairy, with clasping bases.
- **Flowers:** April, May. Perfect, cream color, borne in many-flowered, broad, open cymes, at the end of short lateral branches.

- Calyx: The cup-shaped flowers have four petals that are valvate in bud, unwrapping when in bloom with cream colored, oblong shaped petals with rounded ends. The petals are inserted on disk and the stamens are inserted too and arranged alternately to the petals, being four in number also. The stamens are exserted with filaments long and slender. Anthers oblong, introrse, versatile, two-celled; cells opening longitudinally.
- Pistil: Ovary inferior, two-celled; style columnar; stigma capitate.
- Fruit: Drupe, globular, blue-black, 0.3 in (8 mm) across, tipped with remnant of style which rises from a slight depression; nut obovoid, many grooved. October.*[5]

15.2 Habitat



Seedlings

C. alternifolia is found under open deciduous trees, as well as along the margins of forests and swamps. These trees prefer moist, well drained soil.*[6]

Seedlings are shade-tolerant and it is often found as an understory tree in mature forests, such as those dominated by *Acer saccharum* (sugar maple) or *Populus* (aspen). It is also common in younger forests.*[6]

15.3 Ecology

The fruits provide food for at least eleven species of birds and the black bear. The leaves and bark are eaten by white-tailed deer, beaver, and cottontail rabbit.*[6]

15.4 Use

The tree is regarded as attractive because of its wide-spreading shelving branches and flat-topped head, and

is often used in ornamental plantings. The flower clusters have no great white **involucre** as have those of the flowering dogwood, and the fruit is dark purple instead of red.

The **cultivar 'Argentea'***[7] (silver pagoda dogwood) has gained the Royal Horticultural Society's Award of Garden Merit.

C. alternifolia is susceptible to golden canker (*Cryptodiaporthe corni*), particularly when drought-stressed or heat-stressed. Proper siting of the plant in partial to full shade, along with adequate mulch and water, will reduce the incidence of this pathogen.*[8]

Cornus alternifolia has been used in the traditional Chinese medicine as tonic, analgesic, and diuretic.*[9]

15.5 References

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15.5.1 External links

1. Natural Resources Canada: *Cornus alternifolia*
2. WLU data page: *Cornus alternifolia*

Chapter 16

Cornus florida

Cornus florida (**flowering dogwood**) is a species of flowering plant in the family Cornaceae native to eastern North America and northern Mexico. An endemic population once spanned from southernmost coastal Maine south to northern Florida and west to the Mississippi River.* [2] The tree is commonly planted as an ornamental in residential and public areas because of its showy bracts and interesting bark structure.

16.1 Classification

The flowering dogwood is usually included in the dogwood genus *Cornus* as *Cornus florida* L., although it is sometimes treated in a separate genus as *Benthamidia florida* (L.) Spach.

Two subspecies are generally recognized:

- *Cornus florida* subsp. *florida* - eastern + south-central United States.
- *Cornus florida* subsp. *urbiniana* (Rose) Rickett - northeastern Mexico (Nuevo León, Veracruz).

16.2 Description

Flowering dogwood is a small deciduous tree growing to 10 m (33 ft) high, often wider than it is tall when mature, with a trunk diameter of up to 30 cm (1 ft). A 10-year-old tree will stand about 5 m (16 ft) tall. The leaves are opposite, simple, ovate, 6–13 cm (2.4–5.1 in) long and 4–6 cm (1.6–2.4 in) broad, with an apparently entire margin (actually very finely toothed, under a lens); they turn a rich red-brown in fall.

The flowers are individually small and inconspicuous, with four greenish-yellow bracts 4 mm (0.16 in) long. Around 20 flowers are produced in a dense, rounded, umbel-shaped inflorescence, or flower-head, 1–2 cm (0.39–0.79 in) in diameter. The flower-head is surrounded by four conspicuous large white, pink or red “petals” (actually bracts), each bract 3 cm (1.2 in) long and 2.5 cm (0.98 in) broad, rounded, and often with a distinct notch at the apex. The flowers are bisexual.



Cornus florida inflorescence, showing four large white bracts and central flower cluster

When in the wild they can typically be found at the forest edge and frequently on dry ridges. While most of the wild trees have white bracts, some selected cultivars of this tree also have pink bracts, some even almost a true red. They typically flower in early April in the southern part of their range, to late April or early May in northern and high altitude areas. The similar Kousa dogwood (*Cornus kousa*), native to Asia, flowers about a month later.

The fruit is a cluster of two to ten separate drupes, (fused in *Cornus kousa*), each 10–15 mm (0.39–0.59 in) long and about 8 mm (0.31 in) wide, which ripen in the late summer and the early fall to a bright red, or occasionally yellow with a rosy blush. They are an important food source for dozens of species of birds, which then distribute the seeds.

16.3 Cultivation

Flowering dogwood does best horticulturally in moist, acidic soil in a site with some afternoon shade, but good morning sun. It does not do well when exposed to intense heat sources such as adjacent parking lots or air conditioning compressors. It also has a low salinity tolerance. The hardiness zone is 5–9 and the preferred



Close up of a flower cluster showing the four white petals on each flower.

pH is between 6.0–7.0.* [3] In urban and suburban settings, care should be taken not to inflict mower damage on the trunk or roots, as this increases the tree's susceptibility to disease and pest pressure.* [3] The common flowering dogwood has been placed on the endangered species list in Ontario.* [4]*[5]*[6] In regions where dogwood anthracnose is a problem, homeowners and public land managers are encouraged to know the symptoms and inspect trees frequently. The selection of healthy, disease-free planting stock is essential and transplanting trees from the forest should be avoided. Sites should be selected for reasonably well-drained, fertile soils; full sun is recommended in high-hazard areas (such as stream or pond banks). New plantings should be mulched to a depth of 5 to 10 cm (2 to 4 in), avoiding the stem. Dead wood and leaves should be pruned and completely removed and destroyed yearly. Plants should be watered weekly during droughts, with watering done in the morning, avoiding wetting the foliage. Registered fungicides can be applied when necessary, according to manufacturers instructions and advice of local Extension Service.* [7]

Flowering dogwood is grown widely throughout the temperate world.

Selected cultivars

- ‘Amerika Touch-O-Pink’ – large bracts, tinged pink; large leaves; good disease resistance.
- ‘Appalachian Spring’ – large white bracts; red fall foliage; resistant to dogwood anthracnose.
- ‘Autumn Gold’ - white bracts; yellow fall color.
- ‘Barton’ - large white bracts; blooms at early age; resistant to stem canker and powdery mildew.
- ‘Bay Beauty’ - double white bracts; resists heat and drought; good for Deep South.
- ‘Cherokee Daybreak’ - white bract; vigorous grower with variegated leaves.
- ‘Cherokee Chief’ - red bracts; red new growth.* [8]
- ‘Cherokee Brave’ - Even redder than ‘Cherokee Chief’, smaller bracts but dark red color; consistently resistant to powdery mildew.
- ‘Cherokee Princess’ - vigorous white bracts, industry standard for white flowers.
- ‘Cherokee Sunset’ - purplish-red bracts; variegated foliage.
- ‘Gulf Coast Pink’ - best pink flowering dogwood in Florida – northern part only.
- ‘Hohman’s Gold’ - white bracts; variegated foliage.
- ‘Jean’s Appalachian Snow’ – large, overlapping white bracts w/ green flowers; very resistant to powdery mildew.
- ‘Karen’s Appalachian Blush’ – delicate white bracts edged in pink; some powdery mildew resistance.
- ‘Kay’s Appalachian Mist’ – stiff, creamy white bracts; red fall foliage; good resistance to powdery mildew.
- ‘Plena’ - double white bracts; spot anthracnose-resistant.
- ‘Purple Glory’ - red bracts; purple foliage; spot anthracnose-resistant but susceptible to stem canker.
- ‘Weaver White’ - large white blooms; large leaves; candelabra shape; good in north-central Florida.



Pink variety flower clusters



Foliage during autumn

16.4 Propagation

Cornus florida is easily propagated by seeds, which are sown in the fall into prepared rows of sawdust or sand, and emerge in the spring. Germination rates for good clean seed should be near 100% if seed dormancy is first overcome by cold stratification treatments for 90 to 120 days at 4 °C (39 °F).^{*[9]*[10]} Flowering dogwood demonstrates gametophytic self-incompatibility, meaning that the plants can't self-fertilize. This is important for breeding programs as it means that it is not necessary to emasculate (remove the anthers from) *C. florida* flowers before making controlled cross-pollinations. These pollinations should be repeated every other day, as the flowers must be cross-pollinated within one or two days of opening for pollinations to be effective.^{*[11]}

Softwood cuttings taken in late spring or early summer from new growth can be rooted under mist if treated with 8,000 to 10,000 ppm indole-3-butyric acid (IBA). In cold climates, potted cuttings must be kept in heated cold frames or polyhouses the following winter to maintain temperatures between 0 and 7 °C (32 and 45 °F). Although rooting success can be as high as 50–85%, this technique is not commonly used by commercial growers. Rather, selected cultivars are generally propagated by T-budding in late summer or by whip grafting in the greenhouse in winter onto seedling rootstock.^{*[10]*[12]}

Micropropagation of flowering dogwood is now used in breeding programs aiming to incorporate resistance to dogwood anthracnose and powdery mildew into horticulturally and economically important cultivars. Nodal (axillary bud) sections are established in a culture of Woody Plant Medium (WPM) amended with 4.4 µmol/L 6-Benzyladenine (BA) to promote shoot growth.^{*[13]} Rooting of up to 83% can be obtained when 5–7 week-old microshoots are then transferred to WPM amended with 4.9 µmol/L IBA.^{*[14]}

16.5 Historical uses

Other old names now rarely used include American Dogwood, Florida Dogwood, Indian Arrowwood, Cornelian Tree, White Cornel, White Dogwood, False Box, and False Boxwood. This species has in the past been used in the production of inks, scarlet dyes, and as a quinine substitute. The hard, dense wood has been used for products such as golf club heads, mallets, wooden rake teeth, tool handles, jeweler's boxes and butcher's blocks.^{*[15]*[16]} *Cornus florida* is the state tree and flower of Virginia.^{*[17]} It is also the state tree of Missouri and state flower of North Carolina.^{*[18]*[19]} It was used to treat dogs with mange, which may be how it got its name.^{*[19]} The red berries are edible, but do not taste good.^{*[20]}

In 2012, the United States sent 3,000 dogwood saplings to Japan to commemorate the 100 year anniversary of the Washington D.C. cherry trees given as a gift to the U.S. by Japan in 1912.^{*[21]}



Tree in the wild in autumn

16.6 References

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- [21] "U.S. eyes 3,000 dogwoods for 'sakura' anniversary. The Japan Times. Posted: Jan. 17, 2012" . Japantimes.co.jp. Retrieved March 28, 2014.

- Dogwood placed on Endangered List

16.7 External links

- Germplasm Resources Information Network: *Cornus florida*
- NRCS: United States Department of Agriculture Plants Profile: *Cornus florida*
- Missouriplants: *Cornus florida*
- Bioimages: *Cornus florida*
- Floridata: *Cornus florida*
- University of Connecticut Plant Database: *Cornus florida*
- United States Department of Agriculture, National Forest Service: *Cornus florida*
- University of California @ Davis, Integrated Pest Management Online: Dogwood pest management
- Cornell University, Integrated Pest Management, Dogwood Borer
- United States Department of Agriculture, National Forest Service, St. Paul Field Office, How to Identify and Control Dogwood Anthracnose
- Virginia State University Cooperative Extension, Foliar Diseases of Dogwood
- flowering dogwood - Interactive Native Range Distribution Map of *Cornus florida*

Chapter 17

Diospyros virginiana

For other uses, see [Possumwood \(disambiguation\)](#).
Not to be confused with *Amelanchier canadensis*, also called *sugarplum*

See also [SIMMON](#) (a software program)

Diospyros virginiana is a persimmon species commonly called the [American persimmon](#), ^{*[1]} [common persimmon](#), ^{*[2]} [eastern persimmon](#), "[simmon](#)", "[possum-wood](#)", or "[sugar-plum](#)". ^{*[3]} It ranges from southern Connecticut/Long Island to Florida, and west to Texas, Louisiana, Oklahoma, Kansas, and Iowa. The tree grows wild but has been cultivated for its fruit and wood since prehistoric times by Native Americans.

Diospyros virginiana grows through 20 m (66 ft), in well-drained soil. In summer, this species produces fragrant flowers which are dioecious, so one must have both male and female plants to obtain fruit. Most cultivars are parthenocarpic (setting seedless fruit without pollination). The flowers are pollinated by insects and wind. Fruiting typically begins when the tree is about 6 years old.

The fruit is round or oval and usually orange-yellow, sometimes bluish, and from 2 to 6 cm (0.79 to 2.4 in) in diameter. In the U.S. South and Midwest, the fruits are referred to as simply persimmons or "[simmons](#)", and are popular in desserts and cuisine.

Commercial varieties include the very productive Early Golden, the productive John Rick, Miller, Woolbright and the Ennis, a seedless variety. Another nickname of the American persimmon, 'date-plum' also refers to a persimmon species found in South Asia, *Diospyros lotus*.

17.1 Description

It is a small tree usually 30 through 80 feet (10 through 24 meters) in height, with a short, slender trunk and spreading, often pendulous branches, which form a broad or narrow, round-topped canopy. The roots are thick, fleshy and stoloniferous. This species has a shrubby growth form.^{*[4]} This plant has oval entire leaves, and unisexual flowers on short stalks. In the male flowers, which are nu-



American persimmon tree bearing fruit in the fall



Flower

merous, the stamens are sixteen in number and arranged in pairs; the female flowers are solitary, with traces of stamens, and a smooth ovary with one ovule in each of the eight cells—the ovary is surmounted by four styles, which are hairy at the base. The fruit-stalk is very short, bearing a subglobose fruit an inch in diameter or a bit larger, of an orange-yellow color, ranging to bluish, and with a sweetish astringent pulp. It is surrounded at the base by the persistent calyx-lobes, which increase in size as the fruit ripens. The astringency renders the fruit somewhat unpalatable, but after it has been subjected to the action of frost, or has become partially rotted or "bletted" like a

medlar, its flavor is improved.*[5]

- Bark: Dark brown or dark gray, deeply divided into plates whose surface is scaly. Branchlets slender, zigzag, with thick pith or large pith cavity; at first light reddish brown and pubescent. They vary in color from light brown to ashy gray and finally become reddish brown, the bark somewhat broken by longitudinal fissures. Astringent and bitter.
- Wood: Very dark; sapwood yellowish white; heavy, hard, strong and very close grained. Specific gravity, 0.7908; weight of cubic foot, 49.28 lb (22.35 kg). The heartwood is a true **ebony**. Forestry texts indicate that about a century of growth is required before a tree will produce a commercially viable yield of ebony wood.
- Winter buds: Ovate, acute, one-eighth of an inch long, covered with thick reddish or purple scales. These scales are sometimes persistent at the base of the branchlets.
- Leaves: Alternate, simple, four to six inches (152 mm) long, oval, narrowed or rounded or cordate at base, entire, acute or acuminate. They come out of the bud revolute, thin, pale, reddish green, downy with ciliate margins, when full grown are thick, dark green, shining above, pale and often pubescent beneath. In autumn they sometimes turn orange or scarlet, sometimes fall without change of color. Midrib broad and flat, primary veins opposite and conspicuous. Petioles stout, pubescent, one-half to an inch in length.
- Flowers: May, June, when leaves are half-grown; dioecious or rarely polygamous. Staminate flowers borne in two to three-flowered cymes; the pedicels downy and bearing two minute bracts. Pistillate flowers solitary, usually on separate trees, their pedicels short, recurved, and bearing two bractlets.
- Calyx: Usually four-lobed, accrescent under the fruit.
- Corolla: Greenish yellow or creamy white, tubular, four-lobed; lobes imbricate in bud.
- Stamens: Sixteen, inserted on the corolla, in staminate flowers in two rows. Filaments short, slender, slightly hairy; anthers oblong, introrse, two-celled, cells opening longitudinally. In pistillate flowers the stamens are eight with aborted anthers, rarely these stamens are perfect.
- Pistil: Ovary superior, conical, ultimately eight-celled; styles four, slender, spreading; stigma two-lobed.
- Fruit: A juicy berry containing one to eight seeds, crowned with the remnants of the style and seated in

the enlarged calyx; depressed-globular, pale orange color, often red-cheeked; with slight bloom, turning yellowish brown after freezing. Flesh astringent while green, sweet and luscious when ripe.*[4]

17.2 Distribution

The tree is very common in the South Atlantic and Gulf states, and attains its largest size in the basin of the **Mississippi River**.*[5] Its habitat is southern, it appears along the coast from **Connecticut** to **Florida**; west of the Alleghenies it is found in southern **Ohio** and along through southeastern **Iowa** and southern **Missouri**; when it reaches **Louisiana**, eastern **Kansas** and **Oklahoma** it becomes a mighty tree, one hundred fifteen feet high.*[4]

Its fossil remains have been found in Miocene rocks of Greenland and Alaska and in Cretaceous formations in Nebraska.*[4]

Diospyros virginiana is believed to be an evolutionary remnant that was consumed by the megafauna that roamed the North American continent until 10,000 years ago and would have eaten the fruit, assisting in its dispersal. However, as it is attractive to raccoons, rodents, and smaller animals, the loss of large grazing herbivores and omnivores in historical times has not seriously affected the tree's survival strategy as compared to **Kentucky Coffeetree** and **Osage Orange** which are inedible to most extant wildlife and saw their ranges greatly diminish without **mastodons** and other dispersal agent fauna. A 2015 study supports the notion that elephants would have been a more effective disperser of the seeds than living North American mammals *[6]

17.3 Uses

The peculiar characteristics of its fruit have made the tree well known. This fruit is a globular berry, with variation in the number of seeds, sometimes with eight and sometimes without any. It bears at its apex the remnants of the styles and sits in the enlarged and persistent calyx. It ripens in late autumn, is pale orange with a red cheek, often covered with a slight glaucous bloom. One joke among Southerners is to induce strangers to taste unripe persimmon fruit, as its very astringent bitterness is shocking to those unfamiliar with it. Folklore states that frost is required to make it edible, but fully ripened fruit lightly shaken from the tree or found on the ground below the tree is sweet, juicy and delicious. The peculiar astringency of the fruit is due to the presence of a tannin similar to that of *Cinchona*. The seeds were used as buttons during the **American Civil War**.*[7]

The fruit is high in **vitamin C**. The unripe fruit is extremely astringent. The ripe fruit may be eaten raw, cooked or dried. Molasses can be made from the fruit

pulp. A tea can be made from the leaves and the roasted seed is used as a coffee substitute. Other popular uses include desserts such as persimmon pie, persimmon pudding, or persimmon candy.

The fruit is also fermented with hops, cornmeal or wheat bran into a sort of beer or made into brandy. The wood is heavy, strong and very close-grained and used in woodturning.*[5]

17.4 Cultivation

The tree prefers light, sandy, well-drained soil, but will grow in rich, southern, bottom lands. It can be grown in northern Ohio only with the greatest of care, and in southern Ohio its fruit is never edible until after frost.*[4]

The tree is greatly inclined to vary in the character and quality of its fruit, in size this varies from that of a large cherry to a small apple. Some trees in the south produce fruit that is delicious without the action of the frost, while adjoining trees produce fruit that never becomes edible.*[4]

It was brought to England before 1629 and is cultivated, but rarely if ever ripens its fruit. It is easily raised from seed and can also be propagated from stolons, which are often produced in great quantity. The tree is hardy in the south of England and in the Channel Islands.*[5]

In respect to the power of making heartwood, the persimmon rarely develops any heartwood until it is nearly one hundred years old. This heartwood is extremely close-grained and almost black, resembling ebony (of which it is a true variety).*[4]*[8]

It is a common misconception persimmon fruit needs frost to ripen and soften, called bletting. Some, such as the early-ripening varieties “pieper” and “NC21”(also known as “supersweet”), easily lose astringency and become completely free of it when slightly soft at the touch —these are then very sweet, even in the British climate. On the other hand, some varieties (like the very large fruited “yates”, which is a late ripening variety) remain astringent even when the fruit has become completely soft (at least in the British climate). Frost, however, destroys the cells within the fruit, causing it to rot instead of ripen. Only completely ripe and soft fruit can stand some frost; it will then dry and become even sweeter (hence the misconception). The same goes for the Oriental persimmon (*Diospyros kaki*), where early frost can severely damage a fruit crop.

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17.6 External links

- USDA Plants Profile for *Diospyros virginiana* (common persimmon)
- Lady Bird Johnson Wildflower Center —Native Plant Information Network (NPIN): *Diospyros virginiana* (Common persimmon, Eastern persimmon)
- Bioimages.vanderbilt.edu: *Diospyros virginiana* images
- Persimmonpudding.com - dedicated to growing, education, and use of *Diospyros virginiana*, the Common or American persimmon
- Treerail.net: *Diospyros virginiana* (American Persimmon) Native Range Distribution Map

Chapter 18

Fagus grandifolia

Fagus grandifolia (**American beech** or **North American beech**) is the species of beech tree native to the eastern United States and extreme southeast Canada. The genus name *Fagus* is Latin for “beech”, and the species name *grandifolia* comes from *grandis* “large” and *folium* “leaf”.

18.1 Distribution and varieties

The American beech is native to eastern North America, from Nova Scotia west to southern Ontario in southeastern Canada, west to Wisconsin and south to eastern Texas and northern Florida in the United States.

Trees in the southern half of the range are sometimes distinguished as a variety, *F. grandifolia* var. *caroliniana*, but this is not considered distinct in the Flora of North America. The Mexican beech (*Fagus mexicana*), native to the mountains of central Mexico, is closely related, and is sometimes treated as a subspecies of American beech, but more often as a distinct species. The only *Fagus* species found in the Western Hemisphere (assuming *F. mexicana* is treated as a subspecies), *F. grandifolia* is believed to have spanned the width of the North American continent all the way to the Pacific coast before the last ice age.

18.2 Description

It is a deciduous tree growing to 20–35 m (66–115 ft) tall, with smooth, silver-gray bark. The leaves are dark green, simple and sparsely-toothed with small teeth that terminate each vein, 6–12 cm (2.4–4.7 in) long (rarely 15 centimetres (5.9 in)), with a short petiole. The winter twigs are distinctive among North American trees, being long and slender (15–20 mm (0.59–0.79 in) by 2–3 mm (0.079–0.118 in)) with two rows of overlapping scales on the buds. Beech buds are distinctly thin and long, resembling cigars; this characteristic makes beech trees relatively easy to identify. The tree is monoecious, with flowers of both sexes on the same tree. The fruit is a small, sharply-angled nut, borne in pairs in a soft-spined,

four-lobed husk. It has two means of reproduction: one is through the usual dispersal of seedlings, and the other is through root sprouts (new trees sprout from the roots in different locations).^{*[1]}

The American beech is a shade-tolerant species, favoring shade more than other trees, commonly found in forests in the final stage of succession. Ecological succession is essentially the process of forests changing their composition through time; it is a pattern of events often observed on disturbed sites.^{*[2]} Although sometimes found in pure stands, it is more often associated with sugar maple (forming the beech-maple climax community), yellow birch, and Eastern hemlock, typically on moist well drained slopes and rich bottomlands. Near its southern limit, it often shares canopy dominance with Southern Magnolia. Although it has a reputation for slow growth (sometimes only 13 feet in 20 years), rich soil and ample moisture will greatly speed the process up. American beech favors a well-watered, but also well-drained spot and is intolerant of urban pollution, salt, and soil compaction. It also casts dense shade and has an extensive network of shallow, fibrous surface roots that make gardening underneath it almost impossible. Because American beech needs plenty of moisture and rich soil to thrive, it naturally occurs in bottomland forests. Early settlers often looked for beeches as a sign of a good potential place to clear the forest for farming.

18.3 Gallery



• The long and thin winter bud of a beech



- Spring leaves



- Autumn foliage



- Beech leaf and nut



- In the winter, some fall leaves stay on beech trees (marcescence)



- Bark



- The foot of the tree

18.4 Disease

Beech bark disease has become a major killer of beech trees in the Northeastern United States. This disease occurs when the beech scale insect, *Cryptococcus fagisuga*, attacks the bark, creating a wound that is then infected by one of two different species of fungi in the genus *Nectria*. This causes a canker to develop and the tree is eventually killed.

Beech blight aphids colonize branches of the tree, but without serious harm to otherwise healthy trees. Below these colonies, deposits of sooty mold develop caused by the fungus *Scorias spongiosa* growing saprophytically on the honeydew the insects exude. This is also harmless to the trees.^{*[3]}

18.5 Uses



A carving in the bark of the tree

American beech is an important tree in forestry. The wood is heavy, hard, tough and strong, and until the advent of power tools in the 20th century, lumbering beech trees were often left uncut to grow. As a result, many areas today still have extensive groves of old beeches that would not otherwise occur. Today, the wood is harvested for uses such as flooring, containers, furniture, handles and woodenware.

Like European beech bark, the American beech bark is smooth and uniform, making it an attraction for vandals to carve names, dates, gang symbols, and other material into its surface.*[4] One such beech tree in Louisville, Kentucky, in what is now the southern part of Iroquois Park, bore the legend "D. Boone kilt a bar" and the year in the late 18th century. This carving was first reported in the 19th century, but is believed to have not been produced by Boone since he was an educated man who would not have written something so semi-literate. The beech finally fell over in 1916 during a storm; its age was estimated at around 325 years. Its trunk is now on display at The Filson Historical Society.

It is sometimes planted as an ornamental tree, but even within its native area, it is planted much less often than the European beech. Although American beech can handle hotter climates,*[5] its European variant is faster-growing and more pollution-tolerant, in addition to being easier to propagate.

American beech can take up to 40 years to begin producing seeds. Large crops are produced by 60 years and the tree's total lifespan may be up to 300 years. The fruit is a triangle-shaped shell containing 2-3 nuts inside, but many of them do not fill in, especially on solitary trees. Beech nuts are edible to humans, although too small to be commercially valuable.

The mast (crop of nuts) from American beech provides food for numerous species of animals. Among vertebrates alone, these include ruffed grouse, wild turkeys, raccoons, red/gray foxes, white-tailed deer, rabbits, squirrels, opossums, pheasants, black bears, porcupines, and humans. For lepidopteran caterpillars feeding on American beech, see list of Lepidoptera that feed on beeches. Beech nuts were one of the primary foods of the now-extinct passenger pigeon; the clearing of beech and oak forests are pointed to as one of the major factors that may have contributed to the bird's extinction.*[6]

- R.C. Hosie, 1969. *Native Trees of Canada*. Canadian Forestry Service, Ottawa.

18.7 External links

- USDA Plants Profile for *Fagus grandifolia* (American beech)
- efloras.org: Flora of North America —*Fagus grandifolia*
- efloras.org: range map
- Interactive distribution map for *Fagus grandifolia*
- Bioimages.vanderbilt.edu —*Fagus grandifolia* photo gallery

18.6 References

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- [2] Horn, Henry S. (1974). "The Ecology of Secondary Succession" . *Annual Review of Ecology and Systematics*. **5**: 25–37. doi:10.1146/annurev.es.05.110174.000325.
- [3] Tom Volk's Fungus of the Month
- [4] David Martin, Smooth Bark Compulsion
- [5] Gardening with Native Plants of the South by Sally and Andy Wasowski, p.44
- [6] Jon M. Conrad, " Open access and extinction of the passenger pigeon in North America" , *Natural Resource Modeling*, Vol. 18, no. 4, pp. 501–519. 2005.

Chapter 19

Fraxinus americana

This article is about the tree. For the town in Kentucky, see [White Ash, Kentucky](#). For the Japanese band, see [White Ash \(band\)](#). For another species referred to as white ash, see [Eucalyptus fraxinoides](#).

Fraxinus americana (white ash or American ash) is a species of [ash tree](#) native to eastern and central North America. It is found in mesophytic hardwood forests from Nova Scotia west to Minnesota, south to northern Florida, and southwest to eastern Texas. Isolated populations have also been found in western Texas, Wyoming and Colorado, and the species is reportedly naturalized in Hawaii.*[2]*[3]*[4]



Autumn foliage

19.1 Characteristics

The name White Ash derives from the [glaucous](#) undersides of the leaves. It is similar in appearance to the [Green Ash](#), making identification difficult. The lower sides of the leaves of White Ash are lighter in color than their upper sides, and the outer surface of the twigs of White Ash may be flaky or peeling. Green Ash leaves are similar in color on upper and lower sides, and twigs are smoother. Despite some overlap, the two species tend to grow in different locations as well; White Ash is a forest tree that commonly occurs alongside Sugar Maple while Green Ash is a pioneer species that inhabits riparian zones and disturbed areas.*[5]*[6]

a very servicable longbow if properly worked. The wood was used in ceiling fan blades from the 1970s through the mid-1980s, though cane was sometimes simulated with plastic then. It is no longer used for ceiling fan blades in most countries.

White Ash is not seen in cultivation as often as Green Ash due to its preference for undisturbed forest sites away from urban pollution and soil compaction, but sometimes has been planted for its consistently reliably autumn colors, which typically are bright orange and red hues as opposed to other species of ash that produce a uniform yellow color.

A related species, Biltmore Ash, is sometimes treated as a variety of White Ash. However, other taxonomists argue that Biltmore Ash is its own species (*Fraxinus biltmoreana*).*[9]*[10]

19.2 Cultivation and uses

White ash is one of the most used trees for everyday purposes and, to keep up with high demand, is cultivated almost everywhere it can be. The wood is white and quite dense (within 20% of 670 kg/m³),*[7] strong, and straight-grained. It is the timber of choice for production of [baseball bats](#) and tool handles. The wood is also favorable for furniture and flooring. Woodworkers use the timber mainly for interior uses due to high perishability in contact with ground soil.*[7] It is also used to make [lobster traps](#). Since the 1950s, it has also become a popular choice for solid [electric guitar bodies](#).*[8] It makes

19.3 Emerald ash borer

Main article: [Emerald ash borer](#)

The emerald ash borer (*Agrilus planipennis*), also commonly known by the acronym EAB, is a green beetle native to Asia.

In North America the emerald ash borer is an inva-

sive species, highly destructive to ash trees in its introduced range. The damage of this insect rivals that of Chestnut blight and Dutch Elm Disease.*[11] To put its damage in perspective, the number of chestnuts killed by the Chestnut blight was around 3.5 billion chestnut trees while there are 3.5 billion ash trees in Ohio alone. Dutch Elm Disease killed only 200 million elm trees while EAB threatens 7.5 billion ash trees in the United States. The insect threatens the entire North American genus *Fraxinus*, while past invasive tree pests have only threatened a single species within a genus. Since its accidental introduction into the United States and Canada in the 1990s, and its subsequent detection in 2002, it has spread to eleven states and adjacent parts of Canada. It has killed at least 50 million ash trees so far and threatens to kill most of the ash trees throughout North America. The green ash and the black ash trees are affected. White ash is also killed rapidly, but usually only after green and black ash trees are eliminated. Blue ash displays some resistance to the emerald ash borer by forming callous tissue around EAB galleries; however, they are usually killed. White ash has been less affected by emerald ash borer due to its small population (unlike its cousin, *F. americana* is not commonly seen in cultivation) compared to green ash, which was planted in huge numbers as an ornamental.*[12]*[13]

19.4 References

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19.5 External links

- US Forest Service United States Department of Agriculture, National Forest Service. Retrieved 19 January 2009.

Chapter 20

Fraxinus nigra

***Fraxinus nigra* (black ash)** is a species of ash native to much of eastern Canada and the northeastern United States, from western Newfoundland west to southeastern Manitoba, and south to Illinois and northern Virginia.*[1] Formerly abundant, as of 2014 the species is threatened with near total extirpation throughout its range, as a result of infestation by a parasitic insect known as the emerald ash borer.

20.1 Description



Image of black ash trunk. Tree is located in a seasonally wet, riparian habitat near a small-scale stream. Tree bark is corky and spongy.

Black ash is a medium-sized deciduous tree reaching 15–20 m (exceptionally 26 m) tall with a trunk up to 60 cm (24 inches) diameter, or exceptionally to 160 cm (63 inches). The bark is grey, thick and corky even on young

trees, becoming scaly and fissured with age. The winter buds are dark brown to blackish, with a velvety texture. The leaves are opposite, pinnately compound, with 7–13 (most often 9) leaflets; each leaf is 20–45 cm (8–18 in) long, the leaflets 7–16 cm (2 3/4–6 1/4 in) long and 2.5–5 cm (1–2 in) broad, with a finely toothed margin. The leaflets are sessile, directly attached to the rachis without a petiolule. The flowers are produced in spring shortly before the new leaves, in loose panicles; they are inconspicuous with no petals, and are wind-pollinated. The fruit is a samara 2.5–4.5 cm (1–1 3/4 in) long comprising a single seed 2 cm (3/4 in) long with an elongated apical wing 1.5–2 cm (5/8–3/4 in) long and 6–8 mm (1/4–5/16 in) broad.*[2]*[3]*[4]

20.2 Ecology and conservation status

Black ash commonly occurs in swamps,*[4] often with the closely related green ash. Its fall foliage is yellow. Black ash is one of the first trees to lose its leaves in the fall. It is very closely related to Manchurian ash, and will easily hybridize with it. Some consider the two to be geographic isolates of each other.

Black ash is a food plant for the larvae of several species of Lepidoptera; see List of Lepidoptera that feed on ashes.

The species was considered abundant and its survival of little concern prior to the invasion of the emerald ash borer, first detected in North America in 2002. However, since that time this invasive insect has spread throughout most of the tree's range, and within a few years black ash is expected to be all but extirpated; a similar fate awaits green ash. In 2014, a U.S. Forest Service agent estimated that “ninety-nine percent of the ashes in North America are probably going to die.” Blue ash and white ash are only slightly less affected.*[5]

20.3 Uses

This wood is used by Native Americans of the North East for making baskets and other devices. The Shakers also made extensive use of the Black Ash for creating baskets. Also called Basket Ash, Brown Ash, Swamp Ash, hoop ash, and water ash. It is also a popular wood for making electric guitars and basses, due to its good resonant qualities.* [6]

[6] Guitar Wood FAQ – Wood Types & Tones

20.4 Creating basket strips



Black ash splint basket by Kelly Church (Odawa-Ojibwe)

Black ash is unique among all trees in North America in that it does not have fibers connecting the growth rings to each other. This is a useful property for basket makers. By pounding on the wood with a mallet, the weaker spring wood layer is crushed, allowing the tougher and darker summer wood layer to be peeled off in long strips. The long strips are trimmed, cleaned, and used in basket weaving. Indigenous peoples of the Northeastern Woodlands also make bark baskets from black ash, traditionally used for berry-gathering.

20.5 References

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Chapter 21

Fraxinus pennsylvanica

“Red Ash” redirects here. For other uses, see Red Ash (disambiguation).

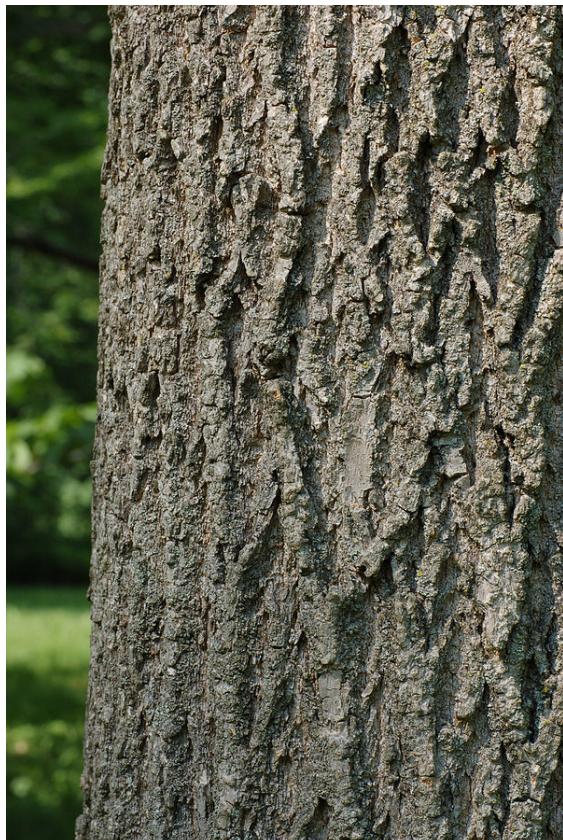
Fraxinus pennsylvanica (green ash or red ash)^{*[1]} is a species of ash native to eastern and central North America, from Nova Scotia west to southeastern Alberta and eastern Colorado, south to northern Florida, and southwest to Oklahoma and eastern Texas. It has spread and become naturalized in much of the western United States and also in Europe from Spain to Russia.^{*[2]*[3]*[4]}

Other names more rarely used include downy ash, swamp ash and water ash.

21.1 Description

Fraxinus pennsylvanica is a medium-sized deciduous tree reaching 12–25 m (39–82 ft) (rarely to 45 m or 148 ft) tall with a trunk up to 60 cm (24 in) in diameter. The bark is smooth and gray on young trees, becoming thick and fissured with age. The winter buds are reddish-brown, with a velvety texture. The leaves are 15–30 cm (6–12 in) long, pinnately compound with seven to nine (occasionally five or eleven) leaflets, these 5–15 cm (2–6 in) (rarely 18 cm or 7 in) long and 1.2–9 cm ($\frac{1}{2}$ – $\frac{9}{16}$ in) broad, with serrated margins and short but distinct, downy petiolules a few millimeters long. They are green both above and below. The autumn color is golden-yellow and depending on the climate, Green Ash's leaves may begin changing color the first week of September. The flowers are produced in spring at the same time as the new leaves, in compact panicles; they are inconspicuous with no petals, and are wind-pollinated. The fruit is a samara 2.5–7.5 cm (1–3 in) long comprising a single seed 1.5–3 cm ($\frac{5}{8}$ – $1\frac{1}{8}$ in) long with an elongated apical wing 2–4 cm ($\frac{3}{4}$ – $1\frac{1}{2}$ in) long and 3–7 mm ($\frac{1}{8}$ – $\frac{9}{32}$ in) broad.^{*[5]*[6]*[7]*[8]}

It is sometimes divided into two varieties, *Fraxinus pennsylvanica* var. *pennsylvanica* (red ash) and *Fraxinus pennsylvanica* var. *lanceolata* (Borkh.) Sarg. (syn. var. *subintegerrima* (Vahl) Fern.; green ash) on the basis of the hairless leaves with narrower leaflets of the latter, but the two intergrade completely, and the distinction is no longer up-



Bark

held by most botanists.^{*[2]}

21.2 Ecology

It is the most widely distributed of all the American ashes, although its range centers on the Midwestern US and Great Plains. A pioneer species, it naturally grows along streambanks and disturbed areas. The large seed crops provide food to many kinds of wildlife.^{*[1]}

Green ash is threatened by the emerald ash borer, a beetle introduced accidentally from Asia to which it has no natural resistance.^{*[9]} A common garden experiment showed that green ash is killed readily when exposed to emerald



Bark and leaf

ash borer, while the Asian species *F. mandschurica* shows resistance against emerald ash borer.*[10] The United States Forest Service has discovered small numbers of green ash in the wild that have remained healthy after emerald ash borer swept through the population.*[11] The possibility of these trees possessing genetic resistance to the beetle is currently being investigated with the hope that green ash could be restored using the surviving trees.*[12]

The spread of emerald ash borer was facilitated by the extensive use of green ash as an ornamental tree in the central US following the loss of American elms in the 1950s-60s due to Dutch elm disease. That epidemic was the result of a similar overuse of elms in urban environments, leading to a monoculture that lacked any disease or pest resistance. Scientifically for red ash this is because modern cultivars utilized regionally were parented from sometimes only four individual trees selected for unique traits and male seedless flowering. Proclaiming a harsh lesson learned, cities like Chicago did not replace dead elms with a 1:1 ash:elm ratio. Instead, Norway, silver, red and sugar maples, honey locust, linden/basswood, redbud, crabapples and hackberry, among others, were also utilized during this recovery period and in new urban and suburban areas. Fortunately, with these additional species, many cities were able to reduce the percent of ash and other species to much lower levels (20% average) than during the Dutch elm disease era where from

56% to 100% of the trees were elm.

Both American elm and green ash were extremely popular due to rapid growth and tolerance of urban pollution and road salt, so many housing developments in Michigan were lined from end to end with ashes, a result of which the beetles had an enormous food supply to boost their population well above Infestation thresholds. The tree was also extensively propagated and sold by local nurseries. According to the American Nursery Industry, "Back in the late 1980s, Dr. Frank Santamour Jr., then a research geneticist with the U.S. National Arboretum, proposed the 10-20-30 formula for diversity in the urban forest, limiting the plantings in a community to no more than 10 percent within a single species, 20 percent within a genus and 30 percent within a family." Because of EAB today, many communities are using a more strict 20 – 10-5 rule.

The emerald ash borer proved to be a far worse and potentially more serious threat than epidemics of the past such as chestnut blight and Dutch elm disease because those diseases spread at a slower rate, only affected one species, and did not kill the trees before they could attain reproductive maturity. Many areas have banned the sale of ash seedlings in nurseries, although seeds may be sold as they are not a vector for the insect.

21.3 Uses

21.3.1 Urban ornamental trees



Autumn leaf color

Green ash is one of the most widely planted ornamental trees throughout the United States and much of Canada but mostly Alberta, including in western areas where it is not native. It is also widely planted in Argentina. It is very popular due to its good form and resistance to disease. About 40% of boulevard trees in Edmonton, Alberta are green ash.*[13]

For the last two centuries American elm and ash, which both belong to the ancient Elm-Ash-Cottonwood Bot-

tomland ecosystem,*[14] achieved distinction as North America's two most popularly planted urban species, used primarily for their superior survival traits and slowly maturing 180-300 year majestic natural beauty. Today used as living national monuments, the National Park Service is protecting Thomas Jefferson's 200-year-old planted example, and George Washington's 250-year-old white ash which has a 600-year possible lifespan. Green ash had been widely used as a primary ornamental and long lived monument tree until the elm fad of the 1880s, and regained top position once again after Dutch elm disease arrived.

Other continents learned of American ash species' urban survivability and unique beauty through the worldwide popularity of Midwestern Prairie style ecology and architectural movement. Modernizing cities in Russia and China then began using imported green ash a century ago to line streets and landscape new public parks. When one Chinese city's original collection, which had survived into late 1980's suddenly all died, city fathers used trees by sending them back to America as wooden crates containing Chinese made parts supplying the American auto industry. Advantages of green ash include its tolerance of harsh urban environmental conditions, ease of propagation, and (in eastern North America) its value for wildlife as a native keystone species.*[15]

21.3.2 Other uses

Green ash wood is similar in properties to white ash wood, and is marketed together as "white ash". The commercial supply is mostly in the South. It is very popular, used in making electric guitars because it can be somewhat lighter than white ash without sacrificing too much in tone. It has a bright sound with long sustain, plus the wood grain is aesthetically desirable to many guitar players. Gibson, Fender, Ibanez, Warwick, M2Guitars and many other luthiers use ash in the construction of their guitars.

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Chapter 22

Hamamelis virginiana

Hamamelis virginiana, known as **common** or **American witch-hazel**, is a species of witch-hazel native to eastern North America, from Nova Scotia west to Minnesota, and south to central Florida to eastern Texas.*[1]

22.1 Description



leaf closeup

It is a small, deciduous tree growing up to 6 m (rarely to 10 m) tall, often with a dense cluster of stems from its base. The **bark** is light brown, smooth, scaly, inner bark reddish purple. The branchlets are pubescent at first, later smooth, light orange brown, marked with occasional white dots, finally dark or reddish brown. The foliage buds are acute, slightly falcate, downy, light brown. The leaves are oval, 3.7–16.7 cm long and 2.5–13 cm broad, oblique at the base, acute or rounded at the apex, with



Hamamelis virginiana, Flower and fruit

a wavy-toothed or shallowly lobed margin, and a short, stout petiole 6–15 mm long; the midrib is more or less hairy, stout, with six to seven pairs of primary veins. The young leaves open involute, covered with stellate rusty down; when full grown, they are dark green above, and paler beneath. In fall, they turn yellow with rusty spots. The leaf **stipules** are lanceolate, acute; they fall soon after the leaf expands.

The **flowers** are pale to bright yellow, rarely orange or reddish, with four ribbon-shaped **petals** 10–20 mm long and four short stamens, and grow in clusters; flowering begins in about mid-fall and continues until late fall. The flower **calyx** is deeply four-parted, very downy, orange brown within, imbricate in bud, persistent, cohering with the base of the ovary. Two or three bractlets appear at base. The fruit is a hard woody capsule 10–14 mm long, which splits explosively at the apex at maturity one year after pollination, ejecting the two shiny black seeds up to 10 m distant from the parent plant. It can be distinguished from the related *Hamamelis vernalis* by its flowering in fall, not winter.*[1]*[2]*[3]*[4]

22.2 Uses

Native Americans produced witch hazel extract by boiling the stems of the shrub and producing a **decoction**,

which was used to treat swellings, inflammations, and tumors.* [5] Early Puritan settlers in New England adopted this remedy from the natives, and its use became widely established in the United States.* [6]

An extract of the plant is used in the astringent **witch hazel**.

H. virginiana produces a specific kind of tannins called *hamamelitannins*. One of those substances displays a specific cytotoxic activity against colon cancer cells.* [7]

The bark and leaves were used by Native Americans in the treatment of external inflammations. *Pond's Extract* was a popular distillation of the bark in dilute alcohol.

The wood is light reddish brown, sapwood nearly white; heavy, hard, close-grained, with a density of 0.68.* [4]

The forked twigs of witch-hazel are preferred as divining rods.

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22.4 External links

- "Witch Hazel". *The American Cyclopædia*. 1879.

Chapter 23

Juglans cinerea

“White walnut” and “White Walnut” redirect here. For the Australian tree, see [Cryptocarya obovata](#). For other uses of the term “butternut”, see [Butternut \(disambiguation\)](#).

Juglans cinerea, commonly known as **butternut** or **white walnut**,^{*} [3] is a species of walnut native to the eastern United States and southeast Canada.

23.1 Distribution

The distribution range of *J. cinerea* extends east to New Brunswick, and from southern Quebec west to Minnesota, south to northern Alabama and southwest to northern Arkansas.^{*} [4] It is absent from most of the Southern United States.^{*} [5] The species also proliferates at middle elevations (about 2,000 ft or 610 m above sea level) in the Columbia River basin, Pacific Northwest; as an off-site species. Trees with 7 ft or 2.1 m (over mature) class range diameter at breast height were noted in the Imnaha River drainage as late as January 26, 2015.

23.2 Description

J. cinerea is a deciduous tree growing to 20 m (66 ft) tall, rarely 40 m (130 ft). Butternut is a slow-growing species, and rarely lives longer than 75 years. It has a 40–80 cm (16–31 in) stem diameter, with light gray bark.

The leaves are pinnate, 40–70 cm (16–28 in) long, with 11–17 leaflets, each leaflet 5–10 cm (2–4 in) long and 3–5 cm (1 1/4–2 in) broad. The whole leaf is downy-pubescent, and a somewhat brighter, yellower green than many other tree leaves.

23.2.1 Flowering and fruiting

Butternut flowers from April to June, depending upon location, about the same time as the new leaves appear. The species is monoecious. Male (staminate) flowers are inconspicuous, yellow-green slender catkins that develop



A butternut

from auxiliary buds and female (pistillate) flowers are short terminal spikes on current year's shoots. Each female flower has a light pink stigma. Flowers of both sexes do not usually mature simultaneously on any individual tree.

The fruit is a lemon-shaped nut, produced in bunches of two to six together; the nut is oblong-ovoid, 3–6 cm (1 1/4–2 1/4 in) long and 2–4 cm (3/4–1 1/2 in) broad, surrounded by a green husk before maturity in midautumn.

Key characteristics:

- Alternate, compound leaves
- Odd number of leaflets – has a terminal leaflet

23.3 Ecology

23.3.1 Soil and topography

Butternut grows best on stream banks and on well-drained soils. It is seldom found on dry, compact, or infertile soils. It grows better than black walnut, however, on dry, rocky soils, especially those of limestone origin.

Butternut is found most frequently in coves, on stream benches and terraces, on slopes, in the talus of rock ledges, and on other sites with good drainage. It is found up to an elevation of 1,500 metres (4,900 ft) in the Virginias – much higher altitudes than black walnut.



Butternuts killed by butternut canker

Butternut is found with many other tree species in several hardwood types in the mixed mesophytic forest. It is an associated species in the following four northern and central forest cover types: sugar maple–basswood, yellow poplar–white oak–northern red oak, beech–sugar maple, and river birch–sycamore. Commonly associated trees include basswood (*Tilia spp.*), black cherry (*Prunus serotina*), beech (*Fagus grandifolia*), black walnut (*Juglans nigra*), elm (*Ulmus spp.*), hemlock (*Tsuga canadensis*), hickory (*Carya spp.*), oak (*Quercus spp.*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), yellow poplar (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), and yellow birch (*Betula alleghaniensis*). In the northeast part of its range, it is often found with sweet birch (*Betula lenta*) and in the northern part of its range it is occasionally found with white pine (*Pinus strobus*). Forest stands seldom contain more than an occasional butternut tree, although in local areas, it may be abundant. In the past, West Virginia, Wisconsin, Indiana, and Tennessee have been the leading producers of butternut timber.

Canopy competition

Although young trees may withstand competition from the side, butternut does not survive under shade from above. It must be in the overstory to thrive. Therefore, it is classed as intolerant of shade and competition.

23.3.3 Diseases

Butternut canker

The most serious disease of *J. cinerea* is butternut decline or butternut canker.* [6] In the past, the causal organism of this disease was thought to be a fungus, *Melanconis juglandis*. Now this fungus has been associated with secondary infections and the primary causal organism of the disease has been identified as another species of fungus, *Sirococcus clavigignenti-juglandacearum*. The fungus is spread by wide-ranging vectors, so isolation of a tree offers no protection.

Symptoms of the disease include dying branches and stems. Initially, cankers develop on branches in the lower crown. Spores developing on these dying branches are spread by rainwater to tree stems. Stem cankers develop 1 to 3 years after branches die. Tree tops killed by stem-girdling cankers do not resprout. Diseased trees usually die within several years. Completely free-standing trees seem better able to withstand the fungus than those growing in dense stands or forest. In some areas, 90% of the butternut trees have been killed. The disease is reported to have eliminated butternut from North and South Carolina. The disease is also reported to be spreading rapidly in Wisconsin. By contrast, black walnut seems to be resistant to the disease.

Hybrid resistance

The hybrid between butternut and the Japanese walnut is commonly known as the 'buartnut' and shows resistance to the butternut canker. Researchers are back-crossing butternut to buartnut, creating 'butter-buarts' which should have more butternut traits than buartnuts. They are selecting for resistance to the butternut canker.

Other pests

Bunch disease also attacks butternut. Currently, the causal agent is thought to be a mycoplasma-like organism. Symptoms include a yellow witches' broom resulting from sprouting and growth of auxiliary buds that would normally remain dormant. Infected branches fail to become dormant in the fall and are killed by frost; highly susceptible trees may eventually be killed. Butternut seems to be more susceptible to this disease than black walnut.

The common grackle has been reported to destroy immature fruit and may be considered a butternut pest when populations are high.

Butternut is very susceptible to fire damage, and although the species is generally wind firm, it is subject to frequent storm damage.

23.3.4 Conservation

The species is not listed as threatened federally in the US, but is listed as “Special Concern” in Kentucky, “Exploitably Vulnerable” in New York State, and “Threatened” in Tennessee.*[7]

The Committee on the Status of Endangered Wildlife in Canada placed the butternut on the endangered species list in Canada in 2005.*[1]

23.4 Uses



Cross-sections from The American Woods

23.4.1 Lumber

Butternut wood is light in weight and takes polish well, and is highly rot resistant, but is much softer than black walnut wood. Oiled, the grain of the wood usually shows much light. It is often used to make furniture, and is a favorite of woodcarvers.

23.4.2 Fabric dye

Butternut bark and nut rinds were once often used to dye cloth to colors between light yellow*[8] and dark brown.*[9] To produce the darker colors, the bark is

boiled to concentrate the color. This appears to never have been used as a commercial dye, but rather was used to color homespun cloth.

In the mid-19th century, inhabitants of areas such as southern Illinois and southern Indiana – many of whom had moved there from the Southern United States – were known as “butternuts” from the butternut-dyed homespun cloth that some of them wore. Later, during the American Civil War, the term “butternut” was sometimes applied to Confederate soldiers. Some Confederate uniforms apparently faded from gray to a tan or light brown. It is also possible that butternut was used to color the cloth worn by a small number of Confederate soldiers.*[10] The resemblance of these uniforms to butternut-dyed clothing, and the association of butternut dye with home-made clothing, resulted in this derisive nickname.

23.4.3 Medicinal

Butternut bark has mild cathartic properties and was once used medicinally in place of jalap, a more expensive cathartic which was imported from Mexico.

During the American Revolution, a butternut extract made from the inner bark of the tree was used in an attempt to prevent smallpox, and to treat dysentery and other stomach and intestinal discomfort.*[11]

23.4.4 Fishing

Crushed fruits can be used to poison fish, though the practice is illegal in most jurisdictions. Bruised fruit husks of the closely related black walnut can be used to stun fish.*[12]

23.5 References

- [1] Government of Canada, Species at Risk Public Registry, species profile, butternut
- [2] The Plant List, *Juglans cinerea* L.
- [3] Snow, Charles Henry. *The Principal Species of Wood: Their Characteristic Properties*. 2nd ed. New York: John Wiley & Sons, 1908. Page 56.
- [4] Sargent, Charles Sprague. *The Woods of the United States*. New York: D. Appleton & Co., 1885. Page 238.
Snow, cited above, says “New Brunswick to Georgia, westward to Dakota and Arkansas. Best in Ohio River Basin” .
- [5] “*Juglans cinerea Range Map*” (PDF). United States Geological Survey. Retrieved 2008-03-06.
- [6] “Butternut Canker”. *Gallery of Pests*. Don't Move Firewood. Retrieved 28 October 2011.

- [7] PLANTS Profile for *Juglans cinerea* (butternut) | USDA PLANTS
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- [9] Saunders, Charles Francis. *Useful Wild Plants of the United States and Canada*. New York: Robert M. McBride & Co., 1920. Page 227.
- [10] Saunders, Charles Francis. *Useful Wild Plants of the United States and Canada*. New York: Robert M. McBride & Co., 1920. Page 227.
- [11] Thatcher, James, M.D. *A Military Journal During the American Revolutionary War*. Boston: Cottons & Barnard, 1827. Page 251.
- [12] Petrides, G. A., & Wehr, J. (1998). Eastern Trees. New York, NY: Houghton Mifflin Company.

23.6 External links

- Vt.edu: *Juglans cinerea* (Butternut) ID photos and range map
- United States Department of Agriculture Forest Service: *Juglans cinerea* fact sheet
- Photo of fruit with husk removed
- Cross-section photo of fruit with husk removed
- Photo of herbarium specimen at Missouri Botanical Garden, collected in Missouri in 1937, showing leaf

Chapter 24

Juglans nigra

“Black walnut” redirects here. For other uses, see Black walnut (disambiguation).

Juglans nigra, the **eastern black walnut**, is a species of deciduous tree in the **walnut** family, Juglandaceae, native to eastern North America. It grows mostly in **riparian zones**, from southern Ontario, west to southeast South Dakota, south to Georgia, northern Florida and southwest to central Texas. Wild trees in the upper Ottawa Valley may be an isolated native population or may have derived from planted trees.

Black walnut is an important tree commercially, as the wood is a deep brown color and easily worked. The fruits, walnuts, are cultivated for their distinctive and desirable taste. Often, trees are grown for both lumber and walnuts simultaneously and many cultivars have been developed for improved quality nuts or wood. Black walnut is currently under pressure from the **thousand cankers disease** which is causing decline of walnuts in some areas. Black walnut is also **allelopathic** which means that it releases chemicals from roots and other tissues which harm other organisms and give the tree a competitive advantage; this is often undesirable as it can harm garden plants and grasses.

24.1 Description

- **Odor** Most parts of the tree including leaves, stems, and fruit **husks** have a very characteristic pungent or spicy odor. This odor is lacking in the nut itself.*[1]*[2]
- **Trunk** Height 30–40 m (100–130 ft). Under forest competition, it develops a tall and straight **trunk**. When grown in an open area it has a short trunk and broad crown.*[2]
- **Bark** The **bark** is typically grey-black and deeply furrowed into thin ridges which gives the bark a diamond shaped pattern.*[2]
- **Pith** The pith of the twigs is chambered and light brown.*[1]

- **Buds** The **buds** are pale silky and covered in downy hairs. The terminal buds are ovate, and 8 mm ($\frac{5}{16}$ in) long, and slightly longer than broad, the lateral buds are smaller and superposed.*[2]

- **Leaves** The leaves are **compound** and alternately arranged on the stem. They are 30–60 cm (1–2 ft) long, typically even-pinnate but there is heavy variation among leaves. The stems have 15–23 leaflets, with the largest leaflets located in the center, 7–10 cm (2 $\frac{3}{4}$ –4 in) long and 2–3 cm ($\frac{3}{4}$ –1 $\frac{1}{4}$ in) broad.*[2] The leaflets have a rounded base and a long pointed (acuminate) tip as well as having a **serrated** edge.*[3] The leaves are overall dark green in color and are typically hairy on the underside.

- **Leaf scar** The **leaf scar** has 3 prominent bundle scars and has a notch on the side which points toward the tip of the branch (distal side)

- **Flowers** Black walnut is **monoecious**. The **male** (staminate) flowers are in drooping catkins 8–10 cm (3 $\frac{1}{4}$ –4 in) long. These are borne from axillary buds on the previous year's growth. The **female** (pistillate) flowers are terminal, in clusters of two to five on the current year's growth.*[4]

- **Fruit** Ripens during the autumn into a fruit (nut) with a brownish-green, semifleshy husk and a brown, corrugated nut. The whole fruit, including the husk falls in October or November; the seed is relatively small and very hard.

The fruit production tends to occur irregularly with some years producing larger crops than others (see **mast year**). Fruiting may begin when the tree is 4–6 years old, however large crops take 20 years. Total lifespan of *J. nigra* is about 130 years. Black walnut does not leaf out until late spring when the soil has warmed and all frost danger is past. Like other trees of the order **Fagales**, such as oaks, hickories, chestnuts, and birches, it is monoecious, with wind-pollinated catkins. Male and female flowers are in separate **spikes**, and the female flowers typically appear before the male on a single tree (**dichogamy**). As a consequence, self-pollination is unlikely. However, individual trees usually are not self-sterile; if they are

not pollinated by neighboring trees, they may set self-fertilized seeds.* [4] For maximum seed germination, the seeds should be cold-moist stratified for 3–4 months, although the exact time depends on the seed source.* [4] The seedlings emerge in April or May and typically grow 90 cm (35 in) their first year and even more in the 2nd year.* [4] Black walnut often loses its leaves earlier than other deciduous trees growing in the same area after having a growing period of 115–135 days.* [4]

Black walnut has a strong taproot which makes the seedlings resilient, but difficult to transplant.

Black walnut is more resistant to frost than the English or Persian walnut, but thrives best in the warmer regions of fertile, lowland soils with high water tables, although it will also grow in drier soils, but much more slowly.* [2] Some soils preferred by black walnut include Alfisol and Entisol soil types.* [4] Walnut grows best on sandy loam, loam, or silt loam type soils but will also grow well on silty clay loam soils. It prefers these soils due to the fact that these soils hold large quantities of water which the tree draws from during dry periods.* [4]

Visually, black walnut is similar to the butternut (*Juglans cinerea*) in leaf shape, and the range also overlaps significantly. The fruits are quite different, and their presence makes an identification easy, as black walnut fruits are round and butternuts are more oval-oblong shaped. When a fruit is not available, two species can be differentiated based on the leaf scars, or the place where the leaf meets the stem: butternut has a leaf scar with a flat upper edge and with a velvety ridge above that flat part, but black walnut has an indented leaf scar with no hairy ridge.* [5]

24.2 Ecology

Black walnut is primarily a pioneer species similar to red and silver maple and black cherry. Because of this, black walnut is a common weed tree found along roadsides, fields, and forest edges in the eastern US. It will grow in closed forests, but is classified as shade intolerant, this means it requires full sun for optimal growth and nut production .

The nuts are food for many rodents and make up to 10% of the diet of eastern fox squirrels.* [6] The nuts are also eaten by species of birds. The leaves are browsed by white tailed deer,* [6] although they are not a preferred food. Squirrels benefit this species by distributing and burying the seeds; if the seeds are not reclaimed by the squirrel, they will germinate and help disperse the species.

Where the range of the eastern black walnut overlaps that of the Texas black walnut (*J. microcarpa*), the two species sometimes interbreed, producing populations with characteristics intermediate between the two species.* [7] *J.nigra* and *J. cinerea* often grow in the same range as well but they do not hybridize naturally.* [4]* [6]

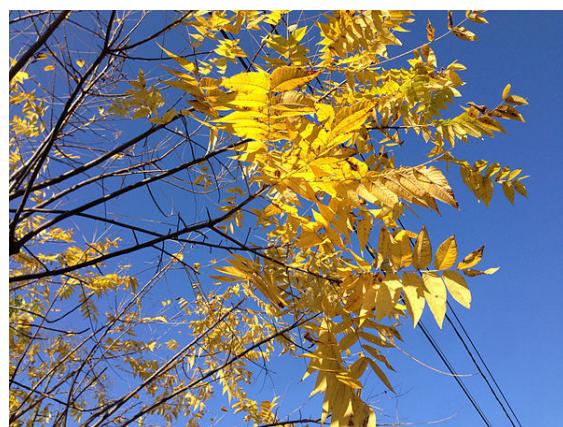
The tree's roots often form endomycorrhizal relationships with fungi in the genus *Glomus*. Some endomycorrhizal relations improve the plant's growth.* [4]

Species often associated with *J. nigra* include yellow-poplar (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), basswood (*Tilia americana*), American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), oaks (*Quercus* spp.), and hickories (*Carya* spp.). Near the western edge of its range, black walnut may be confined to floodplains, where it grows either with American elm (*Ulmus americana*), common hackberry (*Celtis occidentalis*), green ash (*Fraxinus pennsylvanica*), and boxelder (*Acer negundo*), or with basswood and red oak (*Quercus rubra*) on lower slopes and other favorable sites.* [4]

24.3 Uses

24.3.1 Planting

While its primary native region is the Midwest and east-central United States, the black walnut was introduced into Europe in 1629 and is also cultivated in Hawaii.* [6] It is cultivated there and in North America as a forest tree for its high-quality wood. Black walnut plantings can be made to produce timber, nuts, or both timber and nuts. Patented timber-type trees were selected and released from Purdue University in the early 1990s. These trees have been sporadically available from nurseries. Varieties include Purdue #1, which can be used for both timber and nut production, though nut quality is poor compared to varieties selected specifically as nut producers.



Autumn foliage

Grafted, nut-producing trees are available from several nurseries operating in the U.S. Selections worth considering include Thomas, Neel #1, Thomas Myers, Pounds #2, Stoker, Surprise, Emma K, Sparrow, S127, and McGinnis. Several older varieties, such as Kwik Krop, are still in cultivation; while they make decent nuts, they would not be recommended for commercial planting. A variety

index and characteristics guide is available from Missouri Extension.

Pollination requirements should be considered when planting black walnuts. As is typical of many species in Juglandaceae, *Juglans nigra* trees tend to be dichogamous, i.e., produce pollen first and then pistillate flowers or else produce pistillate flowers and then pollen. An early pollen-producer should be grouped with other varieties that produce pistillate flowers so all varieties benefit from overlap. Cranz, Thomas, and Neel #1 make a good pollination trio. A similar group for more northern climates would be Sparrow, S127, and Mintle.

Sometimes black walnut is planted as part of reclaiming mines.* [6] When growing young trees weed control is critical for healthy establishment of the trees, without weed control the young trees are harmed significantly in their growth rate.

J. nigra is also grown as a specimen ornamental tree in parks and large gardens, growing to 30 m (98 ft) tall by 20 m (66 ft) broad.* [8] It has gained the Royal Horticultural Society's Award of Garden Merit.* [9]

24.3.2 Food

Black walnut nuts are shelled commercially in the United States. About 65% of the annual wild harvest comes from the U.S. state of Missouri, and the largest processing plant is operated by Hammons Products in Stockton, Missouri. The nutmeats provide a robust, distinctive, natural flavor and crunch as a food ingredient. Popular uses include ice cream, bakery goods and confections. Consumers include black walnuts in traditional treats, such as cakes, cookies, fudge, and pies, during the fall holiday season. The nuts' nutritional profile leads to uses in other foods, such as salads, fish, pork, chicken, vegetables and pasta dishes.

Nutritionally similar to the milder-tasting English walnut, the black walnut kernel is high in unsaturated fat and protein. An analysis of nut oil from five named *J. nigra* cultivars (Ogden, Sparrow, Baugh, Carter and Thomas) showed the most prevalent fatty acid in *J. nigra* oil is linoleic acid (27.80–33.34 g/100g dry kernel), followed (in the same units) by oleic acid (14.52–24.40), linolenic acid (1.61–3.23), palmitic acid (1.61–2.15), and stearic acid (1.07–1.69).* [10] The oil from the cultivar Carter had the highest mol percentage of linoleate (61.6), linolenate (5.97%), and palmitate (3.98%); the oil from the cultivar Baugh had the highest mol percentage of oleate (42.7%); the oil from the cultivar Ogden has the highest mol percentage of stearate (2.98%).

Tapped in spring, the tree yields a sweet sap that can be drunk or concentrated into syrup or sugar which is not unlike the sap of sugar maple.

Nut processing by hand



Hands after removing the husks from 500 black walnuts

The extraction of the kernel from the fruit of the black walnut is difficult. The thick, hard shell is tightly bound by tall ridges to a thick husk. The husk is best removed when green, as the nuts taste better if it is removed then. Rolling the nut underfoot on a hard surface such as a driveway is a common method; commercial huskers use a car tire rotating against a metal mesh. Some take a thick plywood board and drill a nut-sized hole in it (from one to two inches in diameter) and smash the nut through using a hammer. The nut goes through and the husk remains behind.* [11]

While the flavor of the *Juglans nigra* kernel is prized, the difficulty in preparing it may account for the wider popularity and availability of the Persian walnut.

24.3.3 Dye

Black walnut drupes contain juglone (5-hydroxy-1,4-naphthoquinone), plumbagin (yellow quinone pigments), and tannin. These compounds cause walnuts to stain cars, sidewalks, porches, and patios, in addition to the hands of anyone attempting to shell them.* [12] The brownish-black dye was used by early American settlers to dye hair.* [13] According to Eastern Trees in the Petersen Guide series, black walnuts make a yellowish-brown dye, not brownish-black. The apparent confusion is easily explained by the fact that the liquid (dye) obtained from the inner husk becomes increasingly darker over time, as the outer skin darkens from light green to black. Extracts of the outer, soft part of the drupe are still used as a natural dye for handicrafts.* [14] The tannins present in walnuts act as a mordant, aiding in the dyeing process,* [15]* [16] and are usable as a dark ink or wood stain.* [17]

24.3.4 Industrial

Walnut shells are often used as an abrasive in sand blasting or other circumstances where a medium hardness grit

is required. The hard black walnut shell is also used commercially in abrasive cleaning, a filtering agent in scrubbers in smoke stacks, cleaning jet engines, cosmetics, and oil well drilling and water filtration.*[6]

24.3.5 Wood



Black walnut wood showing the color and grain

Black walnut is highly prized for its dark-colored, straight grained, true heartwood. It is heavy, strong, shock resistant and yet can be easily split and worked. Along with cedars (*Thuja spp.*), chestnut (*Castanea spp.*), and black locust (*Robinia pseudoacacia*) black walnut is one of the most durable hardwoods in the US.*[6] The wood can be kiln dried and holds its shape well after seasoning which makes this wood even more attractive for wood working.*[6]

Walnut wood has historically been used for gun stocks, furniture, flooring, paddles, coffins, and a variety of other wood products.*[6] Due to its value, forestry officials often are called on to track down walnut poachers; in 2004, DNA testing was used to solve one such poaching case, involving a 55-foot (16-m) tree worth US\$2,500. Black walnut has a density of 660 kg per cubic meter (41.2 lb/cubic foot),*[18] which makes it less dense than oak.

24.4 Pests

Maggots (larvae of *Rhagoletis completa* and *Rhagoletis suavis*) in the husk are common, though more a nuisance than a serious problem for amateurs, who may simply remove the affected husk as soon as infestation is noticed. The maggots develop entirely within the husk, thus the quality of the nutmeat is not affected.*[19] However, infestations of maggots are undesirable because they make the husk difficult to remove and are unsightly. Maggots can be serious for commercial walnut growers, who tend to use chemical treatments to prevent damage to the crop.*[20] Some organic controls also exist, such as removing and disposing of infested nuts.*[21]

The walnut curculio (*Conotrachelus retentus*) grows to 5

millimetres ($\frac{3}{16}$ in) long as an adult. The adult sucks plant juices through a snout. The eggs are laid in fruits in the spring and summer. Many nuts are lost due to damage from the larvae, which burrow through the nut shell.*[22]

Black walnut is affected by European canker (*Neonectria galligena*). The infection spreads slowly but infected trees eventually die.*[6]

The walnut caterpillar (*Datana integerrima*) and fall webworm (*Hyphantria cunea*) are two of the most serious pests, they commonly eat the foliage in midsummer and continue into autumn.

Codling moth (*Cydia pomonella*) larvae eat walnut kernels, as well as apple and pear seeds.*[23]

Important leaf sucking insects include species of aphids and plant lice including (*Monellia spp.* and *Monelliopsis spp.*), which suck the juices from leaves and often deposit a sticky substance called “honey-dew” on the leaf surface that may turn black and prevent photosynthesis; and the walnut lace bug (*Corythucha juglandis*), which causes damage when the adults and nymphs suck the sap from the lower surfaces of walnut leaflets.*[4]

A disease complex known as thousand cankers disease has been threatening black walnut in several western states.*[24] This disease has recently been discovered in Tennessee, and could potentially have devastating effects on the species in the eastern United States.*[25] Vectored by the walnut twig beetle (*Pityophthorus juglandis*), *Geosmithia morbida* spreads into the wood around the galleries carved by the small beetles. The fungus causes cankers that inhibit the movement of nutrients in black walnut, leading to crown and branch dieback, and ultimately death.*[26]

24.5 Allelopathy

Black walnut is allelopathic as it excretes chemicals into its environment which harm competition. While many species of plants are allelopathic, walnuts are particularly famous for it, records of walnut toxicity to other plants have been observed as far back as the first century when Pliny the Elder wrote: “The shadow of walnut trees is poison to all plants within its compass.”*[27] Walnuts have since been observed as being toxic to many plants including herbaceous and woody plants

Like other walnuts, the roots, innerbark, nut husks, and leaves contain a nontoxic chemical called hydrojuglone,*[27] when exposed to air or soil compounds it is oxidized into juglone which is biologically active and acts as a respiratory inhibitor to some plants. Juglone is poorly soluble in water and does not move far in the soil and will stay most concentrated in the soil directly beneath the tree.*[28] Even after a tree is removed the soil where the roots once were will still contain juglone for several years after the tree is removed as more juglone will be re-

leased as the roots decay.*[28] Well drained and aerated soils will host a healthy community of soil microbes and these microbes will help to break down the juglone.

Symptoms of juglone poisoning include foliar yellowing and wilting.*[28] A number of plants are particularly sensitive including: apples, tomatoes, pines, and birch are poisoned by juglone, and should not be planted in proximity to a black walnut.*[4]*[29]

24.6 Interaction with horses

Horses are susceptible to laminitis from exposure to black walnut wood in bedding.*[30]

24.7 Alternative medicine

Black walnut has been promoted as a potential cancer cure by alternative medicine practitioners, on the basis it kills a “parasite” responsible for the disease. According to the American Cancer Society, “available scientific evidence does not support claims that hulls from black walnuts remove parasites from the intestinal tract or that they are effective in treating cancer or any other disease”.*[31]

24.8 Largest trees



The largest known living black walnut tree is on Sauvie Island, Oregon.

The US national champion black walnut is on a residential property in Sauvie Island, Oregon. It is 8 ft 7 in (2.62 m) diameter at breast height and 112 ft (34 m) tall, with a crown spread of 144 feet (44 m).*[32]

The largest black walnut in Europe is located in the Castle Park in the city of Sered, Slovakia. It has a circumference of 6.30 m (20 ft 8 in), height of 25 m (82 ft) and estimated age of 300 years.*[33]

24.9 See also

- English walnut, Persian walnut
- List of ineffective cancer treatments
- Taxonomy of walnut tree varieties

24.10 References

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24.11 External links

- USFS: Black Walnut Cultivars
- Guide to “Growing Black Walnuts for Nut Production” University of Missouri Center for Agroforestry
- Walnutsweb.com —extensive information about black walnuts
- Walnut Council.org homepage
- Flora of North America: *Juglans nigra*—Range distribution Map:
- Bioimages.vanderbilt.edu: *Juglans nigra* images
- Set of Black Walnut ID photos and range map
- Harvesting Black Walnuts
- Home Production of Black Walnut Nutmeats
- Growing Black Walnut
- Black Walnut crackers
- Black Walnut Diagnostic photos: tree, leaves, bark and fruit
- The Hiker's Notebook
- Black Walnut Toxicity study
- Images, diseases, galls and fungi on treetrees.com
- *Juglans nigra* - information, genetic conservation units and related resources. European Forest Genetic Resources Programme (EUFORGEN)

Chapter 25

Lindera benzoin

Lindera benzoin (commonly called **spicebush**,^{*[1]} **common spicebush**,^{*[2]} **northern spicebush**,^{*[3]} **wild all-spice**,^{*[4]} or **Benjamin bush**^{*[1]}) is a shrub in the laurel family, native to eastern North America, ranging from New York to Ontario in the north, and to Kansas, Texas, and northern Florida in the center and south. Within its native range it is a relatively common plant where it grows in the **understory** in moist, rich woods, especially those with exposed limestone.^{*[1]}

25.1 Description



L. benzoin showing drupes and leaves

Spicebush is a deciduous shrub growing to 6–12 feet (1.8–3.7 m) tall.^{*[5]} It has a colonial nature and often reproduces by root sprouting, forming clumps or thickets.^{*[6]} The **leaves** are alternately arranged on the stem, simple, 6–15 cm (2–6 in) long and 2–6 cm (1–2 in) broad, oval or broadest beyond the middle of the leaf. They have a smooth edge with no teeth^{*[7]} and are dark green above and paler below.^{*[5]} The leaves, along with the stems are very aromatic when crushed with a spicy, citrusy smell,^{*[8]*[9]} hence the common names and the specific epithet *benzoin*. In the fall the leaves turn a very bright and showy yellow color.^{*[5]*[9]}

The yellow **flowers** grow in showy clusters which appear in early spring, before the leaves begin to grow. The flowers have 6 **sepals** and a very sweet odor.^{*[1]} The ripe **fruit** is a red, elipsoidal, berrylike **drupe**, rich in lipids, about 1 cm ($\frac{1}{2}$ in) long and is eaten by several bird species.^{*[10]}

It has a “turpentine-like” taste and aromatic scent, and contains a large **seed**. Spicebush is dioecious (plants are either male or female), so that both sexes are needed in a garden if one wants drupes with viable seeds.^{*[1]}

Like other **dioecious** plants, the female plants have a greater cost of reproduction compared to the male plants.^{*[11]} In the wild, the population tends to have more males than females possibly due to the heavier reproductive costs on females.^{*[12]}

The stem of *L. benzoin* has a slightly rough, but flat, bark which is covered in small, circular **lenticels** which give it a rough texture.

25.1.1 Related or potentially confused species

Other species in the *Lindera* genus also have common names containing the word “spicebush” and may appear similar. An example is *Lindera melissaefolia* which grows in swamps in southern US; it is differentiated by its hairy stems.^{*[7]} *Calycanthus* (sweetshrub, spicebush) is in a different family within the Laurales and also has aromatic leaves.^{*[10]}

25.2 Cultivation

Spicebush is often cultivated in gardens or edges of gardens. The brightly colored fruits and early flowers along with the spherical growth form make the plant desirable in gardens. It is hardy in **USDA zones** 4-9 and tolerates shade excellently but will also grow in full sun.^{*[5]} When grown in sun the plant tends to grow denser and have more berries and flowers compared to growing in shade or partial shade.^{*[5]*[8]} It is best to grow the plant from seed as its extensive root system does not handle **transplanting** well.^{*[5]} At least three **cultivars** have been developed although they are rarely available:^{*[9]}

- 'Rubra' has brick red male flowers, the winter buds are also a darker red brown color. Since it is male it produces no fruit.^{*[5]*[13]}

- 'Xanthocarpa' has yellow-orange fruits that was discovered in Arnold Arboretum in 1967 by Alfred Fordham.*[5]*[9]
- 'Green gold' a male, non-fruited cultivar with larger ornamental flowers.*[9]

Although several butterflies and moths used spicebush as a host, they are not considered a serious pest.

25.3 Uses



Male spicebush flowers

Due to its habit of growing in rich woods, early land surveyors used spicebush as an indicator of good agricultural land.*[6]*[7] The leaves, buds, and new growth twigs can be made into a tea.

Native Americans, including the Cherokee, Creek, and Iroquois used the plant for treatments in multiple ailments.*[14]

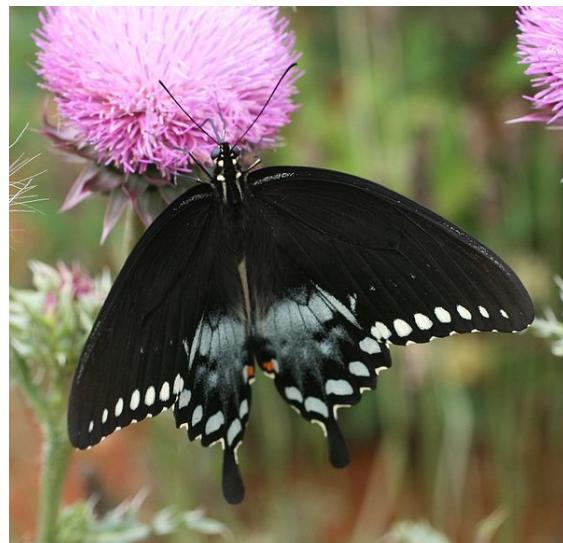
25.4 Ecology

Many animals feed on the leaves, twigs, and berries of spicebush. Some mammals include whitetail deer, Eastern cottontail rabbit, opossums.*[6]*[7] Over 20 species of birds including both gamebirds and song birds such as ring-necked pheasant, bobwhite, ruffed grouse and others have been known to feed on spicebush.*[6]*[7] The berries are a favorite food of wood thrushes.*[6]

25.4.1 Lepidopteran host plant

Spicebush is a favorite food plant of two lepidopterous insects: the spicebush swallowtail (*Papilio troilus*), and the promethea silkmoth, (*Callosamia promethea*).*[15]

The larvae of the spicebush swallowtail are easily found inside leaves that have been folded over by the application



Male spicebush swallowtail nectaring on a thistle

of silk; small larvae are brown, resembling bird droppings, and mature larvae are green. The anterior of a larva has two large eyespots and resembles the head of a snake. Since one or more broods (generations) of spicebush swallowtails typically occur each year, spicebush is a useful plant for the butterfly garden, since the egg-laying females are strongly attracted to it. Promethea moth cocoons, if present, are obvious during the cold season after leaf drop, and resemble dead leaves still hanging from twigs. Neither of these insects is ever present in sufficient quantities to defoliate a medium through large spicebush, although very small specimens may suffer even from a single caterpillar.

25.5 References

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25.6 External links

- Flora of North America: *Lindera benzoin* RangeMap:
- *Lindera benzoin* images at bioimages.vanderbilt.edu
- *Research on Lindera benzoin*
- Winter ID pictures

Chapter 26

Liriodendron tulipifera

Not to be confused with Poplar.

Liriodendron tulipifera—known as the **tulip tree**, **American tulip tree**, **tuliptree**, **tulip poplar**, **white-wood**, **fiddle-tree**, and **yellow poplar**—is the Western Hemisphere representative of the two-species genus *Liriodendron*, and the tallest eastern hardwood. It is native to eastern North America from Southern Ontario and Illinois eastward to southeastern Massachusetts and Rhode Island, and south to central Florida and Louisiana. It can grow to more than 50 m (160 ft) in virgin cove forests of the Appalachian Mountains, often with no limbs until it reaches 25–30 m (80–100 ft) in height, making it a very valuable **timber** tree. It is fast-growing, without the common problems of weak **wood** strength and short lifespan often seen in fast-growing species. April marks the start of the flowering period in the southern USA (except as noted below); trees at the northern limit of cultivation begin to flower in June. The flowers are pale green or yellow (rarely white), with an orange band on the tepals; they yield large quantities of nectar. The tulip tree is the state tree of Indiana, Kentucky, and Tennessee.

26.1 Description

The tulip tree is one of the largest of the native trees of the eastern United States, known to reach the height of 60 m (190 ft), with a trunk 3 m (10 ft) in diameter; its ordinary height is 20 to 30 m (70 to 100 ft). It prefers deep, rich, and rather moist soil; it is common, though not abundant, nor is it solitary. Its roots are fleshy. Growth is fairly rapid, and the typical form of its head is conical.*[4]

The bark is brown, and furrowed. The branchlets are smooth, and lustrous, initially reddish, maturing to dark gray, and finally brown. Aromatic and bitter. The wood is light yellow to brown, and the sapwood creamy white; light, soft, brittle, close, straight-grained. Specific gravity: 0.4230; density: 422 g/dm³ (26.36 lb/cu ft).

- Winter buds: Dark red, covered with a bloom, obtuse; scales becoming conspicuous stipules for the unfolding leaf, and persistent until the leaf is fully

grown. Flower-bud enclosed in a two-valved, caducous bract.

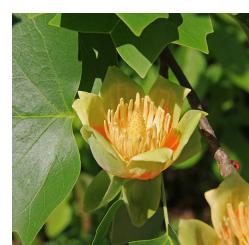
The alternate leaves are simple, pinnately veined, measuring five to six inches long and wide. They have four lobes, and are heart-shaped or truncate or slightly wedge-shaped at base, entire, and the apex cut across at a shallow angle, making the upper part of the leaf look square; midrib and primary veins prominent. They come out of the bud recurved by the bending down of the petiole near the middle bringing the apex of the folded leaf to the base of the bud, light green, when full grown are bright green, smooth and shining above, paler green beneath, with downy veins. In autumn they turn a clear, bright yellow. Petiole long, slender, angled.

- Flowers: May. Perfect, solitary, terminal, greenish yellow, borne on stout peduncles, an inch and a half to two inches long, cup-shaped, erect, conspicuous. The bud is enclosed in a sheath of two triangular bracts which fall as the blossom opens.
- Calyx: Sepals three, imbricate in bud, reflexed or spreading, somewhat veined, early deciduous.
- Corolla: Cup-shaped, petals six, two inches long, in two rows, imbricate, hypogynous, greenish yellow, marked toward the base with yellow. Somewhat fleshy in texture.
- Stamens: Indefinite, imbricate in many ranks on the base of the receptacle; filaments thread-like, short; anthers extrorse, long, two-celled, adnate; cells opening longitudinally.
- Pistils: Indefinite, imbricate on the long slender receptacle. Ovary one-celled; style acuminate, flattened; stigma short, one-sided, recurved; ovules two.
- Fruit: Narrow light brown cone, formed from many samaras which are dispersed by wind, leaving the axis persistent all winter. September, October.*[4]

A description from *Our native trees and how to identify them* by Harriet Louise Keeler.*[4]

The leaves are of unusual shape and develop in a most peculiar and characteristic manner. The leaf-buds are composed of scales as is usual, and these scales grow with the growing shoot. In this respect the buds do not differ from those of many other trees, but what is peculiar is that each pair of scales develops so as to form an oval envelope which contains the young leaf and protects it against changing temperatures until it is strong enough to sustain them without injury. When it has reached that stage the bracts separate, the tiny leaf comes out carefully folded along the line of the midrib, opens as it matures, and until it becomes full grown the bracts do duty as stipules, becoming an inch or more in length before they fall. The leaf is unique in shape, its apex is cut off at the end in a way peculiarly its own, the petioles are long, angled, and so poised that the leaves flutter independently, and their glossy surfaces so catch and toss the light that the effect of the foliage as a whole is much brighter than it otherwise would be.

The flowers are large, brilliant, and on detached trees numerous. Their color is greenish yellow with dashes of red and orange, and their resemblance to a tulip very marked. They do not droop from the spray but sit erect. The fruit is a cone 5 to 8 cm (2 to 3 in) long, made of a great number of thin narrow scales attached to a common axis. These scales are each a carpel surrounded by a thin membranous ring. Each cone contains sixty or seventy of these scales, of which only a few are productive. These fruit cones remain on the tree in varied states of dilapidation throughout the winter.



- *Liriodendron tulipifera*
“tulip” flower



- *Liriodendron tulipifera*
golden autumn leaves and seed cones



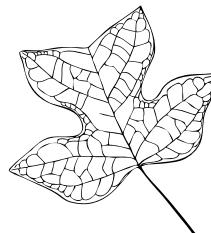
- *Liriodendron tulipifera*,
large gray-green flower bud with yellow bract



- *Liriodendron tulipifera* seeds



- Tulip tree, unfolding leaves



- Tulip tree leaf



- Leaves of 'Aureomarginatum'



- Liriodendron columnar trunk in
streambank woods, North Carolina



- Mature example of the east central Florida ecotype Dr. Howard A. Kelly Park near Apopka, Florida

26.2 Distribution

One of the largest and most valuable hardwoods of eastern North America, it is native from Connecticut and southern New York, westward to southern Ontario and northern Ohio, and south to Louisiana and northern Florida.*[5] It is found sparingly in New England, it is abundant on the southern shore of Lake Erie and westward to Illinois. It extends south to north Florida, and is rare west of the Mississippi River, but is found occasionally for ornamentals. Its finest development is in the Southern Appalachian mountains, where trees may exceed 50 m (170 ft) in height.

26.3 Ecology

Liriodendron tulipifera is generally considered to be a shade-intolerant species that is most commonly associated with the first century of forest succession. In Appalachian forests, it is a dominant species during the 50–150 years of succession, but is absent or rare in stands of trees 500 years or older. On mesic, fertile soils, it often forms pure or nearly pure stands. It can and does persist in older forests when there is sufficient disturbance to generate large enough gaps for regeneration.*[6] Individual trees have been known to live for up to around 500 years.*[7]

All young tulip trees and most mature specimens are intolerant of prolonged inundation; however, a coastal plain swamp ecotype in the southeastern United States is relatively flood-tolerant.*[8] This ecotype is recognized by its blunt-lobed leaves, which may have a red tint. *Liriodendron tulipifera* produces a large amount of seed, which is dispersed by wind. The seeds typically travel a distance equal to 4–5 times the height of the tree, and remain viable for 4–7 years. The seeds are not one of the most important food sources for wildlife, but they are eaten by a number of birds and mammals.*[9]

Vines, especially wild grapevines, are known to be extremely damaging to young trees of this species. Vines are damaging both due to blocking out solar radiation, and increasing weight on limbs which can lead to bending of the trunk and/or breaking of limbs.*[9]

26.4 Taxonomy and naming



Tulip tree sign at Eiteljorg Museum, Indianapolis, Indiana, with Miami-Illinois language name, “oonseentia”

Originally described by Linnaeus, *Liriodendron tulipifera* is one of two species (see also *L.chinense*) in the genus *Liriodendron* in the magnolia family. The name *Liriodendron* is Greek for “lily tree”.*[10] It is also called the tuliptree Magnolia, or sometimes, by the lumber industry, as the tulip poplar or yellow poplar. However, it is not closely related to true lilies, tulips or poplars.

The tulip tree has impressed itself upon popular attention in many ways, and consequently has many common names. The tree's traditional name in the Miami-Illinois language is “oonseentia”. Native Americans so habitually made their dugout canoes of its trunk that the early settlers west of the Appalachian Mountains called it Canoewood. The color of its wood gives it the name White-wood. In areas near the Mississippi River it is called a poplar largely because of the fluttering habits of its leaves, in which it resembles trees of that genus. It is sometimes called “fiddle tree,” because its peculiar leaves, with their arched bases and in-cut sides, suggest the violin shape.*[11] The external resemblance of its flowers to tulips named it the Tulip-tree.*[4] In their internal structure, however, they are quite different. Instead of the triple arrangements of stamens and pistil parts, they have indefinite numbers arranged in spirals.*[12]

26.5 East Central Florida ecotype

Parts of east-central Florida near Orlando have an ecosystem with similar-looking leaves to the coastal plain variant of the Carolinas; it flowers much earlier (usually in March, although flowering can begin in late January), with a smaller yellower bloom than other types. This east central Florida ecotype seems to have the best abil-

ity to tolerate very wet conditions, where it may grow short pencil-like root structures (pneumatophores) similar to those produced by other swamp trees in warm climates. Superior resistance to drought, pests and wind is also noted. Some individuals retain their leaves all year unless a hard frost strikes. Places where it may be seen include Dr. Howard A. Kelly Park, Lake Eola Park, Spring Hammock Preserve, and the University of Central Florida Arboretum.

26.6 Cultivation and use

Liriodendron tulipifera grows readily from seeds, which should be sown in a fine soft mould, and in a cool and shady situation. If sown in autumn they come up the succeeding spring, but if sown in spring they often remain a year in the ground. Loudon says that seeds from the highest branches of old trees are most likely to germinate. It is readily propagated from cuttings and easily transplanted.* [4]

26.6.1 In landscaping

Tulip trees make magnificently shaped specimen trees, and are very large, growing to about 35 m (110 ft) in good soil. They grow best in deep well-drained loam which has thick dark topsoil. They show stronger response to fertilizer compounds (those with low salt index are preferred) than most other trees, but soil structure and organic matter content are more important. In the wild it is occasionally seen around serpentine outcrops.* [13] The southeastern coastal plain and east central Florida ecotypes occur in wet but *not stagnant* soils which are high in organic matter. All tulip trees are unreliable in clay flats which are subject to ponding and flooding. Like other members of the Magnolia family, they have fleshy roots that are easily broken if handled roughly. Transplanting should be done in early spring, before leaf-out; this timing is especially important in the more northern areas. Fall planting is often successful in Florida. The east central Florida ecotype may be more easily moved than other strains because its roots grow over nine or ten months every year—several months longer than other ecotypes. Most tulip trees have low tolerance of drought, although Florida natives (especially the east central ecotype) fare better than southeastern coastal plain or northern inland specimens.

It is recommended as a shade tree.* [4] The tree's tall and rapid growth is a function of its shade intolerance. Grown in the full sun, the species tends to grow shorter, slower, and rounder, making it adaptable to landscape planting. In forest settings, most investment is made in the trunk (i.e., the branches are weak and easily break off, a sign of axial dominance) and lower branches are lost early as new, higher branches closer to the sun continue the

growth spurt upward. A tree just 15 years old may already reach 12 m (40 ft) in height with no branches within reach of humans standing on the ground.

Cultivars

- 'Ardis' – dwarf, with smaller leaves than wild form. Leaves shallow-lobed, some without lower lobes.
- 'Arnold' – narrow, columnar crown; may flower at early age.
- 'Aureomarginatum' – variegated form with pale-edged leaves; sold as 'Flashlight' or 'Majestic Beauty'.
- 'Fastigatum' – similar form to 'Arnold' but flowers at later age.
- 'Florida Strain' – blunt-lobed leaves, fast grower, flowers at early age.
- 'Integrifolium' – leaves without lower lobes.
- 'JFS-Oz' – compact oval form with straight leader, leaves dark and glossy; sold as 'Emerald City.'
- 'Leucanthum' – flowers white or nearly white.
- 'Little Volunteer' – almost as diminutive as 'Ardis' but with stronger form. Leaves more deeply lobed than 'Ardis.'
- 'Mediopictum' – variegated form with yellow spot near center of leaf.
- 'Roothaan' – blunt-lobed leaves.

The species* [14] and its variegated cultivar 'Aureo-marginatum'* [15] have both gained the Royal Horticultural Society's Award of Garden Merit.

Liriodendron tulipifera has been introduced to many temperate parts of the world, at least as far north as Sykkylven, Norway and Arboretum Mustila, Finland.* [16]* [17] A few nurseries in Finland offer this species even though it is not fully hardy there and tends to be held to shrub form.* [18]* [19]

26.6.2 Honey

This tree species is a major honey plant in the eastern United States, yielding a dark reddish, fairly strong honey which gets mixed reviews as a table honey but is favorably regarded by bakers; nectar is produced in the orange part of the flowers.* [20]

26.6.3 Wood

Main article: Tulipwood

The soft, fine-grained wood of tulip trees is known as “poplar” (short for “yellow poplar”) in the U.S., but marketed abroad as “American tulipwood” or by other names. It is very widely used where a cheap, easy-to-work and stable wood is needed. The sapwood is usually a creamy off-white color. While the heartwood is usually a pale green, it can take on streaks of red, purple, or even black; depending on the extractives content (i.e. the soil conditions where the tree was grown, etc.). It is clearly the wood of choice for use in organs, due to its ability to take a fine, smooth, precisely cut finish and so to effectively seal against pipes and valves. It is also commonly used for siding clapboards. Its wood may be compared in texture, strength, and softness to white pine.

Used for interior finish of houses, for siding, for panels of carriages, for coffin boxes, pattern timber, and wooden ware. During scarcity of the better qualities of white pine, tulip wood has taken its place to some extent, particularly when very wide boards are required.* [4]

It also has a reputation for being resistant to termites, and in the Upland South (and perhaps elsewhere) house and barn sills were often made of tulip poplar beams.

26.6.4 Arts

The tulip tree has been referenced in many poems and the namesakes of other poems, such as William Stafford's “Tulip Tree.” * [21]

Another form of art that the tulip tree is a major part of is wood carving. The tulip poplar can be very useful and has been one of the favorite types of trees for wood carving by sculptors such as Wilhelm Schimmel and Shields Landon Jones.* [22]*[23]

26.7 History

In the Cretaceous age the genus was represented by several species, and was widely distributed over North America and Europe. Its remains are also found in Tertiary rocks.* [4]

26.7.1 See also

- The Queens Giant, a tulip tree that is the oldest living thing in the New York Metropolitan area (350–450 years old, 40 m or 130 ft tall)
- *Spathodea campanulata*, often known as the African tulip tree, an unrelated plant in a separate family (Bignoniaceae).

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 - Michigan Bee Plants :: Magnoliaceae :: Liriodendron tulipifera
 - Archaeanthus: Paleontologists Identify Ancient Ancestor of Tulip Tree by Enrico de Lazaro (September 13, 2013)

26.9 External links

- USDA Profile for *Liriodendron tulipifera* (tuliptree)

Chapter 27

Nyssa sylvatica

Nyssa sylvatica, commonly known as **black tupelo**, **tupelo**, or **blackgum**, is a medium-sized deciduous tree native to eastern North America from the coastal Northeast USA and southern Ontario south to central Florida and eastern Texas, as well as Mexico.

27.1 Names

Nyssa sylvatica's genus name (*Nyssa*) refers to a Greek water nymph;*[1] the species epithet *sylvatica* refers to its woodland habitat.*[1]

The species' common name **tupelo** is of Native American origin, coming from the Creek words *ito* 'tree' and *opilwa* 'swamp'; it was in use by the mid-18th century*[2]

While these trees are often known as simply "tupelo", the fuller name **black tupelo** helps distinguish it from the other species of the **tupelo** genus (*Nyssa*), some of which have overlapping ranges, such as **water tupelo** (*N. aquatica*) and **swamp tupelo** (*N. biflora*). The name "tupelo" is used primarily in the American South; northward and in Appalachia, the tree is more commonly called the **black gum** or the **sour gum**, although no part of the plant is particularly gummy.*[1] Both of these names contrast it with a different tree species with a broadly overlapping range, the **sweet gum** (*Liquidambar styraciflua*), which does produce an aromatic resin.*[1] Another common name used occasionally in the Northeast is **pepperidge**.*[1]

On Martha's Vineyard, in Massachusetts, this species is called "beetlebung", perhaps for its use in making the mallet known as a beetle, used for hammering bungs (stoppers) into barrels.*[3]

27.2 Description

Nyssa sylvatica grows to 20–25 metres (66–82 ft) tall, rarely to 35 metres (115 ft), with a trunk diameter of 50–100 centimetres (20–39 in), rarely up to 170 centimetres (67 in). These trees typically have a straight trunk with the branches extending outward at right angles.*[1] The bark is dark gray and flaky when young, but it becomes



Nyssa sylvatica leaves in the autumn.



Trunk of a mature *Nyssa sylvatica* tree

furrowed with age, resembling alligator hide on very old stems. The twigs of this tree are reddish-brown, usually hidden by a greyish skin. The pith is chambered with

greenish partitions.

The leaves of this species are variable in size and shape. They can be oval, elliptical, or obovate, and 5–12 cm (2–4.5 in) long. They have lustrous upper surfaces, with entire, often wavy margins. The foliage turns purple in autumn, eventually becoming an intense bright scarlet. Deer are extremely fond of the leaves on seedlings and saplings, to the point where large populations of them can make establishment of the tree almost impossible. For comparison, mature trees are largely left alone.

The flowers are very small, in greenish-white in clusters at the top of a long stalk and a rich source or nectar for bees. They are often dioecious so a male and female tree in proximity is required to set seed, however, many trees are also polygamo-dioecious, which means they have both male and female flowers on the same tree. The fruit is a black-blue, ovoid stone fruit, about 10 mm long with a thin, oily, bitter-to-sour tasting flesh and very popular with small bird species. There are from one to three fruits together on a long slender stalk. They are a valuable energy food for birds, especially the American robin.

Nyssa sylvatica forms a large deep taproot when young that makes transplanting difficult. Because of this, it is fairly uncommon in cultivation and the nursery trade.

Additional characteristics include:

- Bark: Light reddish brown, deeply furrowed and scaly. Branchlets at first pale green to orange, sometimes smooth, often downy, later dark brown.
- Wood: Pale yellow, sapwood white; heavy, strong, very tough, hard to split, not durable in contact with the soil. Used for turnery. Sp. gr., 0.6353; weight of cu. ft., 39.59.
- Winter buds: Dark red, obtuse, one-fourth of an inch long. Inner scales enlarge with the growing shoot, becoming red before they fall.
- Leaves: Alternate, often crowded at the end of the lateral branches, simple, linear, oblong to oval, two to five inches (127 mm) long, one-half to three inches (76 mm) broad, wedge-shaped or rounded at base, entire, with margin slightly thickened, acute or acuminate. They come out of the bud conduplicate, coated beneath with rusty tomentum, when full grown are thick, dark green, very shining above, pale and often hairy beneath. Feather-veined, midrib and primary veins prominent beneath. In autumn they turn bright scarlet, or yellow and scarlet. Petioles one-quarter to one-half an inch long, slender or stout, terete or margined, often red.
- Flowers: May, June, when leaves are half grown. Polygamodioecious, yellowish green, borne on slender downy peduncles. Staminate in many-flowered heads; pistillate in two to several flowered clusters.
- Calyx: Cup-shaped, five-toothed.

- Corolla: Petals five, imbricate in bud, yellow green, ovate, thick, slightly spreading, inserted on the margin of the conspicuous disk.
- Stamens: Five to twelve. In staminate flowers exserted, in pistillate short, often wanting.
- Pistil: Ovary inferior, one to two-celled; style stout, exserted, reflexed above the middle. Entirely wanting in sterile flower. Ovules, one in each cell.
- Fruit: Fleshy drupe, one to three from each flower cluster. Ovoid, two-thirds of an inch long, dark blue, acid. Stone more or less ridged. October.*[4]

27.3 Distribution

Nyssa sylvatica grows in various uplands and in alluvial stream bottoms from southwestern Maine and New York, to extreme southern Ontario, central Michigan, Illinois, and central Missouri, south to southern Florida, eastern Texas, and eastern Oklahoma. It also occurs locally in central and southern Mexico.*[5] Optimum development is made on lower slopes and terraces in the Southeastern United States.*[6]

27.4 Ecology

Nyssa sylvatica is found in a variety of upland and wetland habitats in its extensive range. Its flowers are an important source of honey and its fruits are important to many bird species. Hollow trunks provide nesting or denning opportunities for bees and various mammals. It is the longest living non-clonal flowering plant in Eastern North America, capable of obtaining ages of over 650 years.*[7]

27.4.1 Habitats

Nyssa sylvatica is found in a wide range of climates, due to its extensive distribution. It commonly grows in both the creek bottoms of the southern coastal plains, to altitudes of about 900 meters (3,000 feet) in the Southern Appalachians. These trees grow best on well-drained, light-textured soils on the low ridges of second bottoms and on the high flats of silty alluvium. In the uplands it grows best on the loams and clay loams of lower slopes and coves.

The species occurs 35 different forest cover types.*[6] When found on drier upper slopes and ridges, it is seldom of log size or quality.*[6]

27.4.2 Wildlife

Nyssa sylvatica is an important food source for many migrating birds in the fall. Its early color change (foliar



Nyssa sylvatica with mature fruit, starting to show fall coloring

fruit flagging) is thought to attract birds to the available fruit, which ripen before many other fall fruits and berries. The fruit is quite marked, dark blue, in clusters of two or three. The sour fruits are eagerly sought by many kinds of birds, including: American robin, Swainson's thrush, gray-cheeked thrush, hermit thrush, wood thrush, northern cardinal, northern mockingbird, blue jay, red-bellied woodpecker, yellow-bellied sapsucker, northern flicker, pileated woodpecker, eastern phoebe, brown thrasher, eastern bluebird, European starling, scarlet tanager, gray catbird, cedar waxwing, and American crow, all primarily eastern North American birds migrating or residing year-round within the tree's range.

The limbs of these trees often deteriorate early, and the decayed holes make excellent dens for squirrels, raccoons, Virginia opossums, as well as nesting sites for honeybees.

27.5 Uses

27.5.1 Cultivation

Nyssa sylvatica is cultivated as an ornamental tree in parks and large gardens, where it is often used as a specimen or shade tree. The tree is best when grown in sheltered but not crowded positions, developing a pyramidal shape in youth, and spreading with age. The stem rises to the summit of the tree in one tapering unbroken shaft, the branches come out at right angles to the trunk and either extend horizontally or droop a little, making a long-narrow, cone-like head.

The leaves are short-petioled and so have little individual motion, but the branches sway as a whole. The spray is fine and abundant and lies horizontally so that the foliage arrangement is not unlike that of the beech (*Fagus*). Its often spectacular autumnal coloring, with intense reds to purples, is highly valued in landscape settings. It is the most fiery and brilliant of the 'brilliant group' that includes maple, dogwood, sassafras, and sweet gum, as well as various species of tupelo.*[4]



Nyssa sylvatica turning scarlet in autumn

27.5.2 Honey production

Nyssa sylvatica is a major source of wild honey in many areas within its range. Hollow sections of black gum trunks were formerly used as bee gums by beekeepers.*[8]

27.5.3 Wood

The wood of *Nyssa sylvatica* is heavy, hard, cross-grained, and difficult to split, especially after drying. This resistance to splitting led to its use for making mauls, pulleys, wheel hubs, agricultural rollers, bowls, and paving blocks.*[1] The wood is also used for pallets, rough floors, pulpwood, and firewood. Since the wood is very tough, resistant to wear, it has been used for shuttles in weaving.

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27.7 External links

- USDA Plant Profile - *Nyssa sylvatica*
- "Nyssa sylvatica". *World Checklist of Selected Plant Families (WCSP)*. Royal Botanic Gardens, Kew – via The Plant List.
- Virginia Polytechnic Institute and State University Source
- Ohio State University Source
- Michigan State University Source
- Hort.net profile
- *Nyssa sylvatica* images at bioimages.vanderbilt.edu
- Interactive Distribution Map for *Nyssa sylvatica*

Chapter 28

Paulownia tomentosa

Paulownia tomentosa (common names **princess tree**,^{*[1]} **foxglove-tree**,^{*[2]} **empress tree** or **kiri**) is a **deciduous tree** in the family Paulowniaceae, native to central and western China. *Paulownia tomentosa* is an extremely fast-growing tree, and is a persistent exotic invasive in North America.^{*[3]}

28.1 Nomenclature

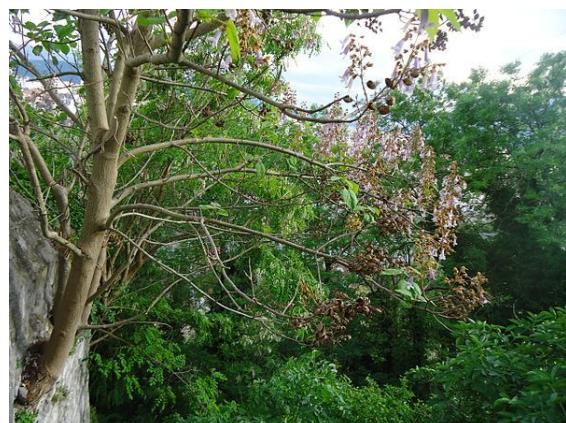


Flowering tree

The generic name *Paulownia* honors Anna Pavlovna of Russia.^{*[4]} The specific epithet *tomentosa* is a Latin word meaning ‘covered in hairs’.^{*[5]}



Flowers and young leaves



Paulownia tomentosa growing in a wall, Grenoble, France, April 2017.

28.2 Description

This tree grows 10–25 m (33–82 ft) tall, with large heart-shaped to five-lobed leaves 15–40 cm (6–16 in) across, arranged in opposite pairs on the stem. On young growth, the leaves may be in whorls of three and be much bigger than the leaves on more mature growth.*[6] The leaves can be mistaken for those of the catalpa.

The very fragrant flowers are produced before the leaves in early spring, on panicles 10–30 cm long, with a tubular purple corolla 4–6 cm long resembling a foxglove flower. The fruit is a dry egg-shaped capsule 3–4 cm long, containing numerous tiny seeds. The seeds are winged and disperse by wind and water. Pollarded trees do not produce flowers, as these only form on mature wood.

Paulownia tomentosa can survive wildfire because the roots can regenerate new, very fast-growing stems. It is tolerant of pollution and it is not fussy about soil type. For this reason it functions ecologically as a pioneer plant. Its nitrogen-rich leaves provide good fodder and its roots prevent soil erosion. Eventually, *Paulownia* is succeeded by taller trees that shade it. It cannot thrive in the shade of other trees. It is able to grow from small cracks in pavements and walls.

28.3 Uses



Twig with old seed pods

Paulownia tomentosa is cultivated as an ornamental tree in parks and gardens. It has gained the Royal Horticultural Society's Award of Garden Merit.*[7]

The characteristic large size of the young growth is exploited by gardeners: by pollarding the tree and ensuring there is vigorous new growth every year, massive leaves are produced (up to 23in/60 cm across). These are popular in the modern style of gardening which uses large-foliaged and “architectural” plants.

In China, the tree is planted at the birth of a girl. The fast-growing tree matures when she does. When she is eligible

for marriage the tree is cut down and carved into wooden articles for her dowry. Carving the wood of *Paulownia* is an art form in Japan and China. In legend, it is said that the phoenix will only land on the Empress Tree and only when a good ruler is in power. Several Asian string instruments are made from *P. tomentosa*, including the Japanese *koto* and Korean *gayageum* zithers.

The soft, lightweight seeds were commonly used as a packing material by Chinese porcelain exporters in the 19th century, before the development of polystyrene packaging. Packing cases would often leak or burst open in transit and scatter the seeds along rail tracks. The magnitude of the numbers of seeds used for packaging, together with seeds deliberately planted for ornament, has allowed the species to be viewed as an invasive species in areas where the climate is suitable for its growth, notably Japan and the eastern United States.*[8]

28.4 Composition

Some geranylflavonoids can be found in *P. tomentosa*.*[9]

Verbascoside can also be produced in hairy roots cultures of *P. tomentosa*.*[10]

28.5 Pictures



• Flower close-up



• Trunk



• Fruit



- Spent Fruit



- Leaf

- Species Profile- Princess Tree (*Paulownia tomentosa*), National Invasive Species Information Center, United States National Agricultural Library. Lists general information and resources for Princess Tree.

28.6 References

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28.7 External links

- *Paulownia tomentosa* images at bioimages.vanderbilt.edu

Chapter 29

Table mountain pine

Table Mountain pine,*[1] *Pinus pungens*, also called **hickory pine, prickly pine,*[1]** or **mountain pine,*[2]** is a small pine native to the Appalachian Mountains in the United States.

29.1 Description

Pinus pungens is a tree of modest size (6–12 m), and has a rounded, irregular shape. The needles are in bundles of two, occasionally three, yellow-green to mid green, fairly stout, and 4–7 cm long. The pollen is released early compared to other pines in the area to minimize hybridization. The cones are very short-stalked (almost sessile), ovoid, pale pinkish to yellowish buff, and 4–9 cm long; each scale bears a stout, sharp spine 4–10 mm long. Sapling trees can bear cones in a little as 5 years.

This pine prefers dry conditions and is mostly found on rocky slopes, preferring higher elevations, from 300–1760 m altitude. It commonly grows as single scattered trees or small groves, not in large forests like most other pines, and needs periodic disturbances for seedling establishment.

29.2 In culture

Pinus pungens is the **Lonesome Pine** of the 1908 novel *The Trail of the Lonesome Pine* by John Fox, and popularised in the Laurel and Hardy film *Way out West*:

On the Blue Ridge Mountains of Virginia

On the Trail of the Lonesome Pine

Several “Lonesome Pine” hiking trails have been waymarked in the **Blue Ridge Mountains** and elsewhere in the Appalachians.



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29.3 References

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29.4 External links

- Flora of North America: *Pinus pungens* info and *P. pungens* Range Map
- *Pinus pungens* images at bioimages.vanderbilt.edu

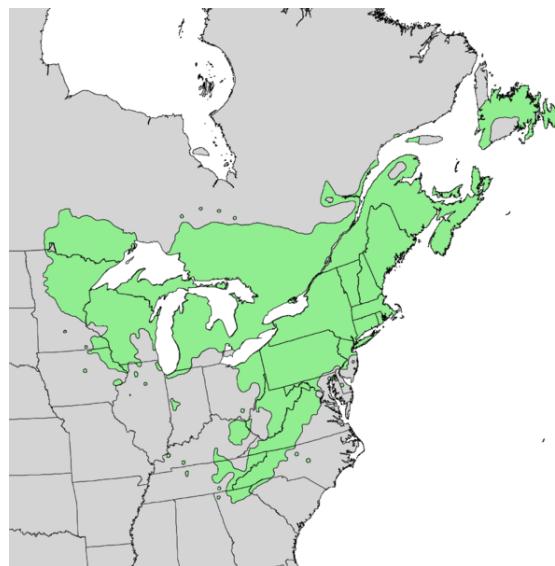
Chapter 30

Pinus strobus

Pinus strobus, commonly denominated the **eastern white pine**, **northern white pine**, **white pine**, **Weymouth pine** (British), and **soft pine***[1] is a large pine native to eastern North America. It occurs from Newfoundland, Canada west through the Great Lakes region to southeastern Manitoba and Minnesota, United States, and south along the **Appalachian Mountains** and upper **Piedmont** to northernmost Georgia and perhaps very rarely in some of the higher elevations in northeastern Alabama.*[2]

The Native American Haudenosaunee denominated it the "Tree of Peace". It is known as the "Weymouth pine" in the United Kingdom,*[3] after Captain George Weymouth of the British Royal Navy, who brought its seeds to England from Maine in 1605.*[4]

30.1 Distribution



Partial distribution map of *Pinus strobus* in North America



Native eastern white pine, Sylvania Wilderness, Michigan

Pinus strobus is found in the nearctic temperate broadleaf and mixed forests biome of eastern North America. It prefers well-drained or sandy soils and humid climates, but can also grow in boggy areas and rocky highlands. In mixed forests, this dominant tree towers over many others, including some of the large broadleaf hardwoods. It provides food and shelter for numerous forest birds, such as the **red crossbill**, and small mammals such as **squirrels**. Eastern White Pine forests originally covered much of

north-central and north-eastern North America. Only one percent of the **old-growth forests** remain after the extensive logging operations of the 18th century to early 20th century.

Old growth forests, or virgin stands, are protected in **Great Smoky Mountains National Park**. Other protected areas with known virgin forests, as confirmed by the Eastern Native Tree Society, include **Algonquin Provincial Park**, **Quetico Provincial Park**, and **Algoma Highlands** in Ontario, Canada; **Estivant Pines**, **Huron Mountains**, **Porcupine Mountains State Park**, and **Sylvania Wilderness Area** in the Upper Peninsula of Michigan, United States; **Hartwick Pines State Park** in the Lower Peninsula of Michigan; **Menominee Indian Reservation** in Wisconsin; **Lost 40 Scientific and Natural Area (SNA)** and **Boundary Waters Canoe Area Wilderness** in Minnesota; **White Pines State Park**, Illinois; **Cook Forest State Park**, **Hearts Content Scenic Area**, and **Anders Run Natural Area** in Pennsylvania; and the **Linville Gorge Wilderness** in North Carolina.

Small **groves** or individual specimens of old growth Eastern White Pines are found across the range of the species in the USA, including in **Ordway Pines**, Maine; **Ice Glen**,

Massachusetts; and Adirondack Park, New York. Many sites with conspicuously large specimens represent advanced old field ecological succession. The tall stands in Mohawk Trail State Forest and William Cullen Bryant Homestead in Massachusetts are examples.

As an introduced species, *Pinus strobus* is now naturalizing in the Outer Eastern Carpathians subdivision of the Carpathian Mountains in Czech Republic and southern Poland. It has spread from specimens planted as ornamental trees.

30.2 Description

Like all members of the white pine group, *Pinus* subgenus *Strobus*, the leaves ("needles") are in fascicles (bundles) of 5, or rarely 3 or 4, with a deciduous sheath. They are flexible, bluish-green, finely serrated, 5–13 cm (2–5 in) long, and persist for 18 months, i.e., from the spring of one season until autumn of the next, when they abscise.

The cones are slender, 8–16 cm (3 $\frac{1}{4}$ –6 $\frac{1}{4}$ in) long (rarely longer than that) and 4–5 cm (1 $\frac{1}{2}$ –2 in) broad when open, and have scales with a rounded apex and slightly reflexed tip. The seeds are 4–5 mm ($\frac{5}{32}$ – $\frac{3}{16}$ in) long, with a slender 15–20 mm ($\frac{5}{8}$ – $\frac{3}{4}$ in) wing, and are dispersed by wind. Cone production peaks every 3 to 5 years.

While Eastern White Pine is self-fertile, seeds produced this way tend to result in weak, stunted, and malformed seedlings.

Mature trees are often 200–250 years old, and some live to over 400 years. A tree growing near Syracuse, New York was dated to 458 years old in the late 1980s and trees in Michigan and Wisconsin were dated to approximately 500 years old.

30.2.1 Dimensions

The Eastern White Pine has the distinction of being the tallest tree in eastern North America. In natural pre-colonial stands it is reported to have grown as tall as 70 m (230 ft). There is no means of accurately documenting the height of trees from these times, but Eastern White Pine may have reached this height on rare occasions. Even greater heights have been reported in popular, but unverifiable, accounts such as Robert Pike's "Tall Trees, Tough Men".

Total trunk volumes of the largest specimens are approximately 28 m³ (990 cu ft), with some past giants possibly reaching 37 or 40 m³ (1,300 or 1,400 cu ft). Photographic analysis of giants suggests volumes closer to 34 m³ (1,200 cu ft).



Measuring the circumference of an Eastern White Pine

Height

Pinus strobus grows approximately 1 m (3.3 ft) annually between the ages of 15 and 45 years, with slower height increments before and after that age range.* [5] The tallest presently living specimens are 50–57.55 m (164 ft 1 in–188 ft 10 in) tall, as determined by the Native Tree Society (NTS).* [6] Three locations in southeastern United States and one site in northeastern United States have trees that are 55 m (180 ft) tall.

The southern Appalachian Mountains have the most locations and the tallest trees in the present range of *Pinus strobus*. One survivor is a specimen known as the "Boogerman Pine" in the Cataloochee Valley of Great Smoky Mountains National Park. At 57.55 m (188 ft 10 in) tall, it is the tallest accurately measured tree in North America east of the Rocky Mountains. It has been climbed and measured by tape drop by the Native Tree Society. Before Hurricane Opal broke its top in October 1995, Boogerman Pine was 63 m (207 ft) tall, as determined by Will Blozan and Robert Leverett using ground based measurements.

The tallest specimens in Hartwick Pines State Park in Michigan are 45–48 m (148–157 ft) tall.

In northeastern USA, 8 sites in 4 states currently have trees over 48 m (157 ft) tall, as confirmed by the Native Tree Society. The Cook Forest State Park of

Pennsylvania has the most numerous collection of 45 m (148 ft) Eastern White Pines in the Northeast, with 110 trees measuring that height or more. The Park's "Longfellow Pine" is the tallest presently living Eastern White Pine in the Northeast, at 55.96 m (183 ft 7 in) tall, as determined by being climbed and measured by tape drop.*[7] The Mohawk Trail State Forest of Massachusetts has 83 trees measuring 45 m (148 ft) or more tall, of which 6 exceed 48.8 m (160 ft). The "Jake Swamp Tree" located there is 51.54 m (169 ft 1 in) tall.*[8]*[9] The Native Tree Society maintains precise measurements of it. A private property in Claremont, New Hampshire has approximately 60 specimens that are 45 m (148 ft) tall. Besides the aforementioned sites, sites with 45 m (148 ft) tall specimens typically have one to 15 specimens.

Diameter

Diameters of the larger pines range from 1.0–1.6 m (3 ft 3 in–5 ft 3 in), which translates to a circumference (girth) range of 3.1–5.0 m (10 ft 2 in–16 ft 5 in). However, single-trunked white pines in both the Northeast and Southeast with diameters over 1.45 m (4 ft 9 in) are exceedingly rare. Notable big pine sites of 40 ha (99 acres) or less will often have no more than 2 or 3 trees in the 1.2 to 1.4 m (3 ft 11 in to 4 ft 7 in) diameter class.



White pine boughs, showing annual yellowing and abscission of older foliage in the autumn. Upstate New York, USA.

Unconfirmed reports from the colonial era gave diameters of virgin white pines of up to 2.4 m (8 ft).*[10]

30.3 Mortality and disease

Because the eastern white pine tree is somewhat resistant to fire, mature survivors are able to re-seed burned areas. In pure stands mature trees usually have no branches on the lower half of the trunk. The white pine weevil (*Pissodes strobi*) and white pine blister rust (*Cronartium*



An illustration dated 1902, showing a variety of insect pests affecting eastern white pine

ribicola), an introduced fungus, can damage or kill these trees.

30.3.1 Blister rust

Mortality from white pine blister rust in mature pine groves was often 50–80% during the early 20th century. The fungus must spend part of its life cycle on alternate hosts of the *Ribes* genus, the native gooseberry or wild currant. Foresters proposed that if all the alternate host plants were removed that white pine blister rust might be eliminated. A very determined campaign was mounted and all land owners in commercial pine growing regions were encouraged to uproot and kill all native gooseberry and wild currant plants.*[10]*[11] The ramifications for wildlife and habitat ecology were of less concern at the time than timber industry protection.

Today native wild currants are relatively rare plants in New England, and planting wild currants or wild gooseberries is strongly discouraged, or even illegal in some jurisdictions. As an alternative, new strains of commercial currants have been developed which are highly resistant to white pine blister rust. Mortality in white pines from rust is only about 3% today.*[11]

30.4 Historical uses

30.4.1 Lumber

In the 19th century, the harvesting of Midwestern white pine forests played a major role in America's westward expansion through the Great Plains. A quarter million white pines were harvested and sent to lumber yards in Chicago in a single year.*[12]

The white pine had aesthetic appeal to contemporary naturalists such as Henry David Thoreau ("There is no finer tree.")*[13] Beyond that, it had commercial applications. It was considered "the most sought and most widely utilized of the various forest growths of the northwest."*

*[14] Descriptions of its uses are quoted below from a contemporary source:

Being of a soft texture and easily worked, taking paint better than almost any other variety of wood, it has been found adaptable to all the uses demanded in the building art, from the manufacture of packing cases to the bearing timber and finer finish of a dwelling. Of light weight, it has borne transportation to the farms of the west, where it is used for building purposes in dwellings, barns and corn cribs, while as a fencing material it has no superior. Aside from those conditions which demand a dense strong timber, such as ship-building or in wagon-making, white pine has been found adaptable to all the economic uses in which lumber is required, not excluding its use in coarser articles of furniture. No wood has found greater favor or entered more fully into supplying all those wants of man which could be found in the forest growths.*[14]

The species was imported in 1620 to England by Captain George Weymouth, who planted it for a timber crop, but had little success because of white pine blister rust disease.

Old growth pine in the Americas, of various *Pinus* species, was a highly desired wood since huge, knot-free boards were the rule rather than the exception. Pine was common and easy to cut, thus many colonial homes used pine for paneling, floors and furniture. Pine was also a favorite tree of loggers since pine logs can still be processed in a lumber mill a year or more after being cut down. In contrast, most hardwood trees such as cherry, maple, oak, and ash must be cut into 1" thick boards immediately after felling or large cracks will develop in the trunk which can render the wood worthless.*[10]

Although eastern white pine was frequently used for flooring in buildings constructed before the U.S. Civil War, the wood is soft and will tend to cup over time with wear. George Washington opted for the much harder southern yellow pine at Mount Vernon instead.*[10]

30.4.2 Masts

During the age of square riggers, tall white pines with high quality wood in the Thirteen Colonies were known as *mast pines*. Marked by agents of the Crown with the broad arrow, these "mast pines" were reserved for the British Royal Navy.

Special barge-like vessels were built to ship up to 50 pine trunks destined to become masts. The wood was often squared immediately after felling to fit in the holds of ships better.*[10] A 30 m (100 ft) mast was about 91 cm × 91 cm (3 ft × 3 ft) at the butt and 61 cm × 61 cm (2 ft × 2 ft) at the top, while a 37 m (120 ft) mast was 1.2 m × 1.2 m (4 ft × 4 ft) by 76 cm (30 in) on its ends.

Marking of large specimens by the Crown was very controversial in the colonies, leading to the Pine Tree Riot in 1772; its act of rebellion played a significant role in the events leading to the American Revolution. During that conflict colonists cut down and hauled off many mast pines.*[15]*[16]

The original masts on the USS *Constitution* were single trees but were later replaced by laminated spars to better withstand cannonballs. An unusual large, lone, white pine was found in colonial times in coastal South Carolina along the Black River, far east of its southernmost normal range. The king's mark was carved into it, giving rise to the town of Kingtree.*[17]

30.5 Contemporary uses

30.5.1 Lumber



Board of *Pinus strobus*

Eastern white pine is now widely grown in plantation forestry within its native area.

Freshly cut eastern white pine is creamy white or a pale straw color but pine wood which has aged many years tends to darken to a deep rich golden tan. Occasionally one can find light brown pine boards with unusual

yellowish-golden or reddish-brown hues. This is the famous “pumpkin pine”. It is generally thought that slow growing pines in old-growth forests accumulate colored products in the heartwood, but genetic factors and soil conditions may also play a role in rich color development.*[15]

This wood is also favored by pattern makers for its easy working.

30.5.2 Foods and medicines

Eastern white pine needles contain five times the amount of Vitamin C (by weight) of lemons and make an excellent herbal tea. The cambium is edible. It is also a source of resveratrol. Linnaeus noted in the 18th century that cattle and pigs fed pine bark bread grew well, but he personally did not like the taste. Caterpillars of Lusk's Pinemoth (*Coloradia luski*) have been found to feed only on *Pinus strobus*.

Pine tar is produced by slowly burning pine roots, branches, or small trunks in a partially smothered flame. Pine tar mixed with beer can be used to remove tapeworms (flat worms) or nematodes (round worms). Pine tar mixed with sulfur is useful to treat dandruff, and marketed in present-day products. Pine tar can also be processed to make turpentine.*[18]

Native American traditional uses

The name “Adirondack” is an Iroquois word which means tree-eater and referred to their neighbors (more commonly known as the Algonquians) who collected the inner bark of this tree, *Picea rubens*, and others during times of winter starvation. The white soft inner bark (cambial layer) was carefully separated from the hard, dark brown bark and dried. When pounded this product can be used as flour or added to stretch other starchy products.*[19]*[20]

The young staminate cones were stewed by the Ojibwe Indians with meat and were said to be sweet and not pitchy. In addition, the seeds are sweet and nutritious, but not as tasty as those of some of the western nut pines.*[19]

Pine resin (sap) has been used by various tribes to waterproof baskets, pails, and boats. The Chippewa also used pine resin to successfully treat infections and even gangrenous wounds.*[19] This is because pine resin apparently has a number of quite efficient antimicrobials. Generally a wet pulp from the inner bark, or pine tar mixed with beeswax or butter was applied to wounds and used as a salve to prevent infection.

30.5.3 Cultivation

Pinus strobus is cultivated by plant nurseries as an ornamental tree, for planting in gardens and parks.*[21]

The species is low-maintenance and rapid growing as a specimen tree. With regular shearing it can also be trained as a hedge. Some cultivars are used in bonsai.*[22]

Cultivars

Cultivars have been selected for small to dwarf mature forms, and foliage color characteristics.*[22] They include:

- *Pinus strobus* Nana Group —ave. 91 cm (3 ft) tall by 1.2 m (4 ft) wide. MBG: *Pinus strobus* (Nana Group)
- *Pinus strobus* 'Macopin' —30 to 91 cm (1 to 3 ft) tall & wide. MBG: *Pinus strobus* 'Macopin'
- *Pinus strobus* 'Paul Waxman' —61 to 152 cm (2 to 5 ft) tall & wide. MBG: *Pinus strobus* 'Paul Waxman'

Christmas trees

Smaller specimens are popular as live Christmas trees. Eastern white pines are noted for holding their needles well, even long after being harvested. They also are well suited for people with allergies, as they give little to no aroma. A standard 1.8-meter (6 ft) tree takes approximately 6 to 8 years to grow in ideal conditions. Sheared varieties are usually desired because of their stereotypical Christmas tree conical shape, as naturally grown ones can become too thick for larger ornaments, or grow bushy in texture.*[23] The branches of the eastern white pine are also widely used in making holiday wreaths and garland because of their soft, feathery needles.

30.6 Symbolism

Eastern White Pine is the Provincial Tree of Ontario, Canada.*[24]

In the United States it is the State Tree of Maine (as of 1945)*[25] and Michigan (as of 1955).*[26] Its “pine cone and tassel” is also the State Flower of Maine.*[27] Sprigs of Eastern White Pine were worn as badges as a symbol of Vermont identity during the Vermont Republic and are depicted in a stained glass window in the Vermont State House, on the Flag of Vermont, and on the naval ensign of the Commonwealth of Massachusetts.

The Native American Haudenosaunee (Iroquois Confederation) denominated it the "Tree of Peace".

30.7 See also

- Giants in the Land

30.8 References

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 - Eastern Native Tree Society – Boogerman Pine photo gallery
 - The Monday Garden: The Eastern White Pine

30.9 External links

- *Pinus strobus* at the Encyclopedia of Life
- USDA Plants Profile for *Pinus strobus* (eastern white pine)
- EFLORAS—Flora of North America: *Pinus strobus* treatment
- EFLORAS: *P. strobus* Distribution map
- Gymnosperm Database: *Pinus strobus*
- Bioimages.vanderbilt.edu: *Pinus strobus* images
- *Pinus strobus* —U.C. Photo gallery
- *Pinus strobus* - information, genetic conservation units and related resources. European Forest Genetic Resources Programme (EUFORGEN)

Chapter 31

Pinus virginiana

***Pinus virginiana* (Virginia pine, scrub pine, Jersey pine)** is a medium-sized tree, often found on poorer soils from Long Island in southern New York south through the Appalachian Mountains to western Tennessee and Alabama. The usual size range for this pine is 9–18 m, but can grow taller under optimum conditions. The trunk can be as large as 0.5 m diameter. This tree prefers well-drained loam or clay, but will also grow on very poor, sandy soil, where it remains small and stunted. The typical life span is 65 to 90 years.

The short (4–8 cm), yellow-green needles are paired in fascicles and are often twisted. Pinecones are 4–7 cm long and may persist on the tree for many years, often (though not always) releasing their seeds in the second year. In growth habit, some trees may be inclined with twisted trunks.

This pine is useful for reforesting and provides nourishment for wildlife. Its other main use is on Christmas tree farms, despite having sharp-tipped needles and yellowish winter color. It also can provide wood pulp and lumber. Like some other southern yellow pines, Virginia Pine lumber case hardens. That is it becomes very hard over time during wood drying. Wood from Virginia pine is not normally considered to resist rot unless treated with preservatives.

31.1 Introduction

Pinus virginiana is a species of Pine.*[2] Common names for the *Pinus virginiana* are the Virginia, Scrub and Jersey Pine.*[2] *Pinus virginiana* has the following synonyms, *Pinus inops**[3] *Pinus rutenica* and *Pinus turbinata*.*[4] *Pinus virginiana* is a species in the order Pinales and the family Pinaceae. Pines are an evergreen tree. In general, pine trees were thought to have arisen anywhere from 153.1 million years ago to 271 million years ago.*[5] *Pinus virginiana* is a perennial tree, which means that it lives for numerous years. They are also gymnosperms. Gymnosperms produce seeds, but they do not protect these seeds with an ovary or with fruit and they lack flowers.

31.2 Description

Pinus virginiana is a distinct pine in the United States and can be identified by a key characteristic the relatively short needles are twisted and come in bunches of two. The needles are typically two to eight centimeters in length. There is hair on the bracts and on the bud scales of the *P. virginiana*. The leaf sheath of the *P. virginiana* is greater than 2.5 millimeters long. The cones of the *P. virginiana* only open after they are mature. The branches of the *Pinus virginiana* are flexible. They will bend when pressure is added to them.*[6] *Pinus virginiana* are between 9 and 18 meters tall. The bark of *P. virginiana* is red and brown in color, and also has the tendency to be rough with relatively small bark scales. The pollen cones are circular, almost elliptical and are 10–20 millimeters in size. They are the same color as the bark, typically. Seed cones are spread throughout the tree. The mature seed cones (4–7 cm) are much larger than the pollen cones.*[7] The *P. virginiana* prefers to grow in poor soils and dry loam or clay. They can grow on sandy soil, but this usually causes the tree to be smaller than the average *P. virginiana*.*[8]

31.3 Taxonomy

Pinus virginiana is in the family Pinaceae and the order Pinales.*[2] A molecular phylogeny indicates that the sister taxa to *Pinus virginiana* are *Pinus clausa*, *Pinus contorta*, and *Pinus banksiana*.*[9] *Pinus banksiana* has shorter needles than *P. virginiana* at 2–3.5 centimeters in length, whereas *P. virginiana* is 2–8 centimeters in length. *P. banksiana* needles are not twisted, but curved, and has cones that are serotinous and unarmed. The leaf sheaths in *P. banksiana* are less than 2.5 millimeters long. In *P. virginiana* the needles are twisted and straight. The cones open at maturity, are not serotinous and the scales on the cones have prominent prickles. The sheaths of the *P. virginiana* are greater than 2.5 millimeters long. *Pinus clausa* has larger needles than the *P. virginiana*. The *Pinus clausa* has needles that are between 5 and 13 centimeters long, *P. virginiana* has needles that range between 2 and 8 centimeters long. *Pinus clausa* is also seroti-

nous.* [2] Lastly, *Pinus virginiana* and *Pinus contorta* are distributed differently: *Pinus virginiana* are found on the eastern side of the United States, whereas *Pinus contorta* are found on the western side.* [10] A similarity between *Pinus virginiana* and *Pinus contorta* is that the needles of both species are twisted.

31.4 Distribution and habitat

Pinus virginiana inhabit dry forested areas. The tree occurs in New York, New Jersey, Pennsylvania, Virginia, West Virginia, Ohio, Illinois, Kentucky, Tennessee, North Carolina, Georgia, Alabama, Mississippi,* [2] Indiana, South Carolina, Maryland and Delaware.* [7] In locations where the *P. virginiana* lives, rainfall is typically between 890 and 1400 millimeters. The average temperatures in the summer are between 21–24 degrees Celsius and in the winter it is around –4 to 4 degrees Celsius. *Pinus virginiana* is poorly adapted to fire, but if the tree is larger they are able to survive. Between the ages of 65–90 years they no longer reproduce, but they are able to live up to 150 years. The oldest recorded was 150 years old.*[9]

31.5 Ethnobotany

Cherokee Indians used *P. virginiana* medicinally. They used it for many symptoms like diarrhea, stiffness of the body, colds, fevers, hemorrhoids, tuberculosis, and constipation. Cherokee Indians used *P. virginiana* in different ways including bathing in water that had been soaked in the bark, steams and oils, root and needle infusions, and for tar. They also used it in certain cultural rituals. In burial rituals *P. virginiana* branches were burned and the ashes were used for a fire in their homes. Also, they would infuse needles in apple juice and they would drink it. The Cherokee basically did that as a toast to the wind. Lastly, they used the root infusions as a stimulant and the needles were used as a soap.*[9]

31.6 Etymology

The etymology of the *Pinus virginiana* is as follows: *Pinus* is Latin for Pine and *virginiana* means of Virginia.*[11]

31.7 Uses

Pinus virginiana was used historically as mine timbers, for railroad ties, and for fuel and tar. Currently, it is being planted as in reclamation sites for coal mining operations. *Pinus virginiana* can also be used for wood pulp, which is used to make paper, and for lumber.*[3]

31.8 Conservation

On the IUCN Red List of Threatened Species, the *Pinus virginiana* is considered a species that is of least concern. It is a species of least concern due to relative commonness as an early successional species. In areas of abandoned farmland in the eastern US, *P. virginiana* tends to be common.*[12]

31.9 Gallery



• Cone closeup



• Cone and needles



• Bark



• Bark closeup



• New growth and pollen cones

31.10 References

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31.11 External links

- Flora of North America, Profile and map: *Pinus virginiana*
- *Pinus virginiana* images at bioimages.vanderbilt.edu

Chapter 32

Platanus occidentalis

Platanus occidentalis, also known as **American sycamore**, **American planetree**, **occidental plane**, and **buttonwood**, is one of the species of *Platanus* native to North America. It is usually called **sycamore** in North America, a name which can refer to other types of tree in other parts of the world. The name is derived from the Greek word πλάτανος (*platanos*), meaning flat, and the Latin word *occidentalis* meaning “of the west”, and “sycamore” is derived from the ancient Greek συκόμορος (*sukomoros*) meaning “fig-mulberry”.

32.1 Description

An American sycamore tree can often be easily distinguished from other trees by its mottled exfoliating bark which flakes off in great irregular masses, leaving the surface mottled, and greenish-white, gray and brown. The bark of all trees has to yield to a growing trunk by stretching, splitting, or infilling; the sycamore shows the process more openly than many other trees. The explanation is found in the rigid texture of the bark tissue which lacks the elasticity of the bark of some other trees, so it is incapable of stretching to accommodate the growth of the wood underneath, so the tree sloughs it off.*[1]

A sycamore can grow to massive proportions, typically reaching up to 30 to 40 m (98 to 131 ft) high and 1.5 to 2 m (4.9 to 6.6 ft) in diameter when grown in deep soils. The largest of the species have been measured to 51 m (167 ft), and nearly 4 m (13 ft) in diameter. Larger specimens were recorded in historical times. In 1744, a Shenandoah Valley settler named Joseph Hampton and two sons lived for most of the year in a hollow sycamore in what is now Clarke County, Virginia.*[2] In 1770, at Point Pleasant, Virginia (now in West Virginia)*[3] near the junction of the Kanawha and Ohio Rivers, George Washington recorded in his journal a sycamore measuring 13.67 m (44 ft 10 in) in circumference at 91 cm (3 ft) from the ground.*[4]

The sycamore tree is often divided near the ground into several secondary trunks, very free from branches. Spreading limbs at the top make an irregular, open head. Roots are fibrous. The trunks of large trees are often hollow.

Another peculiarity is the way the leaves grow sticky, green buds. In early August, most trees in general will have—nestled in the axils of their leaves—the tiny forming bud which will produce the leaves of the coming year. The sycamore branch apparently has no such buds. Instead there is an enlargement of the petiole which encloses the bud in a tight-fitting case at the base of the petiole.*[1]

- Bark: Dark reddish brown, broken into oblong plate-like scales; higher on the tree, it is smooth and light gray; separates freely into thin plates which peel off and leave the surface pale yellow, or white, or greenish. Branchlets at first pale green, coated with thick pale tomentum, later dark green and smooth, finally become light gray or light reddish brown.
- Wood: Light brown, tinged with red; heavy, weak, difficult to split. Largely used for furniture and interior finish of houses, butcher's blocks. Specific gravity, 0.5678; relative density, 0.53724 g/cm³ (33.539 lb/cu ft).
- Winter buds: Large, stinky, sticky, green, and three-scaled, they form in summer within the petiole of the full grown leaf. The inner scales enlarge with the growing shake. There is no terminal bud.
- Leaves: Alternate, palmately nerved, broadly ovate or orbicular, 10 to 23 cm (4 to 9 in) inches long, truncate or cordate or wedge-shaped at base, decurrent on the petiole. Three to five-lobed by broad shallow sinuses rounded in the bottom; lobes acuminate, toothed, or entire, or undulate. They come out of the bud plicate, pale green coated with pale tomentum; when full grown are bright yellow green above, paler beneath. In autumn they turn brown and wither before falling. Petioles long, abruptly enlarged at base and inclosing the buds. Stipules with spreading, toothed borders, conspicuous on young shoots, caducous.
- Flowers: May, with the leaves; monoecious, borne in dense heads. Staminate and pistillate heads on separate peduncles. Staminate heads dark red, on axillary peduncles; pistillate heads light green tinged

with red, on longer terminal peduncles. Calyx of staminate flowers three to six tiny scale-like sepals, slightly united at the base, half as long as the pointed petals. Of pistillate flowers three to six, usually four, rounded sepals, much shorter than the acute petals. Corolla of three to six thin scale-like petals.

- Stamens: In staminate flowers as many of the divisions of the calyx and opposite to them; filaments short; anthers elongated, two-celled; cells opening by lateral slits; connectives hairy.
- Pistil: Ovary superior, one-celled, sessile, ovate-oblong, surrounded at base by long, jointed, pale hairs; styles long, incurved, red, stigmatic, ovules one or two.
- Fruit: Brown heads, solitary or rarely clustered, 2.5 cm (1 in) in diameter, hanging on slender stems three to six inches long; persistent through the winter. These heads are composed of **achenes** about two-thirds of an inch in length. October.*[1]



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- The characteristic bark of an American sycamore



• A sycamore in winter.



• Old sycamores can have massive trunks



• Tree in autumn



• Autumn leaves

-  Upper branches of a sycamore
-  Sycamore trunk and branches



32.2 Distribution

In its native range, it is often found in riparian and wetland areas. The range extends from Iowa to Ontario and Maine in the north, Nebraska in the west, and south to Texas and Florida. Closely related species (see *Platanus*) occur in Mexico and the southwestern states of the United States. It is sometimes grown for timber, and has become naturalized in some areas outside its native range. It can be found growing successfully in Bismarck, North Dakota,^{*[5]} and it is sold as far south as Okeechobee. The American sycamore is also well adapted to life in Argentina and Australia and is quite widespread across the Australian continent especially in the cooler southern states such as Victoria and New South Wales.

32.3 Uses

The sycamore is able to endure a big city environment and was formerly extensively planted as a shade tree,^{*[1]} but due to the defacing effects of anthracnose it has been largely usurped in this function by the resistant London plane.^{*[6]}

Its wood has been used extensively for butcher's blocks. It has been used for boxes and crates; although coarse-grained and difficult to work, it has also been used to make furniture, siding, and musical instruments.^{*[6]}

Investigations have been made into its use as a biomass crop.^{*[7]}

Wood of the Platanus occidentalis. From Romeyn Beck Hough's fourteen-volume work The American Woods, a collection of over 1000 paper-thin wood samples representing more than 350 varieties of North American tree.

32.4 Pests and diseases

The American sycamore is a favored food plant of the pest sycamore leaf beetle.

American sycamore is susceptible to Plane anthracnose disease (*Apiognomonia veneta*, syn. *Gnomonia platani*), an introduced fungus found naturally on the Oriental plane *P. orientalis*, which has evolved considerable resistance to the disease. Although rarely killed or even seriously harmed, American sycamore is commonly partially defoliated by the disease, rendering it unsightly as a specimen tree.

Sometimes mistaken for frost damage, the disease manifests in early spring, wilting new leaves and causing mature leaves to turn brown along the veins. Infected leaves typically shrivel and fall, so that by summer the tree is regrowing its foliage. Cankers form on twigs and branches near infected leaves, serving to spread the disease by spore production and also weakening the tree. Because cankers restrict the flow of nutrients, twigs and branches afflicted by cankers eventually die. Witch's broom is a symptom reflecting the cycle of twigs dying.^{*[8]}

As a result of the fungus' damage, American sycamore is often avoided as a landscape tree, and the more resistant

London plane (*P. × hispanica*; hybrid *P. occidentalis* × *P. orientalis*) is planted instead.

32.5 History

The terms under which the New York Stock Exchange was formed are called the "Buttonwood Agreement," because it was signed under a buttonwood (sycamore) tree at 68 Wall Street, New York City in 1792.

The sycamore made up a large part of the forests of Greenland and Arctic America during the Cretaceous and Tertiary periods. It once grew abundantly in central Europe, from which it has now disappeared.*[1] It was brought to Europe early in the 17th century.*[9]

32.6 See also

- Buttonball Tree, an American sycamore, said to be the largest on the East Coast, located in Sunderland, Massachusetts
- Pinchot Sycamore, an American sycamore that is the largest tree in Connecticut
- Webster Sycamore, formerly the largest American sycamore in the U.S. state of West Virginia
- Sycamore maple or European sycamore (*Acer pseudoplatanus*), a maple which is visually very similar to sycamore
- El Aliso, the 400 year lived powwow sycamore tree at Yaangna, the original Los Angeles

32.7 Trivia

The sycamore tree is mentioned in the famous song "Dream a Little Dream of Me" (in its 4th line), "Birds singing in the sycamore tree."

It is also mentioned in "Colors of the Wind" from *Pocahontas* (1995), "How high does a sycamore grow? If you cut it down, then you'll never know."

The sycamore tree is one of the main themes in movie "Flipped" (2010) where the lead character Juli Baker is greatly attached to the sycamore tree in the neighborhood.

The sycamore tree*[10] is also featured in the Song "Back Home Again in Indiana", traditionally sung just before the start of the Indianapolis 500 mile auto race.

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32.10 External links

- USDA Plants Profile for *Platanus occidentalis* (American sycamore)
- Flora of North America: *Platanus occidentalis*
- University of Michigan at Dearborn: Native American Ethnobotany of *Platanus occidentalis* (American sycamore)
- Cirrusimage.com: American Sycamore —diagnostic photographs and information
- Forestry.about.com: American sycamore - *Platanus occidentalis*
- photos of *Platanus occidentalis*

Chapter 33

Prunus avium

Prunus avium, commonly called **wild cherry**,^{*} [2] **sweet cherry**,^{*} [2] or **gean**,^{*} [2] is a species of **cherry**, a flowering plant in the rose family Rosaceae. It is native to Europe, Anatolia, Maghreb, and western Asia, from the British Isles^{*} [3] south to Morocco and Tunisia, north to the Trondheimsfjord region in Norway and east to the Caucasus and northern Iran, with a small isolated population in the western Himalaya.^{*} [4] The species is widely cultivated in other regions and has become naturalized in North America and Australia.^{*} [5]^{*} [6]^{*} [7]

Prunus avium, has a **diploid** set of sixteen chromosomes ($2n = 16$).^{*} [8] All parts of the plant except for the ripe fruit are slightly toxic, containing cyanogenic glycosides.

33.1 Nomenclature



Flowers

The early history of its classification is somewhat confused. In the first edition of *Species Plantarum* (1753), Linnaeus treated it as only a variety, *Prunus cerasus* var. *avium*, citing Gaspard Bauhin's *Pinax theatri botanici* (1596) as a synonym; his description, *Cerasus racemosa hortensis* ("cherry with racemes, of gardens") shows it was described from a cultivated plant.^{*} [9] Linnaeus then changed from a variety to a species *Prunus avium* in the second edition of his *Flora Suecica* in 1755.^{*} [10]

Sweet cherry was known historically as **gean** or **mazzard** (also 'massard'), until recently, both were largely obsolete

names in modern English.

The name "wild cherry" is also commonly applied to other species of *Prunus* growing in their native habitats, particularly to the North American species *Prunus serotina*.

Prunus avium means "bird cherry" in the Latin language,^{*} [4] but in English "bird cherry" refers to *Prunus padus*.^{*} [11]

33.1.1 Mazzard

More recently 'Mazzard' has been used to refer to a selected self-fertile cultivar that comes true from seed, and which is used as a seedling rootstock for fruiting cultivars.^{*} [12]^{*} [13] This term is still used particularly for the varieties of *P. avium* grown in North Devon and cultivated there, particularly in the orchards at Landkey.

33.2 Description and ecology



Red glands (extrafloral nectaries) on the petiole.

Prunus avium is a deciduous tree growing to 15–32 m (49–105 ft) tall, with a trunk up to 1.5 m (4.9 ft) in diameter. Young trees show strong **apical dominance** with a straight trunk and symmetrical conical crown, becoming rounded to irregular on old trees. The bark is smooth purplish-brown with prominent horizontal grey-

brown lenticels on young trees, becoming thick dark blackish-brown and fissured on old trees. The leaves are alternate, simple ovoid-acute, 7–14 cm (2.8–5.5 in) long and 4–7 cm (1.6–2.8 in) broad, glabrous matt or sub-shiny green above, variably finely downy beneath, with a serrated margin and an acuminate tip, with a green or reddish petiole 2–3.5 cm (0.79–1.38 in) long bearing two to five small red glands. The tip of each serrated edge of the leaves also bear small red glands.*[14] In autumn, the leaves turn orange, pink or red before falling. The flowers are produced in early spring at the same time as the new leaves, borne in corymbs of two to six together, each flower pendent on a 2–5 cm (0.79–1.97 in) peduncle, 2.5–3.5 cm (0.98–1.38 in) in diameter, with five pure white petals, yellowish stamens, and a superior ovary; they are hermaphroditic, and pollinated by bees. The ovary contains two ovules, only one of which becomes the seed.*[15] The fruit is a drupe 1–2 cm (0.39–0.79 in) in diameter (larger in some cultivated selections), bright red to dark purple when mature in midsummer, edible, variably sweet to somewhat astringent and bitter to eat fresh. Each fruit contains a single hard-shelled stone 8–12 mm long, 7–10 mm wide and 6–8 mm thick, grooved along the flattest edge; the seed (kernel) inside the stone is 6–8 mm long.



Prunus avium in spring

The fruit are readily eaten by numerous kinds of birds and mammals, which digest the fruit flesh and disperse the seeds in their droppings. Some rodents, and a few

birds (notably the hawfinch), also crack open the stones to eat the kernel inside. All parts of the plant except for the ripe fruit are slightly toxic, containing cyanogenic glycosides.*[16]*[17]*[18]

See also: List of Lepidoptera that feed on *Prunus*

The leaves provide food for some animals, including Lepidoptera such as the case-bearer moth *Coleophora anatipennella*.

The tree exudes a gum from wounds in the bark, by which it seals the wounds to exclude insects and fungal infections.*[19]

33.3 Cultivation and uses

33.3.1 Fruit

Main article: [Cherry](#)

Some eighteenth- and nineteenth-century botanical au-



Pair of fruit growing from the same stem

thors assumed a western Asia origin for the species based on the writings of Pliny; however, archaeological finds of seeds from prehistoric Europe contradict this view. Wild cherries have been an item of human food for several thousands of years. The stones have been found in deposits at Bronze Age settlements throughout Europe, including in Britain.*[12] In one dated example, wild cherry macrofossils were found in a core sample from the detritus beneath a dwelling at an Early and Middle Bronze Age pile-dwelling site on and in the shore of a former lake at Desenzano del Garda or Lonato, near the southern shore of Lake Garda, Italy. The date is estimated at Early Bronze Age IA, carbon dated there to 2077 BCE plus or minus 10 years. The natural forest was largely cleared at that time.*[20]

By 800 BCE, cherries were being actively cultivated in Asia Minor, and soon after in Greece.*[12]

As the main ancestor of the cultivated cherry, the sweet cherry is one of the two cherry species which supply most of the world's commercial cultivars of edible cherry (the other is the sour cherry *Prunus cerasus*, mainly used for cooking; a few other species have had a very small input).*[12] Various cherry cultivars are now grown worldwide wherever the climate is suitable; the number of cultivars is now very large.*[12] The species has also escaped from cultivation and become naturalised in some temperate regions, including southwestern Canada, Japan, New Zealand, and the northeast and northwest of the United States.*[4]

33.3.2 Ornamental

It is often cultivated as a flowering tree. Because of the size of the tree, it is often used in parkland, and less often as a street or garden tree. The double-flowered form, 'Plena', is commonly found, rather than the wild single-flowered forms.*[21]

Two interspecific hybrids, *P. x schmittii* (*P. avium* x *P. canescens*) and *P. x fontenesiana* (*P. avium* x *P. mahaleb*) are also grown as ornamental trees.*[21]

33.3.3 Timber

The hard, reddish-brown wood (cherry wood) is valued as a hardwood for woodturning, and making cabinets and musical instruments.*[19] Cherry wood is also used for smoking foods, particularly meats, in North America, as it lends a distinct and pleasant flavor to the product.

33.3.4 Other uses

The gum from bark wounds is aromatic and can be chewed as a substitute for chewing gum.

Medicine can be prepared from the stalks (peduncles) of the drupes that is astringent, antitussive, and diuretic.*[13]

A green dye can also be prepared from the plant.*[13]

Wild cherry is used extensively in Europe for the afforestation of agricultural land and it is also valued for wildlife and amenity plantings. Many European countries have gene conservation and/or breeding programmes for wild cherry.*[22]

33.4 Contribution to other species

Prunus avium is thought to be one of the parent species of *Prunus cerasus* (sour cherry), by way of ancient crosses

between it and *Prunus fruticosa* (dwarf cherry) in the areas where the two species overlap. All three species can breed with one another. *Prunus cerasus* is now a species in its own right, having developed beyond a hybrid and stabilised.*[23]

33.5 Cultural history

Pliny distinguishes between *Prunus*, the plum fruit,*[24] and *Cerasus*, the cherry fruit.*[25] Already in Pliny quite a number of cultivars are cited, some possibly species or varieties, Aproniana, Lutatia, Caeciliana, and so on. Pliny grades them by flavour, including dulcis ("sweet") and acer ("sharp").*[26] and goes so far as to say that before the Roman consul Lucius Licinius Lucullus defeated Mithridates in 74 BC, *Cerasia* "...non fuere in Italia", "There were no cherry trees in Italy". According to him, Lucullus brought them in from Pontus and in the 120 years since that time they had spread across Europe to Britain.*[25]

Although cultivated/domesticated varieties of *Prunus avium* (sweet cherry) didn't exist in Britain or much of Europe, the tree in its wild state is native to most of Europe, including Britain. Evidence of consumption of the wild fruits has been found as far back as the Bronze Age at a Crannog in County Offaly, in Ireland.*[27]

Seeds of a number of cherry species have however been found in Bronze Age and Roman archaeological sites throughout Europe. The reference to "sweet" and "sour" supports the modern view that "sweet" was *Prunus avium*; there are no other candidates among the cherries found. In 1882 Alphonse de Candolle pointed out that seeds of *Prunus avium* were found in the Terramare culture of north Italy (1500–1100 BC) and over the layers of the Swiss pile dwellings.*[28] Of Pliny's statement he says (p. 210):

Since this error is perpetuated by its incessant repetition in classical schools, it must once more be said that cherry trees (at least the bird cherry) existed in Italy before Lucullus, and that the famous gourmet did not need to go far to seek the species with the sour or bitter fruit.

De Candolle suggests that what Lucullus brought back was a particular cultivar of *Prunus avium* from the Caucasus. The origin of cultivars of *P. avium* is still an open question. Modern cultivated cherries differ from wild ones in having larger fruit, 2–3 cm diameter. The trees are often grown on dwarfing rootstocks to keep them smaller for easier harvesting.*[29]

Folkard (1892) similarly identifies Lucullus's cherry as a cultivated variety. He states that it was planted in Britain a century after its introduction into Italy, but "disappeared during the Saxon period". He notes that in the fifteenth

century “Cherries on the ryse” (i.e. on the twigs) was one of the street cries of London, but conjectures that these were the fruit of “the native wild Cherry, or Gean-tree”. The cultivated variety was reintroduced into Britain by the fruiterer of Henry VIII, who brought it from Flanders and planted a cherry orchard at Teynham.*[30]

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33.7 External links

- Data related to *Prunus avium* at Wikispecies
- Media related to *Prunus avium* at Wikimedia Commons
- *Prunus avium* - distribution map, genetic conservation units and related resources. European Forest Genetic Resources Programme (EUFORGEN)

Chapter 34

Prunus serotina

“Black cherry” redirects here. For other uses, see Black Cherry (disambiguation).

Prunus serotina, commonly called **black cherry**, **wild black cherry**, **rum cherry**,^{*[3]} or **mountain black cherry**, is a deciduous^{*[4]} woody plant species belonging to the genus *Prunus*. The species is widespread and common in North America and South America.^{*[5]*[6]*[7]*[8]}



Immature fruit

Black cherry is closely related to the chokecherry (*Prunus virginiana*); chokecherry, however, is classified as a shrub or small tree and has smaller, less glossy leaves.

Subspecies and varieties^{*[2]*[5]}

- *Prunus serotina* var. *alabamensis* (C. Mohr) Little - southeastern United States



Closeup of mature bark

- *Prunus serotina* subsp. *capuli* (Cav. ex Spreng.) McVaugh – central + southern Mexico, Central America, South America as far south as Argentina
- *Prunus serotina* subsp. *eximia* (Small) McVaugh – Texas
- *Prunus serotina* subsp. *hirsuta* (Elliott) McVaugh – Georgia
- *Prunus serotina* var. *rufula* (Wooton & Standl.) McVaugh – southwestern United States, northern + central Mexico
- *Prunus serotina* subsp. *serotina* – Canada, United States, Mexico, Guatemala
- *Prunus serotina* var. *serotina* – Canada, United States, Mexico, Guatemala



Closeup of immature bark

- *Prunus serotina* subsp. *virens* (Wooton & Standl.) McVaugh

34.2 Ecology and cultivation

Prunus serotina is a pioneer species. In the Midwest, it is seen growing mostly in old fields with other sunlight-loving species, such as *black walnut*, *black locust*, and *hackberry*. Gleason and Cronquist (1991) describe *P. serotina* as "[f]ormerly a forest tree, now abundant as a weed-tree of roadsides, waste land, and forest-margins." * [11] It is a moderately long-lived tree, with ages of up to 258 years known, though it is prone to storm damage, with branches breaking easily; any decay resulting, however, only progresses slowly. Seed production begins around 10 years of age, but does not become heavy until 30 years and continues up to 100 years or more. Germination rates are high, and the seeds are widely dispersed by birds who eat the fruit and then excrete them. Some seeds however may remain in the *soil bank* and not germinate for as long as three years. All *Prunus* species have hard seeds that benefit from *scarification* to germinate (which in nature is produced by passing through an animal's digestive tract).



Autumn foliage

34.1 Description

Black cherry is a medium-sized, fast-growing forest tree growing to a height of 50-80 feet. Leaves are 2" to 5" in length, ovate-lanceolate in shape, with finely toothed margins. Fall leaf color is yellow to red. Flowers are small, white and 5-petaled, in racemes 4" to 6" long which contain several dozen flowers. The flowers give rise to edible reddish-black "berries" (drupes). * [4]

A mature black cherry tree can easily be identified in a forest by its very broken, dark grey to black bark, which has the appearance of very thick, burnt cornflakes. However, for about the first decade or so of its life, the bark is thin, smooth, and banded, resembling that of a *birch*. It can also quickly be identified by its long, shiny leaves resembling those of a *sourwood*, and by an almond-like odor released when a young twig is scratched and held close to the nose. * [9] * [10]

P. serotina is also a host of caterpillars of various Lepidoptera (see List of Lepidoptera which feed on *Prunus*). The *eastern tent caterpillar* defoliates entire groves some springs.

Prunus serotina was widely introduced into Western and Central Europe as an *ornamental tree** [12] in the mid 20th century,* [13]* [14] where it has become locally naturalized.* [12] It has acted as an *invasive species* there, negatively affecting forest community biodiversity and regeneration.* [15]

Prunus serotina subsp. *capuli* was cultivated in Central and South America well before European contact.* [16]

34.3 Biochemistry

Like *apricots* and *apples*, the seeds of black cherries contain compounds that can be converted into *cyanide*, such as *amygdalin*. * [17]* [18] These compounds release



Black knot infection

hydrogen cyanide when the seed is ground or minced, which releases enzymes that break down the compounds. These enzymes include amygdalin beta-glucosidase, prunasin beta-glucosidase and mandelonitrile lyase.*[19] In contrast, although the flesh of cherries also contains these compounds, it does not contain the enzymes needed to produce cyanide, so the flesh is safe to eat.*[20]

The foliage, particularly when wilted, contains cyanogenic glycosides, which convert to hydrogen cyanide if eaten by animals.*[21] Farmers are recommended to remove any trees that fall in a field containing livestock, because the wilted leaves could poison the animals. Removal is not always practical, though, because they often grow in very large numbers on farms, taking advantage of the light brought about by mowing and grazing. Entire fencerows can be lined with this poisonous tree, making it difficult to monitor all the branches falling into the grazing area. Black cherry is a leading cause of livestock illness, and grazing animals' access to it should be limited.

34.4 Uses

The fruit of *Prunus serotina* is suitable for making jam and cherry pies,*[22] and has some use in flavoring liqueurs; they are also a popular flavoring for sodas and ice creams. The black cherry is commonly used instead of sweet cherries (*Prunus avium*) to achieve a sharper taste. It is also used in cakes which include dark chocolate, such as a Black Forest gateau and as garnishes for cocktails.

The wood of *Prunus serotina* is also used for cooking and smoking foods, where it imparts a unique flavor.

Prunus serotina timber is valuable; perhaps the premier cabinetry timber of the U.S., traded as "cherry". It is known for its strong reddish color and high price. Its density when dried is around 580 kg/m³ (980 lb/cu yd).

Prunus serotina trees are sometimes planted ornamentals.

34.5 See also

- Cherry Grove, New York, named for *P. serotina*, which is indigenous to the area

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Chapter 35

Quercus alba

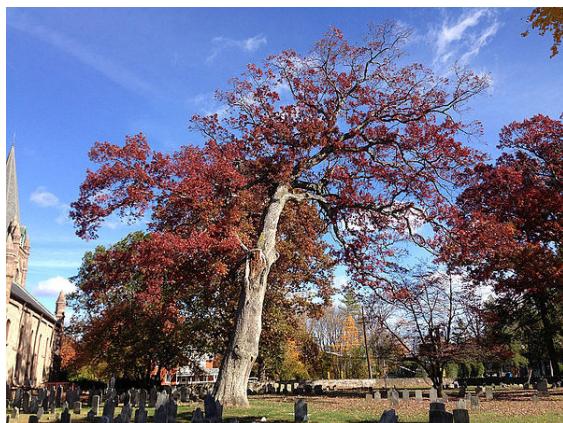
Quercus alba, the **white oak**, is one of the preeminent hardwoods of eastern and central North America. It is a long-lived oak, native to eastern and central North America and found from Minnesota, Ontario, Quebec, and Nova Scotia south as far as northern Florida and eastern Texas.^{*[3]} Specimens have been documented to be over 450 years old.^{*[4]}

Although called a white oak, it is very unusual to find an individual specimen with white bark; the usual color is a light gray. In the forest it can reach a magnificent height and in the open it develops into a massive broad-topped tree with large branches striking out at wide angles.^{*[5]}



Bark on a large trunk.

35.1 Description



Large white oak in a revolutionary war-era cemetery

Q. alba typically reaches heights of 80 to 100 feet (24–30 m) at maturity, and its canopy can become quite massive as its lower branches are apt to extend far out laterally, parallel to the ground. Trees growing in a forest will become much taller than ones in an open area which develop to be short and massive. The tallest known white oak is 144 feet (44 m) tall. It is not unusual for a white oak tree to be as wide as it is tall, but specimens growing at high altitudes may only become small shrubs.

White oak may live 200 to 300 years, with some even older specimens known. The Wye Oak in Wye Mills,

Maryland was estimated to be over 450 years old when it finally fell in a thunderstorm in 2002.^{*[6]}

Another noted white oak is the Great White Oak in Basking Ridge, New Jersey, estimated to be over 600 years old. The tree measures 25 feet (7.6 m) in circumference at the base and 16 feet (4.9 m) in circumference four feet (1.2 m) above the ground. The tree is 75 feet (23 m) tall, and its branches spread over 125 feet (38 m) from tip to tip.^{*[7]} The oak, claimed to be the oldest in the United States, began showing signs of poor health in the mid-2010s.^{*[8]} The tree was declared dead in 2016 and was planned to be taken down in 2017.^{*[9]}

Sexual maturity begins at around 20 years, but the tree does not produce large crops of acorns until its 50th year and the amount varies from year to year. Acorns deteriorate quickly after ripening, the germination rate being only 10% for six-month-old seeds. As the acorns are prime food for animals and insects, all may be lost in years of small crops.^{*[10]}

The bark is a light ash-gray and peels somewhat from the top, bottom and/or sides.^{*[11]}

In spring the young leaves are of a delicate, silvery pink and covered with a soft, blanket-like down. The petioles are short, and the leaves which cluster close to the ends of the shoots are pale green and downy with the result that the entire tree has a misty, frosty look. This condition



New foliage of *Quercus alba*



Fallen acorns from prolific tree

continues for several days, passing through the opalescent changes of soft pink, silvery white and finally yellow green.*[5]*[11]



White oak foliage

The leaves grow to be 5 to 8.5 inches (13–22 cm) long and 2.75 to 4.5 inches (7.0–11.4 cm) wide and have a deep glossy green upper surface. They usually turn red or brown in autumn, but depending on climate, site, and individual tree genetics, some trees are nearly always red, or even purple in autumn. Some brown, dead leaves may remain on the tree throughout winter until very early spring. The lobes can be shallow, extending less than halfway to the midrib, or deep and somewhat branching.

The acorns are usually sessile, and grow to 0.5 to 1 inch (13–25 mm) in length, falling in early October.

Quercus alba is sometimes confused with the swamp white oak, a closely related species, and the bur oak. The white oak hybridizes freely with the bur oak, the post oak, and the chestnut oak.*[5]



Autumn foliage

- Bark: Light gray, varying to dark gray and to white; shallow fissured and scaly. Branchlets at first bright green, later reddish-green and finally light gray. A distinguishing feature of this tree is that a little over halfway up the trunk the bark tends to form overlapping scales that are easily noticed and aid in identification.*[11]
- Wood: Light brown with paler sapwood; strong, tough, heavy, fine-grained and durable. Specific gravity, 0.7470; weight of one cubic foot, 46.35 lbs; weight of one cubic meter 770 kg.*[11]*[12]
- Winter buds: Reddish brown, obtuse, one-eighth of an inch long.*[11]
- Leaves: Alternate, five to nine inches long, three to four inches wide. Obovate or oblong, seven to nine-lobed, usually seven-lobed with rounded lobes and rounded sinuses; lobes destitute of bristles; sinuses sometimes deep, sometimes shallow. On young trees the leaves are often repand. They come out of the bud conduplicate, are bright red above, pale below, and covered with white tomentum; the red fades quickly and they become silvery greenish white and shiny; when full grown they are thin,



Hedgehog gall on white oak

bright yellow green, shiny or dull above, pale, glaucous or smooth below; the midrib is stout and yellow, primary veins are conspicuous. In late autumn the leaves turn a deep red and drop, or on young trees remain on the branches throughout the winter. Petioles are short, stout, grooved, and flattened. Stipules are linear and caducous.*[11]

- Flowers: appear in May, when leaves are one-third grown. Staminate flowers are borne in hairy aments two and a half to three inches long; the calyx is bright yellow, hairy, six to eight-lobed, with lobes shorter than the stamens; anthers are yellow. Pistillate flowers are borne on short peduncles; involucral scales are hairy, reddish; calyx lobes are acute; stigmas are bright red.*[11]
- Acorns: Annual, sessile or stalked; nut ovoid or oblong, round at the apex, light brown, shining, three-quarters to an inch long; cup-shaped, enclose about one-fourth of the nut, tomentose on the outside, tuberculate at base, scales with short obtuse tips becoming smaller and thinner toward the rim.*[5] White oak acorns (referring to *Q. alba* and all its close relatives) have no epigeal dormancy and germination begins readily without any treatment. In most cases, the oak root sprouts in the fall, with the leaves and stem appearing the next spring. The acorns take only one growing season to develop unlike the red oak group, which require two years for maturation.*[11]

35.2 Distribution

Q. alba is fairly tolerant of a variety of habitats, and may be found on ridges, in valleys, and in between, in dry and moist habitats, and in moderately acid and alkaline soils.

It is mainly a lowland tree, but reaches altitudes of 5,249 ft in the Appalachian Mountains. It is often a component of the forest canopy in an oak-heath forest.*[13]*[14]

35.3 Uses

35.3.1 Cultivation

Quercus alba is cultivated as an ornamental tree somewhat infrequently due to its slow growth and ultimately huge size. It is not tolerant of urban pollution and road salt and due to its large taproot, is unsuited for a street tree or parking strips/islands.

35.3.2 Woodcraft

White oak has **tyloses** that give the wood a closed cellular structure, making it water- and rot-resistant. Because of this characteristic, white oak is used by **coopers** to make wine and whiskey barrels as the wood resists leaking. It has also been used in construction, shipbuilding, agricultural implements, and in the interior finishing of houses.*[5]

It was a signature wood used in mission style oak furniture by **Gustav Stickley** in the Craftsman style of the **Arts and Crafts movement**.

White oak is used extensively in Japanese martial arts for some weapons, such as the **bokken** and **jo**. It is valued for its density, strength, resiliency and relatively low chance of splintering if broken by impact, relative to the substantially cheaper red oak.

USS Constitution is made of white oak and **southern live oak**, conferring additional resistance to cannon fire. Reconstructive wood replacement of white oak parts comes from a special grove of *Quercus alba* known as the "**Constitution Grove**" at **Naval Surface Warfare Center Crane Division**.*[15]

35.3.3 Wildlife food

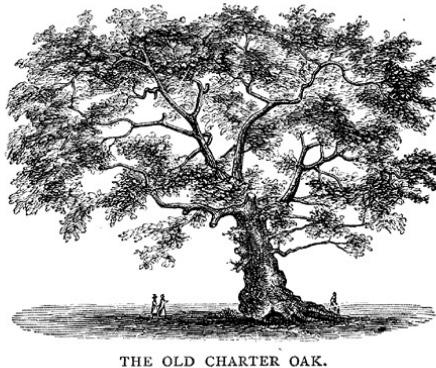
The acorns are much less bitter than the acorns of red oaks. They are small relative to most oaks, but are a valuable wildlife food, notably for turkeys, wood ducks, pheasants, grackles, jays, nuthatches, thrushes, woodpeckers, rabbits, squirrels, and deer. The white oak is the only known food plant of the *Bucculatrix luteella* and *Bucculatrix ochrisuffusa* caterpillars.

The young shoots of many eastern oak species are readily eaten by deer.*[16] Dried oak leaves are also occasionally eaten by white-tailed deer in the fall or winter.*[17] Rabbits often browse twigs and can girdle stems.*[16]

35.3.4 Oak barrels

Barrels made of American white oak are commonly used for oak aging of wine, in which the wood is noted for imparting strong flavors.* [18] Also, by federal regulation, bourbon whiskey must be aged in charred new oak (generally understood to mean specifically American white oak) barrels.* [19]

35.4 In culture



The Old Charter Oak

White oak has served as the official state tree of Illinois after selection by a vote of school children. There are two “official” white oaks serving as state trees, one located on the grounds of the governor’s mansion, and the other in a schoolyard in the town of Rochelle. The white oak is also the state tree of Connecticut and Maryland. The Wye Oak, probably the oldest living white oak until it fell because of a thunderstorm on June 6, 2002, was the honorary state tree of Maryland.

Being the subject of a legend as old as the colony itself, the Charter Oak of Hartford, Connecticut is one of the most famous white oaks in America. An image of the tree now adorns the reverse side of the Connecticut state quarter.

The white oak from the movie *The Shawshank Redemption*, known as the “Shawshank Tree” and the “Tree of Hope”, was estimated to be more than 200 years old when it fell. The tree is seen during the last ten minutes of the movie. As the movie gained fame, the tree became popular as well, and used to attract tens of thousands of movie fans and tourists every year. A portion of the tree came down on July 29, 2011, when the tree was split by lightning during a storm. The remaining half of the tree fell during heavy winds almost exactly five years later, on July 22, 2016.

35.5 Chemistry

Grandinin/roburin E, castalagin/vescalagin, gallic acid, monogalloyl glucose (glucogallin) and valoneic acid dilactone, monogalloyl glucose, digalloyl glucose, trigalloyl glucose, ellagic acid rhamnose, quercitrin and ellagic acid are phenolic compounds found in *Q. alba*.* [20]

35.6 See also

- Creek Council Oak Tree
- Linden Oak, possibly the largest living white oak in the United States
- Central and southern Appalachian montane oak forest

35.7 References

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- [10] Tirmenstein, D. A. (1991). "Quercus alba". Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service. Retrieved 2013-05-08.
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35.8 External links

35.8.1 Taxonomy

- "*Quercus alba* L.". *World Checklist of Selected Plant Families* (WCSP). Royal Botanic Gardens, Kew – via The Plant List.
- "*Quercus alba*". *Flora of North America* (FNA). Missouri Botanical Garden – via eFloras.org.
- "*Quercus alba* L.". *Germplasm Resources Information Network* (GRIN). Agricultural Research Service (ARS), United States Department of Agriculture (USDA).

35.8.2 Genetics

- "*Quercus alba*". *National Center for Biotechnology Information* (NCBI).
- "*Quercus alba* L.". *IPCN Chromosome Reports*. Missouri Botanical Garden. Retrieved 3 February 2016 – via Tropicos.org.

35.8.3 Distribution

- Distribution Map, *Quercus alba* at Flora of North America, eFloras.org.
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35.8.4 Media

- Vanderbilt University: *Quercus alba* images
- Tropicos.org. Missouri Botanical Garden: *Quercus alba* L. images

35.8.5 Further reading

- *Quercus alba* at the Encyclopedia of Life
- Chattooga Conservancy. The Ecology of the White Oak
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Chapter 36

Quercus falcata

Quercus falcata, commonly known as the **southern red oak** or **Spanish oak**, is a tree in the **red oak** section (*Lobatae*) of the genus *Quercus* native to the eastern and south-central United States.

36.1 Range

Quercus falcata occurs on dry or sandy upland sites from southern New York (Long Island) south to central Florida and west to Missouri, Oklahoma, and Texas.*[3] In the northeastern portion of its range the species is relatively rare and found almost exclusively along the coast; its highest prevalence is throughout the **piedmont** region of the Southeast.*[4]

36.2 Description

Quercus falcata is a medium to large-sized deciduous tree reaching 25–30 meters (82–98 ft) tall, rarely 35–38 meters (115–125 ft) (forest grown specimens on highly productive sites), with a trunk up to 1.5 meters (59 inches) or 5 feet) in diameter, the crown with a broad, round-topped head.

The leaves are 10–30 cm (4–12 in) long and 6–16 cm (2.5–6.5 in) wide, with 3 to 5 sharply pointed, often curved, bristle-tipped lobes, the central lobe long and narrow; the small number of long, narrow lobes is diagnostic, readily distinguishing Southern Red Oak from other red oaks. The base of the leaf is distinctly rounded into an inverted bell shape and often lopsided. They are dark green and shiny above, and rusty and hairy below, particularly along the midrib and veins.

The seed is a short acorn 9–16 mm long, bright orange-brown, enclosed for one-third to half of its length in a flat cup. The acorn matures at the end of its second season. The bark is dark brownish gray with narrow, shallow ridges.*[5]

Southern red oak has been reported to form occasional hybrids with several other red oaks in the region.

36.3 References

- [1] "Quercus falcata". *NatureServe Explorer*. NatureServe. Retrieved 2007-07-07.
- [2] The Plant List, *Quercus falcata* Michx.
- [3] Biota of North America Program 2014 county distribution map
- [4] Belanger, Roger P.; Krinard, R. M. (1990). "Quercus falcata". In Burns, Russell M.; Honkala, Barbara H. *Hardwoods. Silvics of North America*. Washington, D.C.: United States Forest Service (USFS), United States Department of Agriculture (USDA). 2. Retrieved July 5, 2011 – via Northeastern Area State and Private Forestry (www.na.fs.fed.us).
- [5] Flora of North America: *Quercus falcata*

36.4 External links

Media related to *Quercus falcata* at Wikimedia Commons

- United States Department of Agriculture Plants Profile: *Quercus falcata*
- United States Department of Agriculture National Forest Service Silvic Manual: *Quercus falcata*
- *Quercus falcata* images from Vanderbilt University
- Interactive Distribution Map of *Quercus falcata*
- photo of herbarium specimen at Missouri Botanical Garden, collected in Missouri in 1948

Chapter 37

Quercus michauxii

Quercus michauxii, the **swamp chestnut oak**, is a species of oak in the white oak section *Quercus* section *Quercus* in the beech family. It is native to bottomlands and wetlands in the eastern and central United States, in coastal states from New Jersey to Texas, inland primarily in the Mississippi/Ohio Valley as far as Oklahoma, Missouri, Illinois, and Indiana.*[2]

37.1 Classification and nomenclature

The swamp chestnut oak closely resembles the **chestnut oak** *Quercus prinus*, and for that reason has sometimes been treated as a variety of that species. However, the swamp chestnut oak is a larger tree which differs in preferred habitat, and the **bark** does not have the distinctive deep, rugged ridging of the chestnut oak, being thinner, scaly, and paler gray. It typically grows to around 65 feet (20 meters) tall, though the tallest specimen currently known is over 150 feet (42 meters) tall.

The name *Q. prinus* was long used by many botanists and foresters for the swamp chestnut oak, even when treated as a species distinct from the chestnut oak, which was then called *Q. montana*, but the application of the name *Q. prinus* to the chestnut oak is now often accepted,*[3] although sometimes that name is declared to be of uncertain position, unassignable to either species, with the chestnut oak then called *Q. montana*, as in the *Flora of North America**[4]

37.2 Description

The leaves of the swamp chestnut oak are simple (not compound), 4-11 in (10–28 cm) long and 2-7 in (5–18 cm) broad, with 15-20 lobe-like, rounded simple teeth on each side, similar to those of chestnut oak and chinkapin oak (*Quercus muehlenbergii*), although they generally do not achieve the more slender form that the leaves of those trees may exhibit at times. The **fruit** is an acorn 1-1½ in (2.5-3.5 cm) long and ¾–1 in (2-2.5) cm broad, borne on a ¾–1¼ in (2-3 cm) peduncle, maturing in the fall,

about 6 months after pollination.*[5]

37.3 Uses

The **wood** of the swamp chestnut oak is similar to, and usually marketed mixed with, that of other white oaks. Swamp chestnut oak is also called basket oak, since the wood is easily split into long, thin, flexible strips excellent for basket weaving.*[6] The swamp chestnut oak's acorns are large and relatively sweet.*[7] They are readily eaten by **livestock**,*[7] and the species is sometimes called the “cow oak” for this reason. However, swamp chestnut oaks bear heavy crops of acorns only at intervals of several years.*[7] Acorns in general are potentially fatal if eaten by horses.

The swamp chestnut oak is sometimes cultivated as a large garden tree or street tree, and is quite easy to grow if it is not subject to extreme urban conditions.

37.4 References

- [1] The Plant List, *Quercus michauxii* Nutt.
- [2] Biota of North America Program 2014 county distribution map
- [3] The confusion arose from differing identifications of the type specimens for the Linnaean name, by some (but not all) botanists considered resolved by close examination of the leaf pubescence, which differs in the two species.
- [4] Flora of North America, *Quercus montana* Willdenow, 1805. Mountain chestnut oak, rock chestnut oak
- [5] Flora of North America, *Quercus michauxii* Nuttall, 1818. Basket oak, cow oak, swamp chestnut oak
- [6] Missouri Department of Conservation, Field Guide, Swamp Chestnut Oak
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37.5 External links

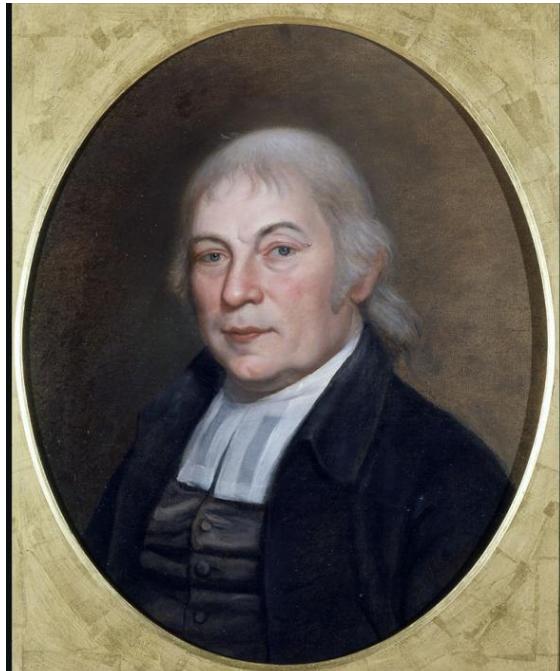
- *Quercus michauxii* images from Vanderbilt University

Chapter 38

Quercus muehlenbergii

Quercus muehlenbergii, the **chinkapin oak** (or **chin-quapin oak**), is an oak in the **white oak** group (*Quercus* sect. *Quercus*). The species was often called *Quercus acuminata* in older literature. *Quercus muehlenbergii*, (its specific epithet often misspelt *muhlenbergii*) is native to eastern and central North America, ranging from Vermont west to Wisconsin and south to South Carolina, western Florida, New Mexico, and northeastern Mexico from Coahuila south to Hidalgo.* [4]

38.1 Classification and nomenclature



Gotthilf Heinrich Ernst Muhlenberg, for whom *Quercus muehlenbergii* was named (portrait by Charles Willson Peale, 1810)

Since its recognition as a different species from the similar-appearing chestnut oak (*Quercus prinus*), *Q. muehlenbergii* has generally been regarded as a distinct

species; no subspecies or varieties are currently recognized within it, although a few infraspecific variants had been accepted in the past.

The tree's scientific name honors Gotthilf Heinrich Ernst Muhlenberg (1753–1815), a Lutheran pastor and amateur botanist in Pennsylvania. In publishing the name *Quercus mühlenbergii*, German-American botanist George Engelmann mistakenly used an umlaut in spelling Muhlenberg's name, even though Pennsylvania-born Muhlenberg himself did not use an umlaut in his name. Under the modern rules of botanical nomenclature, umlauts are transliterated, with "ü" becoming "ue", hence Engelmann's *Quercus mühlenbergii* is now presented as *Quercus muehlenbergii*. In lack of evidence that Engelmann's use of the umlaut was an unintended error, and hence correctable, the *muehlenbergii* spelling is considered correct, although the more appropriate orthographic variant *Quercus muhlenbergii* is often seen.* [5]

The low-growing, cloning *Q. prinoides* (dwarf chinkapin oak) is similar to *Q. muehlenbergii* and has been confused with it in the past, but is now generally accepted as a distinct species.* [6] If the two are considered to be conspecific, the earlier-published name *Quercus prinoides* has priority over *Q. muehlenbergii*, and the larger chinkapin oak can then be classified as *Quercus prinoides* var. *acuminata*, with the dwarf chinkapin oak being *Quercus prinoides* var. *prinoides*. *Q. prinoides* was named and described by the German botanist Karl (Carl) Ludwig Willdenow in 1801, in a German journal article by Muhlenberg.* [3]

38.2 Description

Key characteristics of *Quercus muehlenbergii* (chinkapin oak):* [7]

- The leaf base is typically more rounded.* [3]
- The veins and sinuses are regular.* [3]
- Acorns with no stalks or with short stalks less than 8 mm long. The acorns turn chestnut brown in the fall.* [3]

- The leaves have sharp teeth but no bristles, as a member of the white oak subgenus of *Quercus*.^{*} [3]

Chinkapin oak is monoecious in flowering habit; flowers emerge in April to late May or early June. The staminate flowers are borne in catkins that develop from the leaf axils of the previous year, and the pistillate flowers develop from the axils of the current year's leaves. The fruit, an acorn or nut, is borne singly or in pairs, matures in 1 year, and ripens in September or October. About half of the acorn is enclosed in a thin cup and is chestnut brown to nearly black.^{*} [3]

Chinkapin oak is closely related to the smaller but generally similar dwarf chinkapin oak (*Quercus prinoides*). Chinkapin oak is usually a tree, but occasionally shrubby, while dwarf chinkapin oak is a low-growing, clone-forming shrub. The two species generally occur in different habitats: chinquapin oak is typically found on calcareous soils and rocky slopes, while dwarf chinkapin oak is usually found on acidic substrates, primarily sand or sandy soils, and also dry shales.^{*} [3]^{*} [6]

Chinkapin oak is also sometimes confused with the related chestnut oak (*Quercus montana*), which it closely resembles. However, unlike the pointed teeth on the leaves of the chinkapin oak, chestnut oak leaves generally have rounded teeth. The two species have contrasting kinds of bark: Chinkapin oak has a gray, flaky bark very similar to that of white oak (*Q. alba*) but with a more yellow-brown cast to it (hence the occasional name yellow oak for this species), while chestnut oak has dark, solid, deeply ridged bark. The chinkapin oak also has smaller acorns than the chestnut oak or another similar species, the swamp chestnut oak (*Q. michauxii*), which have some of the largest acorns of any oaks.^{*} [3]

38.3 Ecology

38.3.1 Soil and topography

Chinkapin oak is generally found on well-drained upland soils derived from limestone or where limestone outcrops occur. Occasionally it is found on well-drained limestone soils along streams. The Chinkapin oak is generally found on soils that are weakly acid (pH about 6.5) to alkaline (above pH 7.0). It grows on both northerly and southerly aspects but is more common on the warmer southerly aspects. It is absent or rare at high elevations in the Appalachians.

38.3.2 Associated cover

It is rarely a predominant tree, but it grows in association with many other species. It is a component of the forest cover type White Oak-Black Oak-Northern Red Oak

(Society of American Foresters Type 52) and the Post Oak-Blackjack Oak (Type 40) (2).

It grows in association with white oak (*Quercus alba*), black oak (*Q. velutina*), northern red oak (*Q. rubra*), scarlet oak (*Q. coccinea*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), hickories (*Carya* spp.), black cherry (*Prunus serotina*), cucumber tree (*Magnolia acuminata*), white ash (*Fraxinus americana*), American basswood (*Tilia americana*), black walnut (*Juglans nigra*), butternut (*J. cinerea*), and yellow-poplar (*Liriodendron tulipifera*). American beech (*Fagus grandifolia*), shortleaf pine (*Pinus echinata*), pitch pine (*P. rigida*), Virginia pine (*P. virginiana*), Ozark chinkapin (*Castanea ozarkensis*), eastern redcedar (*Juniperus virginiana*), bluejack oak (*Quercus incana*), southern red oak (*Q. falcata*), blackgum (*Nyssa sylvatica*), and winged elm (*Ulmus alata*) also grow in association with chinkapin oak. In the Missouri Ozarks a redcedar-chinkapin oak association has been described.

The most common small tree and shrub species found in association with chinkapin oak include flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), sourwood (*Oxydendron arboreum*), eastern hop hornbeam (*Ostrya virginiana*), *Vaccinium* spp., *Viburnum* spp., hawthorns (*Crataegus* spp.), and sumacs (*Rhus* spp.). The most common woody vines are wild grape (*Vitis* spp.) and greenbrier (*Smilax* spp.).

38.3.3 Reaction to competition

Chinkapin oak is classed as intolerant of shade. It withstands moderate shading when young but becomes more intolerant of shade with age. It is regarded as a climax species on dry, drought prone soils, especially those of limestone origin. On more moist sites it is subclimax to climax. It is often found as a component of the climax vegetation in stands on mesic sites with limestone soils. However, many oak-hickory stands on moist sites that contain chinkapin oak are succeeded by a climax forest including beech, maple, and ash.

38.4 Diseases and pests

Severe wildfire kills chinkapin oak saplings and small pole-size trees, but these often resprout. However, fire scars serve as entry points for decay-causing fungi, and the resulting decay can cause serious losses.

Oak wilt (*Ceratostomella fagacearum*), a vascular disease, attacks Chinkapin oak and usually kills the tree within two to four years. Other diseases that attack Chinkapin oak include the cankers *Strumella coryneoidea* and *Nectria galligena*, shoestring root rot (*Armillaria mellea*), anthracnose (*Gnomonia veneta*), and leaf blister (*Taphrina* spp.).

The most serious defoliating insects that attack Chinkapin oak are the gypsy moth (*Lymantria dispar*), the orangestriped oakworm (*Anisota senatoria*), and the variable oakleaf caterpillar (*Heterocampa manteo*). Insects that bore into the bole and seriously degrade the products cut from infested trees include the carpenterworm (*Prionoxystus robiniae*), little carpenterworm (*P. macmurtrei*), white oak borer (*Goes tigrinus*), Columbian timber beetle (*Corthylus columbianus*), oak timberworm (*Archonodes minutus*), and twolined chestnut borer (*Agrilus bilineatus*). The acorn weevils (*Curculio* spp.), larvae of moths (*Valentinia glandulella* and *Melissopus latiferreanus*), and gall forming cynipids (*Callirhytis* spp.) feed on the acorns.

38.5 Uses

Like that of other white oak species, the wood of the chinkapin oak (*Quercus muehlenbergii*) is a durable hardwood prized for many types of construction.

The chinquapin oak is especially known for its sweet and palatable acorns. Indeed, the nuts contained inside of the thin shell are among the sweetest of any oak, with an excellent taste even when eaten raw, providing an excellent source of food for both wildlife and people. The acorns are eaten by squirrels, mice, voles, chipmunks, deer, turkey, and other birds.*[8]*[9]

38.6 References

- [1] "*Quercus muehlenbergii*". *Tropicos*. Missouri Botanical Garden.
- [2] The Plant List, *Quercus muehlenbergii* Engelm.
- [3] "*Quercus muehlenbergii*". *Flora of North America (FNA)*. Missouri Botanical Garden – via eFloras.org.
- [4] "*Quercus muehlenbergii*". *County-level distribution map from the North American Plant Atlas (NAPA)*. Biota of North America Program (BONAP). 2013.
- [5] “*Quercus muehlenbergii*” . *NatureServe Explorer*. NatureServe. Retrieved 7 October 2011.
- [6] "*Quercus prinoides*". *Flora of North America (FNA)*. Missouri Botanical Garden. Retrieved 8 October 2011 – via eFloras.org.
- [7] Barnes, B. V. & Wagner Jr., W. H. (2008). *Michigan Trees* University of Michigan Press
- [8] The Boerne Chapter of NPSOT (Native Plant Society of Texas), Chinquapin Oak – a NICE! good looking shade tree/
- [9] Sander, Ivan L. (1990). "*Quercus muehlenbergii*". In Burns, Russell M.; Honkala, Barbara H. *Hardwoods. Silvics of North America*. Washington, D.C.: United

States Forest Service (USFS), United States Department of Agriculture (USDA). 2 – via Northeastern Area State and Private Forestry (www.na.fs.fed.us).

38.7 External links

- Flora of North America: *Quercus muehlenbergii* RangeMap:
- *Quercus muehlenbergii* images from Vanderbilt University

Chapter 39

Quercus montana

“Chestnut oak” redirects here. For swamp chestnut oak, see *Quercus michauxii*.

Quercus montana, the **chestnut oak**, is a species of **oak** in the **white oak group**, *Quercus* sect. *Quercus*. It is native to the **eastern United States**, where it is one of the most important ridgeline trees from southern Maine southwest to central Mississippi, with an outlying northwestern population in southern Michigan. It is also sometimes called “rock oak” because of its presence in **montane** and other rocky habitats. As a consequence of its dry habitat and ridgeline exposure, it is not usually a large tree, typically 18–22 m (59–72 ft) tall; occasional specimens growing in better conditions can however become large, with trees up to 40–43 m (131–141 ft) tall known. They tend to have a similar spread of 18–22 m (59–72 ft). A 10-year-old sapling grown in full sun will stand about 5 m (16 ft) tall. This species is often an important canopy species in an oak-heath forest.*[3]*[4]

39.1 Taxonomy and nomenclature

Extensive confusion between the chestnut oak (*Quercus montana*) and the swamp chestnut oak (*Quercus michauxii*) has occurred, and some botanists have considered them to be the same species in the past.

The name *Quercus prinus* was long used by many botanists and foresters for either the chestnut oak or the swamp chestnut oak, with the former otherwise called *Q. montana* or the latter otherwise called *Q. michauxii*. The application of the name *Q. montana* to the chestnut oak is now accepted, since *Q. prinus* is of uncertain position, unassignable to either species.*[5]*[6]*[7]*[8]

39.2 Description

The chestnut oak is readily identified by its massively-ridged dark gray-brown **bark**, the thickest of any eastern North American oak. The **leaves** are 12–20 cm (4 $\frac{3}{4}$ –7 $\frac{3}{4}$ in) long and 6–10 cm (2 $\frac{1}{4}$ –4 in) broad, shallowly lobed with 10–15 rounded lobes on each margin;



Leaf cluster of a chestnut oak

they are virtually identical to the leaves of **swamp chestnut oak** and **chinkapin oak**, but the trees can readily be distinguished by the bark, that of the chinkapin oak being a light ash-gray and somewhat peeling like that of the **white oak** and that of swamp chestnut oak being paler ash-gray and scaly. The chinkapin oak also has much smaller acorns than the chestnut oak. The chestnut oak is easily distinguished from the **swamp white oak** because that tree has whitened undersides on the leaves. Another important distinction between the chestnut oak and the swamp chestnut oak is by the habitat; if it grows on a ridge, it is chestnut oak, and if it grows in wet bottomlands, it is probably the more massive swamp chestnut oak; however, this is not fully reliable.

Characteristics of the chestnut oak include:*[9]

- Bark: Dark, fissured into broad ridges, scaly. Branchlets stout, at first bronze green, later they be-



The distinctive bark of the chestnut oak

come reddish brown, finally dark gray or brown. Heavily charged with tannic acid.

- Wood: Dark brown, sapwood lighter; heavy, hard, strong, tough, close-grained, durable in contact with the soil. Used for fencing, fuel, and railway ties. Sp. gr., 0.7499; weight of cu. ft., 46.73 lbs.
- Winter buds: Light chestnut brown, ovate, acute, one-fourth to one-half of an inch long.
- Leaves: Alternate, 5 to 9 in (13 to 23 cm) long, 3 to 4 ½ in (8 to 11 cm) wide, obovate to oblong-lanceolate, wedge-shaped or rounded at base, coarsely crenately toothed, teeth rounded or acute, apex rounded or acute. They come out of the bud convolute, yellow green or bronze, shining above, very pubescent below. When full grown are thick, firm, dark yellow green, somewhat shining above, pale green and pubescent below; midribs stout, yellow, primary veins conspicuous. In autumn they turn a dull yellow soon changing to a yellow brown. Petioles stout or slender, short. Stipules linear to lanceolate, caducous.
- Flowers: May, when leaves are one-third grown. Staminate flowers are borne in hairy catkins (aments) two to three inches long; calyx pale yellow, hairy, deeply seven to nine-lobed; stamens 7 to 9; anthers bright yellow. Pistillate flowers in short spikes; peduncles green, stout, hairy; involucral scales hairy; stigmas short, bright red.

- Acorns: Annual, singly or in pairs; nut oval, rounded or acute at apex, bright chestnut brown, shining, one and a quarter to one and one-half inches in length; cup, cup-shaped or turbinate, usually enclosing one-half or one-third of the nut, thin, light brown and downy within, reddish brown and rough outside, tuberculate near the base. Scales small, much crowded toward the rim sometimes making a fringe. Kernel white, sweetish.

The acorns of the chestnut oak are 1.5–3 cm (1½–1 ¼ in) long and 1–2 cm (3/8–3/4 in) broad,^{*} [5] among the largest of native American oaks, surpassed in size only by the bur oak and possibly swamp chestnut oak.

39.3 Ecology



Chestnut oak sometimes grow on rocks

This species is a predominant ridge-top tree in eastern North American hardwood forests. It often grows with multiple trunks, often as a result of logging or prior injury to the main stem. It is a long-lived tree, with high-quality timber when well-formed. The acorns of the chestnut oak are a valuable wildlife food.

39.4 Uses

Chestnut oak trees are generally not the best timber trees because they are usually branched low and not very straight, but when they grow in better conditions, they are valuable for timber, which is marketed as 'mixed white oak'.

39.5 Notes

[1] "*Quercus montana*". *Tropicos*. Missouri Botanical Garden.

- [2] “*Quercus montana*” . *Germplasm Resources Information Network (GRIN)*. Agricultural Research Service (ARS), United States Department of Agriculture (USDA).
- [3] *The Natural Communities of Virginia Classification of Ecological Community Groups* (Version 2.3), Virginia Department of Conservation and Recreation, 2010 Archived January 5, 2011, at the Wayback Machine.
- [4] Schafale, M. P. and A. S. Weakley. 1990. *Classification of the natural communities of North Carolina: third approximation*. North Carolina Natural Heritage Program, North Carolina Division of Parks and Recreation.
- [5] "Quercus montana". *Flora of North America (FNA)*. Missouri Botanical Garden – via eFloras.org.
- [6] "Quercus prinus L." . Integrated Taxonomic Information System.
- [7] "Quercus montana Willd." . Integrated Taxonomic Information System.
- [8] The confusion arose from differing identifications of the type specimens for the Linnaean name, by some (but not all) botanists considered resolved by close examination of the leaf pubescence, which differs in the two species.
- [9] Keeler, Harriet L. (1900). *Our Native Trees and How to Identify Them*. New York: Charles Scriber's Sons. pp. 338–344.

39.6 Additional references

- USDA Plants Profile: *Quercus montana Willd*

39.7 External links

- Media related to *Quercus montana* (category) at Wikimedia Commons
- Data related to *Quercus montana* at Wikispecies

Chapter 40

Quercus rubra

Not to be confused with Quercus robur.

Quercus rubra, commonly called **northern red oak**, or **champion oak**, (syn. *Quercus borealis*), is an **oak** in the **red oak** group (*Quercus* section *Lobatae*). It is a native of North America, in the eastern and central United States and southeast and south-central Canada. It grows from the north end of the Great Lakes, east to Nova Scotia, south as far as Georgia, Alabama, and Louisiana, and west to Oklahoma, Kansas, Nebraska, and Minnesota.* [2] It has been introduced to small areas in Western Europe, where it can frequently be seen cultivated in gardens and parks. It prefers good soil that is slightly acidic. Often simply called **red oak**, northern red oak is so named to distinguish it from **southern red oak** (*Q. falcata*), also known as the Spanish oak. It is also the state tree of New Jersey and the provincial tree of Prince Edward Island.

40.1 Description

In many forests, this deciduous tree grows straight and tall, to 28 m (92 ft), exceptionally to 43 m (141 ft) tall, with a trunk of up to 50–100 cm (20–39 in) diameter. Open-grown trees do not get as tall, but can develop a stouter trunk, up to 2 m (6.6 ft) in diameter. It has stout branches growing at right angles to the stem, forming a narrow round-topped head. It grows rapidly and is tolerant of many soils and varied situations, although it prefers the glacial drift and well-drained borders of streams.* [3] It is frequently a part of the canopy in an oak-heath forest, but generally not as important as some other oaks.* [4]*[5]*[6]

Under optimal conditions and full sun, northern red oak is fast growing and a 10-year-old tree can be 5–6 m (16–20 ft) tall.* [7] Trees may live up to 500 years according to the **USDA**,* [8] and a living example of 326 years was noted in 2001 by Orwig et al.* [6]*[9]

Northern red oak is easy to recognize by its bark, which feature bark ridges that appear to have shiny stripes down the center. A few other oaks have bark with this kind of appearance in the upper tree, but the northern red oak



Wood of the Red Oak. From Romeyn Beck Hough's fourteen-volume work *The American Woods*, a collection of over 1000 paper-thin wood samples representing more than 350 varieties of North American tree.

is the only tree with the striping all the way down the trunk.* [6]

- Bark: Dark reddish grey brown, with broad, thin, rounded ridges, scaly. On young trees and large stems, smooth and light gray. Rich in tannic acid. Branchlets slender, at first bright green, shining, then dark red, finally dark brown. Bark is brownish gray, becoming dark brown on old trees.
- Wood: Pale reddish brown, sapwood darker, heavy, hard, strong, coarse-grained. Cracks in drying, but when carefully treated could be successfully used for

furniture. Also used in construction and for interior finish of houses. Sp. gr., 0.6621; weight of cu. ft., 41.25 lbs.

- Winter buds: Dark chestnut brown (reddish brown), ovate, acute, generally 6 mm long* [6]
- Leaves: Alternate, seven to nine-lobed, oblong-ovate to oblong, five to ten inches long, four to six inches broad; seven to eleven lobes tapering gradually from broad bases, acute, and usually repandly dentate and terminating with long bristle-pointed teeth; the second pair of lobes from apex are largest; midrib and primary veins conspicuous. Lobes are less deeply cut than most other oaks of the red oak group (except for black oak which can be similar). Leaves emerge from the bud convolute, pink, covered with soft silky down above, coated with thick white tomentum below. When full grown are dark green and smooth, sometimes shining above, yellow green, smooth or hairy on the axils of the veins below. In autumn they turn a rich red, sometimes brown. Often the petiole and midvein are a rich red color in midsummer and early autumn, though this is not true of all red oaks. The acorns mature in about 18 months after pollination; solitary or in pairs, sessile or stalked; nut oblong-ovoid with broad flat base, full, with acute apex, one half to one and one-fourth of an inch long, first green, maturing nut-brown; cup, saucer-shaped and shallow, 2 cm (0.79 in) wide, usually covering only the base, sometimes one-fourth of the nut, thick, shallow, reddish brown, somewhat downy within, covered with thin imbricated reddish brown scales. Its kernel is white and very bitter.* [3] Despite this bitterness, they are eaten by deer, squirrels and birds.* [6]

Red oak acorns, unlike the white oak group, display epigeal dormancy and will not germinate without a minimum of three months' exposure to sub-40 °F (4 °C) temperatures. They also take two years of growing on the tree before development is completed.* [6]

40.2 Uses

The northern red oak is one of the most important oaks for timber production in North America. Quality red oak is of high value as lumber and veneer, while defective logs are used as firewood. Other related oaks are also cut and marketed as red oak, although their wood is not always of as high a quality. These include eastern black oak, scarlet oak, pin oak, Shumard oak, southern red oak and other species in the red oak group. Construction uses include flooring, veneer, interior trim, and furniture. It is also used for lumber, railroad ties, and fence posts.

Red oak wood grain is so open that smoke can be blown through it from end-grain to end-grain on a flat-sawn



Red oak in Appalachian mountains

board. For this reason, it is subject to moisture infiltration and is unsuitable for outdoor uses such as boatbuilding or exterior trim.

40.2.1 Ornamental use

Quercus rubra is grown in parks and large gardens as a specimen tree.* [10] It is not planted as often as the closely related Pin Oak as it develops a taproot and quickly becomes difficult to transplant. Acorns should either be sown in the location where the tree is intended to be planted or else moved to their permanent location within the seedling's first year. As the tree gets older, the taproot gradually becomes less dominant and the lateral root network expands. Northern Red Oak is easy to start from seed, however the acorns must be protected from animal predation over the winter months.

As with other oaks, germination takes place in late spring when all frost danger has passed. The seedling grows rapidly for its first month, then pauses for another month, and sends out more new shoots until September when growth stops for the year. If the weather stays favorable, a third burst of growth may occur.

This oak is grown across Canada almost everywhere it will grow. It has naturalized in southeastern British Columbia near the Alberta border.

40.3 Famous specimens

- Ashford Oak – A very large Northern Red Oak in Ashford, Connecticut. The tree has suffered falling limbs because of its great age. However, this tree is still a sight to behold; the trunk is 8 m (26 ft) in circumference and the root-knees are also particularly impressive. The oak is located on Giant Oak Lane off U.S. Highway 44. There are several other large oaks in the area.* [11]
- Chase Creek Red Oak – This forest tree is located

on a very rich steep slope in Anne Arundel County, Maryland. It is a high-stump coppice with three leads. It was the state champion oak in Maryland in 2002. The circumference at breast height is 6.7 m (22 ft), the height 41.5 m (136 ft) and the spread 29.9 m (98 ft)*[11]

- **Shera-Blair Red Oak** – This majestic red oak tree is located on Shelby Street in the South Frankfort neighborhood in Franklin County, Kentucky, and is the largest red oak tree in the oldest neighborhood in Frankfort, Kentucky. It is in the backyard of a house built in 1914 by architect Arthur Raymond Smith, who at one time worked for D.X. Murphy & Bros., famed architects that designed the twin spires at Churchill Downs. The circumference at breast height is 6.4 m (21 ft), with the trunk reaching higher than 40 feet before the branches begin and an estimated height of 130 feet.

- [11] Rucker, Colby B. (February 2004), *Great Eastern Trees, Past and Present*, retrieved 2007-05-05

40.6 External links

- *Quercus rubra* images from Vanderbilt University
- photo of herbarium specimen at Missouri Botanical Garden, collected in Missouri in 1992
- *Quercus rubra* - information, genetic conservation units and related resources. European Forest Genetic Resources Programme (EUFORGEN)

40.4 See also

- Central and southern Appalachian montane oak forest

40.5 References

- [1] NatureServe (2006), “*Quercus rubra*”, *NatureServe Explorer: An online encyclopedia of life*, Version 6.1., Arlington, retrieved 2007-06-13 |first2= missing |last2= in Authors list (help)
- [2] “*Quercus rubra*”. *County-level distribution map from the North American Plant Atlas (NAPA)*. Biota of North America Program (BONAP). 2013.
- [3] Keeler, Harriet L. (1900). *Our Native Trees and How to Identify Them*. New Roak: Charles Scriber's Sons. pp. 349–354.
- [4] *The Natural Communities of Virginia Classification of Ecological Community Groups* (Version 2.3), Virginia Department of Conservation and Recreation, 2010 Archived January 5, 2011, at the Wayback Machine.
- [5] Schafale, M. P. and A. S. Weakley. 1990. *Classification of the natural communities of North Carolina: third approximation*. North Carolina Natural Heritage Program, North Carolina Division of Parks and Recreation.
- [6] Flora of North America: *Quercus rubra*
- [7] Arbor Day Foundation, Northern Red Oak
- [8] United States Department of Agriculture Plant Guide
- [9] Lamont-Doherty Earth Observatory and Columbia University, Eastern US oldlist
- [10] “RHS Plant Selector – *Quercus rubra*”. Retrieved 27 June 2013.

Chapter 41

Quercus velutina

Quercus velutina, the **eastern black oak** or more commonly known as simply **black oak**, is a species in the **red oak** (*Quercus* sect. *Lobatae*) group of oaks. It is widespread in eastern and central North America, found in all the coastal states from Maine to Texas, inland as far as Ontario, Minnesota, Nebraska, Kansas, Oklahoma, and eastern Texas.* [2]

Quercus velutina was previously known as yellow oak due to the yellow pigment in its inner bark, however nowadays this name is usually reserved for Chinkapin oak.* [3] It is a close relative of the western black oak (*Quercus kelloggii*) found in western North America.



41.1 Description

In the northern part of its range, black oak is a relatively small tree, reaching a height of 20–25 m (66–82 ft) and a diameter of 90 cm (35 in), but it grows larger in the south and center of its range, where heights of up to 42 m (138 ft) are known. Black oak is well known to readily hybridize with other members of the red oak (*Quercus* sect. *Lobatae*) group of oaks being one parent in at least a dozen different named hybrids.* [4]



Detail of mature bark

The **leaves** of the black oak are alternately arranged on the twig and are 10–20 cm (3.9–7.9 in) long with 5–7 bristle tipped lobes separated by deep U-shaped notches. The upper surface of the leaf is a shiny deep green, the



Young leaves are densely pubescent.

lower is yellowish-brown. There are also stellate hairs on the underside of the leaf that grow in clumps.* [4]

The inner bark of the black oak contains a yellow pigment called **quercitron**, which was sold commercially in Europe

until the 1940s.

Key Characteristics:

Sun leaves have very deep u-shaped sinuses.* [4]

The buds are velvety and covered in white hair.* [4]

The fruits or acorns of the black oak are medium-sized and broadly rounded.* [5] The cap is large and covers almost half of the nut.* [4]

41.2 Soil and topography

In southern New England, black oak grows on cool, moist soils. Elsewhere it occurs on warm, moist soils.

The most widespread soils on which black oak grows are the Udalfs and Udolls. These soils are derived from glacial materials, sandstones, shales, and limestone and range from heavy clays to loamy sands with some having a high content of rock or chert fragments. Black oak grows best on well drained, silty clay to loam soils.

Black oak grows on all aspects and slope positions. It grows best in coves and on middle and lower slopes with northerly and easterly aspects. It is found at elevations up to 1,200 m (3,900 ft) in the southern Appalachians.

The most important factors determining site quality for black oak are the thickness and texture of the A horizon, texture of the B horizon, aspect, and slope position. Other factors may be important in localized areas. For example, in northwestern West Virginia increasing precipitation to 1,120 mm (44 in) resulted in increased site quality; more than 1,120 mm (44 in) had no further effect. In southern Indiana, decreasing site quality was associated with increasing slope steepness.

Near the limits of black oak's range, topographic factors may restrict its distribution. At the western limits black oak is often found only on north and east aspects where moisture conditions are most favorable. In southern Minnesota and Wisconsin it is usually found only on ridge tops and the lower two-thirds of south- and west-facing slopes.

Black oak is often a predominant species in the canopy of an oak–heath forest.* [6]* [7]

41.3 Associated forest cover

Black Oak is the forest cover type that designates pure stands of the species or those in which it makes up more than 50 percent of the stand basal area. Black oak is a major associate in White Oak–Black Oak–Northern Red Oak.

Other tree associates of black oak include pignut hickory (*Carya glabra*), mockernut hickory (*C. tomentosa*), bitternut hickory (*C. cordiformis*), and shagbark hickory (*C. ovata*); American elm (*Ulmus americana*) and

slippery elm (*U. rubra*); white ash (*Fraxinus americana*); black walnut (*Juglans nigra*) and butternut (*J. cinerea*); scarlet oak (*Quercus coccinea*), southern red oak (*Q. falcata*), and chinkapin oak (*Q. muehlenbergii*); red maple (*Acer rubrum*) and sugar maple (*A. saccharum*); black cherry (*Prunus serotina*); and blackgum (*Nyssa sylvatica*).

Common small tree associates of black oak include flowering dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), sassafras (*Sassafras albidum*), eastern hop hornbeam (*Ostrya virginiana*), redbud (*Cercis canadensis*), pawpaw (*Asimina triloba*), downy serviceberry (*Amelanchier arborea*), and American bladdernut (*Staphylea trifolia*). Common shrubs include *Vaccinium* spp., mountain-laurel (*Kalmia latifolia*), witch-hazel (*Hamamelis virginiana*), beaked hazel (*Corylus cornuta*), spicebush (*Lindera benzoin*), sumac (*Rhus* spp.), and *Viburnum* spp. The most common vines are greenbrier (*Smilax* spp.), grape (*Vitis* spp.), poison-ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*).

41.4 Flowers and fruiting

Black oak is monoecious. The staminate flowers develop from leaf axils of the previous year and the catkins emerge before or at the same time as the current leaves in April or May. The pistillate flowers are borne in the axils of the current year's leaves and may be solitary or occur in two- to many-flowered spikes. The fruit, an acorn that occurs singly or in clusters of two to five, is about one-third enclosed in a scaly cup and matures in 2 years. Black oak acorns are brown when mature and ripen from late August to late October, depending on geographic location.

41.5 Seed production and dissemination

In forest stands, black oak begins to produce seeds at about age 20 and reaches optimum production at 40 to 75 years. It is a consistent seed producer with good crops of acorns every 2 to 3 years. In Missouri, the average number of mature acorns per tree was generally higher than for other oaks over a 5-year period, but the number of acorns differed greatly from year to year and from tree to tree within the same stand.

The number of seeds that become available for regenerating black oak may be low even in good seed years. Insects, squirrels, deer, turkey, small rodents, and birds consume many acorns. They can eat or damage a high percentage of the acorn crop in most years and essentially all of it in poor seed years.

Black oak acorns from a single tree are dispersed over a limited area by squirrels, mice, and gravity. The blue jay

may disperse over longer distances.

41.6 Response to competition

Black oak is classed as intermediate in tolerance to shade. It is less tolerant than many of its associates such as white and chestnut oaks, hickories, beech (*Fagus grandifolia*), maples, elm, and blackgum. However, it is more tolerant than yellow-poplar (*Liriodendron tulipifera*), black cherry, and shortleaf pine (*Pinus echinata*). It is about the same as northern red oak and scarlet oak. Seedlings usually die within a few years after being established under fully stocked over stories. Most black oak sprouts under mature stands develop crooked stems and flat-topped or misshapen crowns. After the over story is removed, only the large stems are capable of competing successfully. Seedlings are soon overtapped. The few that survive usually remain in the intermediate crown class.

Even-aged silvicultural systems satisfy the reproduction and growth requirements of black oak better than the all-aged or uneven-aged selection system. Under the selection system, black oak is unable to reproduce because of inadequate light. Stands containing black oak that are managed under the selection system will gradually be dominated by more shade-tolerant species.

Dormant buds are numerous on the boles of black oak trees. These buds may be stimulated to sprout and produce branches by mechanical pruning or by exposure to greatly increased light, as by thinning heavily or creating openings in the stand. Dominant trees are less likely to produce epicormic branches than those in the lower crown classes.

41.7 Damaging agents

Wildfires seriously damage black oak trees by killing the cambium at the base of the trees. This creates an entry point for decay fungi. The end result is loss of volume because of heart rot. Trees up to pole size are easily killed by fire and severe fires may even kill saw timber. Many of the killed trees sprout and form a new stand. However, the economic loss may be large unless at least some of it can be salvaged.

Oak wilt (*Ceratocystis fagacearum*) is a potentially serious vascular disease of black oak that is widespread throughout the eastern United States. Trees die within a few weeks after the symptoms first appear. Usually scattered individuals or small groups of trees are killed, but areas several hectares in size may be affected. The disease is spread from tree to tree through root grafts and over larger distances by sap-feeding beetles (Nitidulidae) and the small oak bark beetle.

Shoestring root rot (*Armillaria mellea*) attacks black oak and may kill trees weakened by fire, lightning, drought,

insects, or other diseases. A root rot, *Phytophthora cinnamomi*, may kill seedlings in the nursery. Cankers caused by *Strumella* and *Nectria* species damage the holes of black oak but seldom kill trees. Foliage diseases that attack black oak are the same as those that typically attack species in the red oak group and include anthracnose (*Gnomonia quercina*), leaf blister (*Taphrina* spp.), powdery mildews (*Phyllactinia corylea* and *Microsphaera alni*), oak-pine rusts (*Cronartium* spp.), and leaf spots (*Actinopelti dryina*).

Tunneling insects that attack the boles of black oak and cause serious lumber degrade include the carpenter worm (*Prionoxystus robiniae*), red oak borer (*Enaphalodes rufulus*), the twolined chestnut borer (*Agrilus bilineatus*), the oak timber worm (*Arrhenodes minutus*), and the Columbian timber beetle (*Corthylus columbianus*).

The gypsy moth (*Lymantria dispar*) feeds on foliage and is potentially the most destructive insect. Although black oaks withstood a single defoliation, two or three defoliations in successive years kill many trees. Other defoliators that attack black oak and may occasionally be epidemic are the variable oak leaf caterpillar (*Heterocampa manteo*), the orange striped oakworm (*Anisota senatoria*), and the brown tail moth (*Euproctis chrysorrhoea*).

The nut weevils (*Curculio* spp.), gall-forming cynips (*Callirhytis* spp.), filbertworm (*Melissopus latiferreanus*), and acorn moth (*Valentinia glandulella*) damage black oak acorns.

41.8 Named hybrids involving black oak

- *Quercus × bushii* (*Quercus marilandica* × *Q. velutina*) – Bush's oak
- *Quercus × cocksii* (*Quercus laurifolia* × *Q. velutina*) – Cocks' oak
- *Quercus × demarei* (*Quercus nigra* × *Q. velutina*)
- *Quercus × discreta* (*Quercus shumardii* × *Q. velutina*)
- *Quercus × filialis* (*Quercus phellos* × *Q. velutina*)
- *Quercus × fontana* (*Quercus coccinea* × *Q. velutina*)
- *Quercus × hawkinsiae* (*Quercus rubra* × *Q. velutina*) – Hawkin's oak
- *Quercus × leana* (*Quercus imbricaria* × *Q. velutina*) – Lea's oak
- *Quercus × palaeolithicola* (*Quercus ellipsoidalis* × *Q. velutina*)
- *Quercus × podophylla* (*Quercus incana* × *Q. velutina*)
- *Quercus × rehderi* (*Quercus ilicifolia* × *Q. velutina*) – Rehder's oak

- *Quercus × vaga* (*Quercus palustris* × *Q. velutina*)
- *Quercus × willdenowiana* (*Quercus falcata* × *Q. velutina*) – Willdenow's oak

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41.10 External links

- *Quercus velutina* images from Vanderbilt University
- Flora of North America Range Map:
- United States Department of Agriculture, National Forest Service, Silvics of North America: *Quercus velutina*
- Virginia Tech Department of Forestry fact sheet on *Black Oak*
- Interactive Distribution Map of *Quercus velutina*
- photo of herbarium specimen at Missouri Botanical Garden, collected in Missouri in 1948

Chapter 42

Robinia pseudoacacia

Robinia pseudoacacia, commonly known in its native territory as **black locust**,^{*[1]} is a medium-sized deciduous tree native to the southeastern United States, but it has been widely planted and naturalized elsewhere in temperate North America, Europe, Southern Africa^{*[2]} and Asia and is considered an invasive species in some areas.^{*[3]} Another common name is **false acacia**,^{*[4]} a literal translation of the specific name (*pseudo* meaning fake or false and *acacia* referring to the genus of plants with the same name.) It was introduced into Britain in 1636.^{*[5]}

42.1 History and naming

The name 'locust' is said to have been given to *Robinia* by Jesuit missionaries, who fancied that this was the tree that supported St. John in the wilderness, but it is native only to North America. The locust tree of Spain (*Ceratonia siliqua* or carob tree), which is also native to Syria and the entire Mediterranean basin, is supposed to be the true locust of the *New Testament*.

Robinia is now a North American genus, but traces of it are found in the Eocene and Miocene rocks of Europe.^{*[6]}

42.2 Distribution and invasive habit

The black locust is native to the eastern United States, but the exact native range is not accurately known^{*[7]} as the tree has been cultivated and is currently found across the continent, in all the lower 48 states, eastern Canada, and British Columbia.^{*[1]} The native range is thought to be two separate populations, one centered about the Appalachian Mountains, from Pennsylvania to northern Georgia, and a second westward focused around the Ozark Plateau and Ouachita Mountains of Arkansas, Oklahoma and Missouri.

Black locust's current range has been expanded by humans distributing the tree for landscaping and now includes Australia, Canada, China, Europe, India, North-



Tree in flower

ern and South Africa, temperate regions in Asia, New Zealand, Southern South America.^{*[8]}

Black locust is an interesting example of how one plant can be considered an invasive species even on the same continent it is native to. For example, within the western United States, New England region, and in the Midwest, black locust is considered an **invasive species**. In the prairie and savanna regions of the Midwest black locust can dominate and shade open habitats.^{*[9]} These ecosystems have been decreasing in size and black locust is contributing to this, when black locust invades an area it will convert the grassland ecosystem into a forested ecosystem where the grasses are displaced.^{*[10]} Black locust has been listed as invasive in Connecticut and Wisconsin, and prohibited in Massachusetts.^{*[1]}

In Australia black locust has become **naturalized** within Victoria, New South Wales, South, and Western Aus-

tralia. It is considered an environmental weed there.*[8] In South Africa, it is regarded as a weed because of its habit suckering.*[11]



Robinia spines

42.3 Description

Black locust reaches a typical height of 40–100 feet (12–30 m) with a diameter of 2–4 feet (0.61–1.22 m).*[12] Exceptionally, it may grow up to 52 metres (171 ft) tall*[13] and 1.6 metres (5.2 ft) diameter in very old trees. It is a very upright tree with a straight trunk and narrow crown which grows scraggly with age.*[5] The dark blue-green compound leaves with a contrasting lighter underside give this tree a beautiful appearance in the wind and contribute to its grace.

Black locust is a shade intolerant species*[7] and therefore is typical of young woodlands and disturbed areas where sunlight is plentiful and the soil is dry. In this sense, black locust can often grow as a weed tree. It also often spreads by underground shoots or suckers which contribute to the weedy character of this species.*[5] Young trees are often spiny, however, mature trees often lack spines. In the early summer black locust flowers; the flowers are large and appear in large, intensely fragrant (reminiscent of orange blossoms), clusters. The leaflets fold together in wet weather and at night (*nyctinasty*) as some change of position at night is a habit of the entire leguminous family.

Although similar in general appearance to the *honey locust*, it lacks that tree's characteristic long branched thorns on the trunk, instead having the pairs of short prickles at the base of each leaf; the leaflets are also much broader than honey locust. It may also resem-

ble *Styphnolobium japonicum* which has smaller flower spikes and lacks spines.

42.3.1 Detailed description



One black locust leaf showing 13 leaflets

- The **bark** is dark gray brown and tinged with red or orange in the grooves. It is deeply furrowed into grooves and ridges which run up and down the trunk and often cross and form diamond shapes.*[5]
- The **roots** of black locust contain **nodules** which allow it to fix **nitrogen** as is common within the pea family.
- The **branches** are typically zig-zag and may have ridges and grooves or may be round.*[5] When young, they are at first coated with white silvery down, this soon disappears and they become pale green and afterward reddish or greenish brown.
- **Prickles** may or may not be present on young trees, root suckers, and branches near the ground; typically, branches high above the ground rarely contain prickles. *R. pseudoacacia* is quite variable in

the quantity and amount of prickles present as some trees are densely prickly and other trees have no prickles at all. The prickles typically remain on the tree until the young thin bark to which they are attached is replaced by the thicker mature bark. They develop from **stipules*** [14] (small leaf like structures which grow at the base of leaves) and since stipules are paired at the base of leaves, the prickles will be paired at the bases of leaves. They range from .25-.8 inches (0.64–2.03 cm) in length and are somewhat triangular with a flared base and sharp point. Their color is of a dark purple and they adhere only to the bark.* [14]

- **Wood:** Pale yellowish brown; heavy, hard, strong, close-grained and very durable in contact with the ground. The wood has a **specific gravity** of 0.7333, and a weight of approximately 45.7 pounds per cubic foot.
- The **leaves** are **compound**, meaning that each leaf contains many smaller leaf like structures called **leaflets**, the leaflets are roughly paired on either side of the stem which runs through the leaf (**rachis**) and there is typically one leaflet at the tip of the leaf (**odd pinnate**). The leaves are alternately arranged on the stem. Each leaf is 6–14 inches (15–36 cm) long and contains 9–19 leaflets, each being 1–2 inches (2.5–5.1 cm) long, and .25–.75 inches (0.64–1.91 cm) wide. The leaflets are rounded or slightly indented at the tip and typically rounded at the base. The leaves come out of the bud folded in half, yellow green, covered with silvery down which soon disappears. Each leaflet initially has a minute **stipe**, which quickly falls, and is connected to the (**rachis**) by a short stem or **petiolule**. The leaves are attached to the branch with slender hairy **petioles** which is grooved and swollen at the base. The **stipules** are linear, downy, membranous at first and occasionally develop into prickles. The leaves appear relatively late in spring.
- The **leaf color** of the fully grown leaves is a dull dark green above and paler beneath. In the fall the leaves turn a clear pale yellow.
- The **flowers** open in May or June for 7–10 days, after the leaves have developed. They are arranged in loose drooping clumps (**racemes**) which are typically 4–8 inches (10–20 cm) long.* [5] The flowers themselves are cream-white (rarely pink or purple) with a pale yellow blotch in the center and imperfectly **papilionaceous** in shape. They are about 1 inch (2.5 cm) wide, very fragrant, and produce large amounts of nectar. Each flower is perfect, having both **stamens** and a **pistil** (male and female parts). There are 10 stamens enclosed within the petals; these are fused together in a diadelphous configuration, where the **filaments** of 9 are all joined to form a



Closeup of flowers

tube and one stamen is separate and above the joined stamens. The single ovary is superior and contains several ovules. Below each flower is a **calyx** which looks like leafy tube between the flower and the stem. It is made from fused **sepals** and is dark green and may be blotched with red. The **pedicels** (stems which connect the flower to the branch) are slender, .5 inches (1.3 cm), dark red or reddish green.

- The **fruit** is a typical legume fruit, being a flat and smooth pea-like pod 2–4 inches (5.1–10.2 cm) long and .5 inches (1.3 cm) broad. The fruit usually contains 4–8 seeds.* [5] The seeds are dark orange brown with irregular markings. They ripen late in autumn and hang on the branches until early spring.* [6] There are typically 25500 seeds per pound.* [15]
- **Winter buds:** Minute, naked (having no scales covering them), three or four together, protected in a depression by a scale-like covering lined on the inner surface with a thick coat of tomentum and opening in early spring. When the buds are forming they are covered by the swollen base of the petiole.
- **Cotyledons** are oval in shape and fleshy.

42.4 Reproduction and dispersal

Black locust produces both sexually via flowers, and asexually via root **suckers**. The flowers are pollinated by in-

sects, primarily by Hymenopteran insects. The physical construction of the flower separates the male and female parts so that self-pollination will not typically occur.*[16] The seedlings grow rapidly but they have a thick seed coat which means that not all seeds will germinate. The seed coat can be weakened via hot water, sulfuric acid, or be mechanically scarified and this will allow a greater quantity of the seeds to grow.*[5]*[15] The seeds are produced in good crops every year or every-other year.

Root suckers are an important method of local reproduction of this tree. The roots may grow suckers after damage (by being hit with a lawn mower or otherwise damaged) or after no damage at all. The suckers are stems which grow from the roots, directly into the air and may grow into full trees. The main trunk also has the capability to grow sprouts and will do so after being cut down.*[12] This makes removal of black locust difficult as the suckers need to be continually removed from both the trunk and roots or the tree will regrow. This is considered an asexual form of reproduction.

The suckers allow black locust to grow into colonies which are often exclude other species. These colonies may form dense thickets which shade out competition.*[17] Black locust has been found to have either $2n=20$ or $2n=22$ chromosomes.

42.4.1 Human mediated dispersal

Black locust has been spread and used as a plant for erosion control as it is fast growing and generally a tough tree.*[15] The wood, considered the most durable wood in America, has been very desirable and motivated people to move the tree to areas where it is not native so the wood can be farmed and used.

42.5 Ecology



Robinia pseudoacacia seeds

When growing in sandy areas this plant can enrich the soil by means of its nitrogen-fixing nodules, allowing other species to move in.*[12] On sandy soils black locust may

also often replace other vegetation which cannot fix nitrogen.*[15]

Black locust is a typical early successional plant, a pioneer species, it grows best in bright sunlight and does not handle shade well.*[7] It specializes in colonizing disturbed and edges of woodlots before it is eventually replaced with more shade tolerant species. It prefers dry to moist limestone soils but will grow on most soils as long as they are not wet or poorly drained.*[7] This tree tolerates a soil pH range of 4.6 to 8.2.*[15] Within its native range it will often grow on soils of Inceptisols, Ultisols, and Alfisols groups. Black locust does not do well on compacted, clayey or eroded soils. Black locust is a part of the Appalachian mixed mesophytic forests.

Black locust is not a particularly valuable plant for wildlife, but does provide valuable cover when planted on previously open areas. Its seeds are also eaten by bobwhite quail and other game birds and squirrels. Woodpeckers may also nest in the trunk since older trees are often infected by heart rot.

42.6 Pests

Locust leaf miner *Odontota dorsalis* attacks the tree in spring and turns the leaves brown by mid summer, it slows the growth of the tree but not seriously.*[15] The locust borer *Megacyllene robiniae* larvae carve tunnels into the trunk of the tree and make it more prone to being knocked down by the wind. Heart rot is the only significant disease affecting black locust.*[15] Black locust is also attacked by *Chlorogenus robiniae*, a virus which causes witch's broom growths, clear leaflet veins are a symptom of the disease.*[18]

42.7 Uses

42.7.1 Cultivation

Black locust is a major honey plant in the eastern US, and has been planted in European countries. In many European countries, it is the source of the renowned acacia honey. Flowering starts after 140 growing degree days. However, its blooming period is short (about 10 days) and it does not consistently produce a honey crop year after year. Weather conditions can have quite an effect on the amount of nectar collected, as well; in Ohio for example, good locust honey flow happens in one of five years.*[19]

It can be easily propagated from roots, softwood, or hardwood*|[5]*[15] and this allows for easy reproduction of the plant. Cultivars may also be grafted as this ensures the parent and daughter plant will be genetically identical.

R. pseudoacacia is considered an excellent plant for



The golden 'Frisia' cultivar planted as an ornamental tree

growing in highly disturbed areas as an erosion control plant.*[15] The roots are shallow aggressive which help to hold onto soil and the tree grows quickly and on poor soils due to its ability to fix nitrogen.

Black locust has nitrogen-fixing bacteria on its root system, so it can grow on poor soils and is an early colonizer of disturbed areas. With fertilizer prices rising, the importance of black locust as a nitrogen-fixing species is also noteworthy. The mass application of fertilizers in agriculture and forestry is increasingly expensive; therefore nitrogen-fixing tree and shrub species are gaining importance in managed forestry.*[20]

It is also planted for firewood because it grows rapidly, is highly resilient in a variety of soils, and it grows back even faster from its stump after harvest by using the existing root system.*[21] (see coppicing)

In Europe, it is often planted along streets and in parks, especially in large cities, because it tolerates pollution well.

Cultivars

Several cultivars exist but 'Frisia' seems to be one of the most planted ones.

- 'Decaisneana' has been considered a cultivar but is more accurately a hybrid (*R. psudeoacacia* x *R. viscosa*). It has light rose-pink colored flowers and small or no prickles.*[22]
- 'Frisia', a selection with bright yellow-green leaves and red prickles, is occasionally planted as an ornamental tree.*[5]
- 'Purple robe' has dark rose-pink flowers and bronze red new growth. The flowers tend to last longer than on the wild tree.*[5]
- 'Tortuosa', a small tree with curved and distorted branches.*[5]*[23]
- 'Unifoliola', a plant with fewer leaflets, no prickles, and a shorter height.

42.7.2 Wood



Wood



Bark

The wood is extremely hard, being one of the hardest woods in Northern America. It is very resistant to rot,

and durable, making it prized for furniture, flooring, paneling, fence posts, and small watercraft. Wet, newly cut planks have an offensive odor which disappears with seasoning. Black locust is still in use in some rustic handrail systems. In the Netherlands and some other parts of Europe, black locust is one of the most rot-resistant local trees, and projects have started to limit the use of tropical wood by promoting this tree and creating plantations. Flavonoids in the heartwood allow the wood to last over 100 years in soil.*[24] As a young man, Abraham Lincoln spent much of his time splitting rails and fence posts from black locust logs.

Black locust is highly valued as firewood for wood-burning stoves; it burns slowly, with little visible flame or smoke, and has a higher heat content than any other species that grows widely in the Eastern United States, comparable to the heat content of anthracite.*[25] For best results, it should be seasoned like any other hardwood, but black locust is also popular because of its ability to burn even when wet.*[20] In fireplaces, it can be less satisfactory because knots and beetle damage make the wood prone to “spitting” coals for distances of up to several feet. If the black locust is cut, split, and cured while relatively young (within 10 years), thus minimizing beetle damage, “spitting” problems are minimal.



Locust railing

In 1900, the value of *Robinia pseudoacacia* was reported to be practically destroyed in nearly all parts of the United States beyond the mountain forests which are its home by locust borers which riddle the trunk and branches. Were it not for these insects, it would be one of the most valuable timber trees that could be planted in the northern and middle states. Young trees grow quickly and vigorously for a number of years, but soon become stunted and diseased, and rarely live long enough to attain any commercial value.*[6]

42.7.3 Food and Medicine

In traditional medicine of India, different parts of *R. pseudoacacia* are used as laxative, antispasmodic, and diuretic.*[26]

In Romania the flowers are sometimes used to produce a sweet and perfumed jam. This means manual harvesting of flowers, eliminating the seeds and boiling the petals with sugar, in certain proportions, to obtain a light sweet

and delicate perfume jam.

Although the bark and leaves are toxic, various reports suggest that the seeds and the young pods of the black locust are edible. Shelled seeds are safe to harvest from summer through fall, and are edible both raw and/or boiled.*[27] Due to the small nature of the seeds, shelling them efficiently can prove tedious and difficult. In France and in Italy, *R. pseudoacacia* flowers are eaten as *beignets* after being coated in batter and fried in oil;*[28] they are also eaten in Japan, largely as tempura.*[29]*[30]

42.8 Toxicity

The bark, leaves, and wood are toxic to both humans and livestock.*[31] Important constituents of the plant are the toxalbumin robin, which loses its toxicity when heated, and robinin, a nontoxic glucoside.*[32]

Horses that consume the plant show signs of anorexia, depression, incontinence, colic, weakness, and cardiac arrhythmia. Symptoms usually occur about 1 hour following consumption, and immediate veterinary attention is required.

42.9 Flavonoids content

Black locust leaves contain flavone glycosides characterised by spectroscopic and chemical methods as the 7-O- β -d-glucuronopyranosyl-(1 → 2)[α -l-rhamnopyranosyl-(1 → 6)]- β -d-glucopyranosides of acacetin (5,7-dihydroxy-4'-methoxyflavone), apigenin (5,7,4'-trihydroxyflavone), diosmetin (5,7,3'-trihydroxy-4'-methoxyflavone) and luteolin (5,7,3',4'-tetrahydroxyflavone).*[33]

42.10 See also

- List of plants poisonous to equines
- *Megacyllene robiniae*

42.11 References

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42.12 External links

- Purdue University
- *Robinia pseudoacacia* images at bioimages.vanderbilt.edu
- *Robinia pseudoacacia* images at Forestry Images
- *Robinia pseudoacacia* – US Forest Service Fire Effects Database
- *Robinia pseudoacacia* at USDA Plants Database
- Black locust – US Forest Service Silvics Manual
- Black Locust (as an invasive species)
- Interactive Distribution Map of *Robinia pseudoacacia*
- *Robinia pseudoacacia* flowers as food
- Black locust – Invasive species: Minnesota DNR
- *Robinia pseudoacacia* - information, genetic conservation units and related resources. European Forest Genetic Resources Programme (EUFORGEN)

Chapter 43

Sassafras albidum

Sassafras albidum (sassafras, white sassafras, red sassafras, or silky sassafras) is a species of *Sassafras* native to eastern North America, from southern Maine and southern Ontario west to Iowa, and south to central Florida and eastern Texas. It occurs throughout the eastern deciduous forest habitat type, at altitudes of sea level up to 1,500 m (5000 feet).^{*[2]*[3]*[4]} It formerly also occurred in southern Wisconsin, but is extirpated there as a native tree.^{*[5]}

43.1 Description

Sassafras albidum is a medium-sized deciduous tree growing to 15–20 m (49–66 ft) tall, with a canopy up to 12 m (39 ft) wide,^{*[6]} with a trunk up to 60 cm (24 in) in diameter, and a crown with many slender sympodial branches.^{*[7]*[8]*[9]} The bark on trunk of mature trees is thick, dark red-brown, and deeply furrowed. The shoots are bright yellow green at first with mucilaginous bark, turning reddish brown, and in two or three years begin to show shallow fissures. The leaves are alternate, green to yellow-green, ovate or obovate, 10–16 cm (4.6–4 inches) long and 5–10 cm (2–4 inches) broad with a short, slender, slightly grooved petiole. They come in three different shapes, all of which can be on the same branch; three-lobed leaves, unlobed elliptical leaves, and two-lobed leaves; rarely, there can be more than three lobes. In fall, they turn to shades of yellow, tinged with red. The flowers are produced in loose, drooping, few-flowered racemes up to 5 cm (2.0 in) long in early spring shortly before the leaves appear; they are yellow to greenish-yellow, with five or six tepals. It is usually dioecious, with male and female flowers on separate trees; male flowers have nine stamens, female flowers with six staminodes (aborted stamens) and a 2–3 mm style on a superior ovary. Pollination is by insects. The fruit is a dark blue-black drupe 1 cm (0.39 in) long containing a single seed, borne on a red fleshy club-shaped pedicel 2 cm (0.79 in) long; it is ripe in late summer, with the seeds dispersed by birds. The cotyledons are thick and fleshy. All parts of the plant are aromatic and spicy. The roots are thick and fleshy, and frequently produce root sprouts which can develop into new trees.^{*[3]*[4]*[10]*[11]*[12]}

43.2 Ecology

It prefers rich, well-drained sandy loam with a pH of 6–7, but will grow in any loose, moist soil. Seedlings will tolerate shade, but saplings and older trees demand full sunlight for good growth; in forests it typically regenerates in gaps created by windblow. Growth is rapid, particularly with root sprouts, which can reach 1.2 m (4 feet) in the first year and 4.5 m (15 feet) in 4 years. Root sprouts often result in dense thickets, and a single tree, if allowed to spread unrestrained, will soon be surrounded by a sizable clonal colony, as its stoloniferous roots extend in every direction and send up multitudes of shoots.^{*[3]*[4]*[11]}

43.3 Laurel wilt

Laurel wilt is a highly destructive disease initiated when the flying redbay ambrosia beetle (*Xyleborus glabratus*) introduces its highly virulent fungal symbiont (*Raffaelea lauricola*) into the sapwood of Lauraceae host shrubs or trees. Sassafras's volatile terpenoids may attract *X. glabratus*.^{*[13]} Sassafras is susceptible to laurel wilt and capable of supporting broods of *X. glabratus*. Underground transmission of the pathogen through roots and stolons of Sassafras without evidence of *X. glabratus* attack is suggested. Studies examining the insect's cold tolerance showed that *X. glabratus* may be able to move to colder northern areas where sassafras would be the main host. The exotic Asian insect is spreading the epidemic from the Everglades through the Carolinas in perhaps less than 15 years by the end of 2014.^{*[14]}

43.4 Humans and *Sassafras albidum*

All parts of the *Sassafras albidum* plant have been used for human purposes, including stems, leaves, bark, wood, roots, fruit, and flowers. *Sassafras albidum*, while native to North America, is significant to the economic, medical, and cultural history of both Europe and North America. In North America, it has particular culinary sig-



Parc Oberthür, Rennes

nificance, being featured in distinct national foods such as traditional root beer, file powder, and Louisiana Creole cuisine. *Sassafras albidum* was an important plant to many Native Americans of the southeastern United States and was used for many purposes, including culinary and medicinal purposes, before the European colonization of North America. Its significance for Native Americans is also magnified, as the European quest for sassafras as a commodity for export brought Europeans into closer contact with Native Americans during the early years of European settlement in the 16th and 17th centuries, in Florida, Virginia, and other parts of the Northeast.

43.4.1 *Sassafras albidum* and indigenous peoples of the United States

Sassafras albidum was a well-used plant by Native Americans in the southeastern United States prior to the European colonization. The Choctaw word for sassafras is “Kombu.” It was known as “Winauk” in Delaware and Virginia and is called “Pauane” by the Timuca.

Some Native American tribes used the leaves of sassafras to treat wounds by rubbing the leaves directly into a wound, and used different parts of the plant for many medicinal purposes such as treating acne, urinary disorders, and sicknesses that increased body temperature, such as high fevers. They also used the bark as a dye, and as a flavoring.*[15]

Sassafras wood was also used by Native Americans in the

southeastern United States as a fire-starter because of the flammability of its natural oils.*[16]

In cooking, sassafras was used by some Native Americans to flavor bear fat, and to cure meats.*[17] Sassafras is still used today to cure meats.*[18] Use of filé powder by the Choctaw in the Southern United States in cooking is linked to the development of gumbo, a signature dish of Louisiana Creole cuisine.*[19]

43.4.2 Culinary use by Europeans in North America, and legislation

Also see, root beer and filé powder.

Sassafras albidum is used in two distinct foods of the United States: as a thickener and flavouring in the Louisiana Creole dish called gumbo and as the key ingredient in traditional root beer.

Filé powder, also called gumbo filé, for its use in making gumbo, is a spicy herb made from the dried and ground leaves of the sassafras tree. It was traditionally used by Native Americans in the Southern United States, and was adopted into Louisiana Creole cuisine. Use of Filé powder by the Choctaw in the Southern United States in cooking is linked to the development of gumbo, the signature dish of Louisiana Creole cuisine that features ground sassafras leaves.*[19]

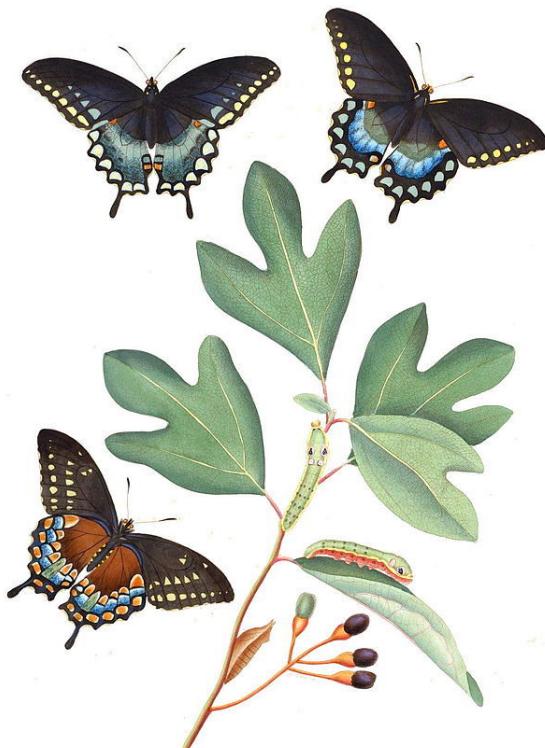
Sassafras roots are used to make traditional root beer, although they were banned for commercially mass-produced foods and drugs by the FDA in 1960.*[20] Laboratory animals that were given oral doses of sassafras tea or sassafras oil that contained large doses of safrole developed permanent liver damage or various types of cancer.*[20] In humans, liver damage can take years to develop and it may not have obvious signs. Along with commercially available Sarsaparilla, sassafras remains an ingredient in use among hobby or microbrew enthusiasts. While sassafras is no longer used in commercially produced root beer and is sometimes substituted with artificial flavors, natural extracts with the safrole distilled and removed are available.*[21]*[22] Most commercial root beers have replaced the sassafras extract with methyl salicylate, the ester found in wintergreen and black birch (*Betula lenta*) bark.

Sassafras tea was also banned in the United States in 1977, but the ban was lifted with the passage of the Dietary Supplement Health and Education Act in 1994.*[20]*[23]*[24]

43.4.3 Safrole oil, aromatic uses, MDMA

See Safrole.

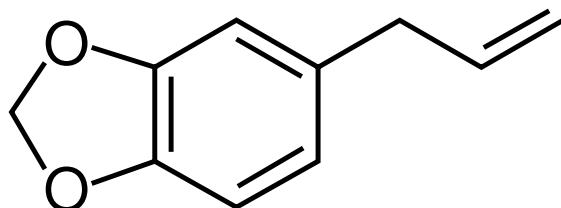
Safrole distilled from *Sassafras albidum* has also been used as a natural insect or pest deterrent.*[18] Godfrey's cordial, as well as other tonics given to children that con-



S. albidum is a host plant for the spicebush swallowtail.

sisted of opiates, used sassafras to disguise other strong smells and odours associated with the tonics. It was also used as an additional flavouring to mask the strong odours of homemade liquor in the United States.*[25]

Commercial “sassafras oil” generally is a byproduct of camphor production in Asia or comes from related trees in Brazil. Safrrole is a precursor for the manufacture of the drug MDMA, as well as the drug MDA (3,4-methylene-dioxyamphetamine) and as such, its transport is monitored internationally.



Chemical structure of safrrole, a constituent of sassafras essential oil

The wood is dull orange brown, hard, and durable in contact with the soil; it was used in the past for posts and rails, small boats and ox-yokes, though scarcity and small size limits current use. Some is still used for making furniture.*[26]

43.5 History exploitation and commodity modification of the *Sassafras albidum* plant

Europeans were first introduced to sassafras, along with other plants such as cranberries, tobacco, and ginseng, when they arrived in North America.*[17]*[27]

The aromatic smell of sassafras was described by early European settlers arriving in North America. According to one legend, Christopher Columbus found North America because he could smell the scent of sassafras.*[25] As early as the 1560s, French visitors to North America discovered the medicinal qualities of sassafras, which was also exploited by the Spanish who arrived in Florida.*[28] English settlers at Roanoke reported surviving on boiled sassafras leaves and dog meat during times of starvation.*[29]

Upon the arrival of the English on the Eastern coast of North America, sassafras trees were reported as plentiful. Sassafras was sold in England and in continental Europe, where it was sold as a dark beverage called “saloop” that had medicinal qualities and used as a medicinal cure for a variety of ailments. The discovery of sassafras occurred at the same time as a severe syphilis outbreak in Europe, when little about this terrible disease was understood, and sassafras was touted as a cure. Sir Francis Drake was one of the earliest to bring sassafras to England in 1586, and Sir Walter Raleigh was the first to export sassafras as a commodity in 1602. Sassafras became a major export commodity to England and other areas of Europe, as a medicinal root used to treat ague (fevers) and sexually transmitted diseases such as syphilis and gonorrhea, and as wood prized for its beauty and durability.*[30]*[31] Exploration for sassafras was the catalyst for the 1603 commercial expedition from Bristol of Captain Martin Pring to the coasts of present-day Maine, New Hampshire, and Massachusetts. During a brief period in the early 17th century, sassafras was the second-largest export from the British colonies in North America behind tobacco.*[32]

Since the bark was the most commercially valued part of the sassafras plant due to large concentrations of the aromatic safrrole oil, commercially valuable sassafras could only be gathered from each tree once. This meant that as significant amounts of sassafras bark was gathered, supplies quickly diminished and sassafras become more difficult to find. For example, while one of the earliest shipments of sassafras in 1602 weighed as much as a ton, by 1626, English colonists failed to meet their 30-pound quota. The gathering of sassafras bark brought European settlers and Native Americans into contact sometimes dangerous to both groups.*[33] Sassafras was such a desired commodity in England, that its importation was included in the Charter of the Colony of Virginia in 1610.*[34]

Through modern times, the sassafras plant has been exploited for the extraction of **safrole**, which is used in a variety of commercial products as well as in the manufacture of illegal drugs like **MDMA**; yet, sassafras plants in **China** and **Brazil** are more commonly used for these purposes than North American *Sassafras albidum*.^{*} [35]



- Flowers



- Flowers



- Bark

43.6 See also

- Sassafras tzumu
- Sassafras randaiense
- Sassafras hesperia
- Root beer
- Filé powder
- Sarsaparilla

43.7 Gallery



- Unilobed leaf



- The fruit



- Bilobed leaf



- Autumn foliage closeup



- Trilobed leaf



- Seedling



- Young plant with 3 leaf varieties



- Autumn foliage



- Flowers

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43.9 External links

Media related to *Sassafras albidum* at Wikimedia Commons

Chapter 44

Tilia americana

“Basswood” redirects here. For other uses, see Basswood (disambiguation).

Tilia americana is a species of *Tilia* native to eastern North America, from southeast Manitoba east to New Brunswick, southwest to northeast Oklahoma, and southeast to South Carolina, and west along the Niobrara River to Cherry County, Nebraska.*[1]*[2] Common names include **American basswood***[3] and **American linden**.

44.1 Description

The American basswood is a medium-sized to large deciduous tree reaching a height of 18 to 37 m (60 to 120 ft) exceptionally 39 m (128 ft) with a trunk diameter of 1–1.5 m (3–5 ft) at maturity. It grows faster than many North American hardwoods, often twice the annual growth rate of **American beech** and many **birch** species. Total life expectancy is around 200 years, with flowering and seeding generally occurring between 15 and 100 years. Occasionally, seed production may start as early as 8 years.

The crown is domed, the branches spreading, often pendulous. The **bark** is gray to light brown, with narrow, well defined fissures. The **roots** are large, deep, and spreading. The **twigs** are smooth, reddish-green, becoming light gray in their second year, finally dark brown or brownish gray, marked with dark wart-like excrescences. The winter buds are stout, ovate-acute, smooth, deep red, with two bud scales visible.

The **leaves** are simple, alternately arranged, ovate to cordate, asymmetrical, unequal at the base (the side nearest the branch the largest), 10–15 cm (4–6 in) (can grow up to 25 cm or 10 in) long and broad, with a long, slender petiole, a coarsely serrated margin and an acuminate apex. They open from the bud conduplicate, pale green, downy; when full grown are dark green, smooth, shining above, paler beneath, with tufts of rusty brown hairs in the axils of the primary veins; the small **stipules** fall soon after leaf opening. The fall color is yellow-green to yellow. Both the twigs and leaves contain mucilaginous sap. The flowers are small, fragrant, yellowish-white, 10–14

mm ($\frac{13}{32}$ – $\frac{9}{16}$ inch) in diameter, arranged in drooping, cymose clusters of 6–20 with a whitish-green leaf-like **bract** attached for half its length at the base of the cyme. They are perfect, regular, with five **sepals** and **petals**, numerous stamens, and a five-celled superior ovary. Flowering is in early to mid summer; pollination is by bees.

The **fruit** is a small, globose, downy, hard and dry cream-colored **nutlet** with a diameter of 8–10 mm ($\frac{5}{16}$ – $\frac{13}{32}$ in).*[1]*[4]*[5]

44.2 Taxonomy

The circumscription of the species is disputed; some authors*[1]*[6] treat it in a narrow sense, with *Tilia caroliniana*, *Tilia heterophylla*, and *Tilia mexicana* regarded as separate species, while others*[2]*[7]*[8] treat these as varieties or synonyms of *T. americana*. The distribution and description above treat the species in its narrow sense; taken in the broad sense, including plants with the leaves white below with dense tomentum (velvety hairs), the distribution extends southwards to Florida, and in Mexico west to Sinaloa and south to Oaxaca.

44.3 Ecology

American basswood is dominant in the sugar maple–basswood forest association, which is most common in western Wisconsin and central Minnesota, but occurs as far east as New England and southern Quebec in places that have mesic soil with relatively high pH. It also has minor occurrence in many other forest cover types.

Its flowers provide abundant nectar for insects. The seeds are eaten by chipmunks, mice, and squirrels. Rabbits and voles eat the bark, sometimes girdling young trees. The leaves serve as food for caterpillars of various Lepidoptera (see Lepidoptera which feed on *Tilia*). The ribbed cocoon maker species *Bucculatrix improvisa* has not been found on other plants.

This species is particularly susceptible to adult Japanese beetles (an invasive species in North America) that feed on its leaves.*[9]

44.4 Cultivation and uses



Sections of *Tilia americana* from *The American Woods*

The American basswood can be propagated by cuttings and grafting as well as by seed. The plants grow rapidly in a rich soil, but are subject to the attacks of many insect enemies.

The American basswood is known for being one of the most difficult native North American trees to propagate from seed, as they not only have a low viability rate (approximately 30% of all seeds are viable), but quickly develop an extremely hard seed coating that may delay germination for up to two years. If planting them, it is recommended to gather the seeds in early autumn and sow them before they dry out and form a coating. This will then allow germination to occur immediately. Overall, seeds are not a major part of the tree's reproductive strategy and it instead mostly spreads by self-coppicing. All juvenile basswoods coppice extremely readily, and even old trees will often sprout from the stump if cut.

The American basswood is recommended as an ornamental tree when the mass of foliage or a deep shade is desired; no native tree surpasses it in this respect. It is often planted on the windward side of an orchard as a protection to young and delicate trees.*[5] It is cultivated at least as far north as Juneau, Alaska.*[10]

The foliage and flowers are both edible, though many prefer only to eat the tender young leaves. It is a beneficial species for attracting pollinators as well. Bees produce

excellent honey with a mildly spicy flavor from its blossoms.

Cultivars include 'Nova', 'Duros' (with an upright crown), the pyramidal 'Frontyard' and the conic-crowned 'Redmond'.

44.4.1 Wood



basswood carving

The wood is pale brown, sometimes nearly white or faintly tinged with red; light, soft with fine close grain; clear of knots but does not split easily. It is low in strength and has a poor steam-bending classification. It can take stains and polish without difficulty and it planes, glues, screws and nails well.*[11] It is sold generally under the name basswood, but is sometimes confounded with tulip-wood and then called white-wood, and is largely used in the manufacture of wooden-ware, wagon boxes and furniture. It has a density of 0.4525. The wood is considered odorless. This makes it valuable in the manufacture of wooden-ware, cheap furniture, bodies of carriages; it is also especially adapted for wood-carving. The inner bark is very tough and fibrous, used in the past for making ropes.*[5]

It is a common wood for use in the production of solid body electric guitars, where it is considered an analogue for aspen and poplar, because it is light, strong and resonant, though it is usually used for guitars that will be painted an opaque color, because its lack of notable grain makes it an unattractive candidate for transparent finish. Linden wood rots easily and old trees have many cavities that serve as nesting places for birds.

44.4.2 Medicinal uses

Although *Tilia cordata* is believed to be stronger, *T. americana* is also used medicinally. The dried flowers are mildly sweet and sticky, and the fruit is somewhat sweet and mucilaginous. Linden tea has a pleasing taste, due to the aromatic volatile oil found in the flowers. The flowers, leaves, wood, and charcoal (obtained from the wood) are used for medicinal purposes. Active ingredients in the linden flowers include flavonoids (which act as antioxidants), volatile oils, and mucilaginous constituents (which soothe and reduce inflammation). The plant also contains tannins that can act as an astringent.*[12]

Linden flowers are used in colds, cough, fever, infections, inflammation, high blood pressure, headache (particularly migraine), as a diuretic (increases urine production), antispasmodic (reduces smooth muscle spasm along the digestive tract), and sedative. The flowers were added to baths to quell hysteria, and steeped as a tea to relieve anxiety-related indigestion, irregular heartbeat, and vomiting. The leaves are used to promote sweating to reduce fevers. The wood is used for liver and gallbladder disorders and cellulitis (inflammation of the skin and surrounding soft tissue). That wood burned to charcoal is ingested to treat intestinal disorders and used topically to treat edema or infection, such as cellulitis or ulcers of the lower leg.*[12]*[13]

Several animal studies showed that the extract of *T. americana* increased sleeping time with 50 minutes (similar to the effects of diazepam) and decreased movement, which indicates sedative effects.*[13]*[14] It is argued that its mechanism of action is due to the flavonoid quercetin,*[15]*[16] as it inhibits the release of histamine.*[17]

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44.6 External links

- Media related to [Tilia americana \(category\)](#) at Wikimedia Commons
- Data related to [Tilia americana](#) at Wikispecies

Chapter 45

"*Ulmus americana*"

Ulmus americana, generally known as the **American elm** or, less commonly, as the **white elm** or **water elm**,*[lower-alpha 1] is a species native to eastern North America, naturally occurring from Nova Scotia west to Saskatchewan and Montana, and south to Florida and central Texas. The American elm is an extremely hardy tree that can withstand winter temperatures as low as -42°C (-44°F). Trees in areas unaffected by **Dutch elm disease** can live for several hundred years. A prime example of the species was the Sauble Elm, *[2]*[3] which grew beside the banks of the **Sauble River** in Ontario, Canada, to a height of 43 m (140 ft), with a **d.b.h** of 196 cm (6.43 ft) before succumbing to Dutch elm disease; when it was felled in 1968, a tree-ring count established that it had germinated in 1701.

For over 80 years, *U. americana* has been identified as a **tetraploid**, i.e. having double the usual number of chromosomes, making it unique within the genus. However, a study published in 2011 by the **Agricultural Research Service** of the **USDA** revealed that about 20% of wild American elms are **diploid**, and may even constitute another species. Moreover, several triploid trees known only in cultivation, such as '**Jefferson**', are possessed of a high degree of resistance to **Dutch elm disease** which ravaged American elms in the 20th century. This suggests that the diploid parent trees, which have markedly smaller cells than the tetraploid, may too be highly resistant to the disease.*[4]*[5]

like canopy. The leaves are alternate, 7–20 cm long, with double-serrate margins and an oblique base. The perfect flowers are small, purple-brown and, being wind-pollinated, apetalous. The flowers are also **protogynous**, the female parts maturing before the male, thus reducing, but not eliminating, self-fertilization,*[6] and emerge in early spring before the leaves. The fruit is a flat **samara** 2 cm long by 1.5 cm broad, with a circular papery wing surrounding the single 4–5 mm seed. As in the closely related **European White Elm** *Ulmus laevis*, the flowers and seeds are borne on 1–3 cm long stems. American Elm is wholly insensitive to daylight length (**photoperiod**), and will continue to grow well into autumn until injured by frost.*[7] **Ploidy** ($2n = 56$, or more rarely, $2n = 28$).*[8]



• *U. americana*, Toronto, c.1914



• Bark



• Leaf



• Foliage

45.1 Classification

Ulmus americana was first described and named by Carl Linnaeus in his *Species Plantarum*, published in 1753. No subspecies or varieties are currently recognized within the species.

45.2 Description

The American elm is a **deciduous hermaphroditic** tree which, before the introduction of Dutch elm disease, commonly grew to > 30 m (100 ft) tall with a trunk > 1.2 m (4 ft) **d.b.h** supporting a high, spreading umbrella-



45.3 Ecology

The American elm occurs naturally in an assortment of habitats, most notably rich bottomlands, floodplains, stream banks, and swampy ground, although it also often thrives on hillsides, uplands and other well-drained soils.*[9] On more elevated terrain, as in the Appalachian Mountains, it is most often found along rivers.*[10] The species' wind-dispersed seeds enable it to spread rapidly as suitable areas of habitat become available.*[9] American elm produces its seed crop in late spring (which can be as early as February and as late as June depending on the climate) and the seeds usually germinate right away with no cold stratification needed (occasionally some might remain dormant until the following year). The species attains its greatest growth potential in the Northeastern US, while elms in the Deep South and Texas grow much smaller and have shorter lifespans, although conversely their survival rate in the latter regions is higher due to the climate being unfavorable for the spread of Dutch elm disease.

In the United States, the American elm is a major member of four major forest cover types: black ash-American elm-red maple; silver maple-American elm; sugarberry-American elm-green ash; and sycamore-sweetgum-American elm, with the first two of these types also occurring in Canada.*[11] A sugar maple-ironwood-American elm cover type occurs on some hilltops near Témiscaming, Quebec.*[12]

The leaves of the American elm serve as food for the larvae of various lepidopterans (butterflies & moths).

45.4 Pests and diseases

The American elm is highly susceptible to Dutch elm disease (DED) and elm yellows. In north America, there are three species of elm bark beetles; one native: *Hylurgopinus rufipes* ("native elm bark beetle"), and two invasive: *Scolytus multistriatus* ("smaller European elm bark beetle") and *Scolytus schevyrewi* ("banded elm bark beetle"). Although intensive feeding by elm bark beetles can kill weakened trees,*[13] their main impact is as vectors of DED.

American elm is also moderately preferred for feed-

ing and reproduction by the adult elm leaf beetle *Xanthogaleruca luteola*,*[14] and highly preferred for feeding by the Japanese beetle *Popillia japonica**[15] in the United States.

U. americana is also the most susceptible of all the elms to verticillium wilt,*[16] whose external symptoms closely mimic those of DED. However, the condition is far less serious, and afflicted trees should recover the following year.

45.4.1 Dutch elm disease

Main article: Dutch elm disease

Dutch elm disease (DED) is a fungal disease which has ravaged the American elm, causing catastrophic die-offs in cities across the range. It has been estimated that only approximately 1 in 100,000 American elm trees is DED-tolerant, most known survivors simply having escaped exposure to the disease.*[17] However, in some areas still not populated by Dutch elm disease, the American elm continues to thrive, notably in Florida, Alberta and British Columbia.

The American elm is particularly susceptible to disease because the period of infection often coincides with the period, approximately 30 days, of rapid terminal growth when new springwood vessels are fully functional. Spores introduced outside of this period remain largely static within the xylem and are thus relatively ineffective.*[18]

The American elm's biology in some ways has helped to spare it from obliteration by the Dutch elm disease, in contrast to what happened to the American chestnut with the chestnut blight. The elm's seeds are largely wind-dispersed, and the tree grows quickly and begins bearing seeds at a young age. It grows well along roads or railroad tracks, and in abandoned lots and other disturbed areas, where it is highly tolerant of most stress factors. Elms have been able to survive and to reproduce in areas where the disease had eliminated old trees, although most of these young elms eventually succumb to the disease at a relatively young age. There is some reason to hope that these elms will preserve the genetic diversity of the original population, and that they eventually will hybridize with DED-resistant varieties that have been developed or that occur naturally. After 20 years of research, American scientists first developed DED-resistant strains of elms in the late 1990s.*[17]

Fungicidal injections can be administered to valuable American elms, to prevent infection. Such injections generally are effective as a preventive measure for up to three years when performed before any symptoms have appeared, but may be ineffective once the disease is evident.

45.5 Cultivation

In the 19th and early 20th century, American elm was a common street and park tree owing to its tolerance of urban conditions, rapid growth, and graceful form. This however led to extreme overplanting of the species, especially to form living archways over streets, which ultimately produced an unhealthy **monoculture** of elms that had no resistance to disease and pests.*[19] These trees' rapid growth and longevity, leading to great size within decades, also favored its horticultural use before the advent of Dutch elm disease.*[9] Ohio botanist William B. Werthner, discussing the contrast between open-grown and forest-grown American elms, noted that:

In the open, with an abundance of air and light, the main trunk divides into several leading branches which leave the trunk at a sharp angle and continue to grow upward, gradually diverging, dividing and subdividing into long, flexible branchlets whose ends, at last, float lightly in the air, giving the tree a round, somewhat flattened top of beautifully regular proportions and characteristically fine twig-gery.*[9]

It is this distinctive growth form that is so valued in the open-grown American elms of street plantings, lawns, and parks; along most narrower streets, elms planted on opposite sides arch and blend together into a leafy canopy over the pavement. However, elms can assume many different sizes and forms depending on the location and climate zone, and the classic vase-like shape is far from the norm in naturally occurring (as opposed to cultivated) specimens.



- Early photos of New England American elms, showing growth patterns, *The New International Encyclopædia* (1905).



- Lafayette Street, Salem, MA.: 'high-tunnel effect' of *U. americana* avenues once common in New England.



- Surviving American elm "street tree" in western Massachusetts (2016).



- *Ulmus americana* as campus elm: Cambridge, Massachusetts



- American elm, Massachusetts (2012). Girth 19.3 ft at 4.5 ft above ground; height 106.8 ft; avg. crown spread 105 ft.



- American elm, Massachusetts (2012). Girth 17 ft at 4.5 ft above ground; est. height 100 ft; spread 87 ft.



- American elm, New England (2012). Girth 18 ft at 4.5 ft above ground; est. height 80 ft; spread 100 ft.



- "The Grayson Elm" in winter. American elm, Massachusetts (2013), with

octopus-like limbs. Girth 17 ft; height 80 ft.



- “The Grayson Elm” in summer (2016).



- Grant Crescent, Griffith, Australia: American elms in autumn.



- Grant Crescent, Griffith, Australia: American elms in winter.



- American Elm in Johnstown, NY. 199 inches in circumference and 90 feet tall.



- American elm, Spring Grove Cemetery, Hartford, CT (2012). Girth 15 ft at 4.5 ft above ground; height 95 ft; spread 75 ft.



- American Elms, Central Park (Spring 2011).

American elms have been planted in North America beyond its natural range as far north as central Alberta, and south to Lake Worth, Florida. It also survives low desert heat at Phoenix, Arizona.

Introductions across the Atlantic rarely prospered, even before the outbreak of Dutch elm disease. Introduced to the UK by James Gordon in 1752, it was noted that the foliage of the American elm was far more susceptible to insect damage than native elms.* [20] A few, mostly young, cultivars survive in British arboreta.* [21] Introduced to Australasia, the tree was listed by Australian nurseries in the early 20th century. It is known to have been planted along the Avenue of Honour at Ballarat, Victoria and the Avenue of Honour in Bacchus Marsh, Victoria. In addition, a heritage-listed planting of American elms can be found along Grant Crescent in Griffith, Australian Capital Territory.* [22] American Elms are only rarely found in New Zealand.* [23]

45.5.1 Cultivars

See the list of Elm cultivars, hybrids and hybrid cultivars for more details.

Numerous cultivars have been raised, originally for their aesthetic merit but more recently for their resistance to Dutch elm disease* [24] The total number of named cultivars is circa 45, at least 18 of which have probably been lost to cultivation as a consequence of Dutch elm disease or other factors:

- American Liberty, Ascendens, Augustine, Aurea, Beaverlodge, Beebe's Weeping, Brandon, Burgoine, College, Columnaris, Creole Queen, Deadfree, Delaware, Exhibition, Fiorei, Flick's Spreader, Folia Aurea Variegata, Hines, Incisa, Independence, Iowa State, Jackson, Jefferson, 'JFS-Prince II' = Colonial Spirit™, Kimley, Klehmii, Lake City, L'Assomption, Lewis & Clark = Prairie Expedition™, Littleford, Markham, Miller Park, Minneapolis Park, Moline, Morden, New Harmony, Nigricans, Patmore, Pendula, Penn Treaty, Princeton, Pyramidata, Queen City, St. Croix, Sheyenne, Skinner Upright, Star, Valley Forge, Variegata, Vase, Washington

The National Elm Trial, begun in 2005, is currently evaluating 19 hybrid and species cultivars in scientific plantings across the United States to better assess their strengths and weaknesses.

The few disease-resistant selections made available to the public as yet include 'Valley Forge', 'New Harmony', 'Princeton', 'Jefferson', and a set of six different clones collectively known as 'American Liberty'.* [25] The United States National Arboretum released 'Valley Forge' and 'New Harmony' in late 1995, after screening

tests performed in 1992–1993 showed both had unusually high levels of resistance to DED. 'Valley Forge' performed especially well in these tests. 'Princeton' has been in occasional cultivation since the 1920s, and gained renewed attention after its performance in the same screening tests showed it also to have a high degree of DED resistance. A later test performed in 2002–2003 confirmed the DED resistance of these same three varieties, and that of 'Jefferson'. 'Jefferson' was released to wholesale nurseries in 2004 and is becoming increasingly available for planting. Thus far, plantings of these four varieties generally appear to be successful.

In 2005, 90 'Princeton' elms were planted along Pennsylvania Avenue near the White House and to date are healthy and thriving. Introduced to the UK in 2001, 'Princeton' was planted by HRH The Prince of Wales to form the Anniversary Avenue from the Orchard Room reception centre to the Golden Bird statue at Highgrove House, however the trees succumbed to DED five years later and were felled and burned. In 2007, the 'Elm Recovery Project'*[26] from the University of Guelph in Ontario, Canada, reported that cuttings from healthy surviving old elms surveyed across Ontario had been grown to produce a bank of resistant trees, isolated for selective breeding of highly resistant cultivars.*[27]

45.5.2 Hybrids and hybrid cultivars

- *Ulmus 'Rebella'* (*U. americana* × *U. parvifolia*)

Thousands of attempts to cross the American elm with the Siberian elm *U. pumila* failed.*[28] Attempts at the Arnold Arboretum using ten other American, European and Asiatic species also ended in failure, attributed to the differences in ploidy levels, and operational dichogamy,*[6] although the ploidy factor has been discounted by other authorities.*[29]

Success was finally achieved with the autumn-flowering Chinese elm *Ulmus parvifolia* by the late Prof. Eugene Smalley towards the end of his career at the University of Wisconsin-Madison after he overcame the problem of keeping Chinese elm pollen alive until spring.*[30] Only one of the hybrid clones was commercially released, as 'Rebella' in 2011 by the German nursery Eisele GmbH; the clone is not available in the USA.

Other artificial hybridizations with American elm are rare, and now regarded with suspicion. Two such alleged successes by the nursery trade were 'Hamburg', and 'Kansas Hybrid', both with Siberian elm *Ulmus pumila*. However, given the repeated failure with the two species by research institutions, it is now believed that the "American elm" in question was more likely to have been the red elm, *Ulmus rubra*.*[31]

45.6 Other uses

45.6.1 Wood



A wooden hand plane made of American elm.

The American elm's wood is coarse, hard, and tough, with interlacing, contorted fibers that make it difficult to split or chop, and cause it to warp after sawing.*[9] Accordingly, the wood originally had few uses, save for making hubs for wagon wheels.*[9] Later, with the advent of mechanical sawing, American elm wood was used for barrel staves, trunk-slats, and hoop-poles, and subsequently became fundamental to the manufacture of wooden automobile bodies, with the intricate fibers holding screws unusually well.*[9]

45.6.2 Pioneer and traditional uses

Young twigs and branchlets of the American elm have tough, fibrous bark that has been used as a tying and binding material, even for rope swings for children, and also for making whips.*[9]

45.7 Notable trees

See also: List of elm trees § American Elm *Ulmus americana*

A fair number of mostly small to medium-sized American elms survive nowadays in woodlands, suburban areas, and occasionally cities, where most often the survivors had been relatively isolated from other elms and thus spared a severe exposure to the fungus. For example, in Central Park and Tompkins Square Park in New York City,*[32] stands of several large elms originally planted by Frederick Law Olmsted survive because of their isolation from neighboring areas in New York where there had been heavy mortality. The Olmsted-designed park system in Buffalo, NY *[33] did not fare

as well. A row of mature American elms graces Central Park along the entire length of Fifth Avenue from 110th St to 59th.* [34] In Akron, Ohio there is a very old elm tree that has not been infected. In historical areas of Philadelphia, Pennsylvania, there are also a few mature American elms still standing — notably in Independence Square and the Quadrangle at the University of Pennsylvania, and also at the nearby campuses of Haverford College, Swarthmore College, and The Pennsylvania State University, believed to be the largest remaining stand in the country.* [35] There are several large American Elm trees in western Massachusetts. The large Massachusetts Champion Elm stands on Summer Street in the Berkshire County town of Lanesborough, Massachusetts has been kept alive by antifungal treatments. Rutgers University has preserved 55 mature elms on and in the vicinity of Voorhees Mall on the College Avenue Campus in New Brunswick, New Jersey in addition to seven disease-resistant trees that have been planted in this area of the campus in recent years.* [36]

The largest surviving urban forest of American elms in North America is believed to be in the city of Winnipeg, Canada, where close to 200,000 elms remain. The city of Winnipeg spends \$3M annually to aggressively combat the disease utilizing Dursban Turf* [37] and the Dutch Trig vaccine,* [38] losing 1500-4000 trees per year.

45.7.1 Treaty Elm

The Treaty Elm, Philadelphia, Pennsylvania. In what is now Penn Treaty Park, the founder of Pennsylvania, William Penn, is said to have entered into a treaty of peace in 1683 with the native Lenape Turtle Clan under a picturesque elm tree immortalized in a painting by Benjamin West. West made the tree, already a local landmark, famous by incorporating it into his painting after hearing legends (of unknown veracity) about the tree being the location of the treaty. No documentary evidence exists of any treaty Penn signed beneath a particular tree. On March 6, 1810 a great storm blew the tree down. Measurements taken at the time showed it to have a circumference of 24 feet (7.3 m), and its age was estimated to be 280 years. Wood from the tree was made into furniture, canes, walking sticks and various trinkets that Philadelphians kept as relics.* [39]

45.7.2 Liberty Tree

The Liberty Tree, an elm on Boston Common in Boston, Massachusetts, was a rallying point for the growing resistance to the rule of England over the American colonies.* [40]



Plaque marking the site of the original Liberty Tree in Boston

45.7.3 Washington Elm (Massachusetts)

The Washington Elm, Cambridge, Massachusetts. George Washington is said to have taken command of the American Continental Army under the Washington Elm in Cambridge on July 3, 1775. The tree survived until the 1920s and “was thought to be a survivor of the primeval forest”. In 1872, a large branch fell from it and was used to construct a pulpit for a nearby church.* [41] The tree, an American white elm, became a celebrated attraction, with its own plaque, a fence constructed around it and a road moved in order to help preserve it.* [42] The tree was cut down (or fell —sources differ) in October 1920 after an expert determined it was dead. The city of Cambridge had plans for it to be “carefully cut up and a piece sent to each state of the country and to the District of Columbia and Alaska,” according to *The Harvard Crimson*.* [43] As late as the early 1930s, garden shops advertised that they had cuttings of the tree for sale, although the accuracy of the claims has been doubted. A Harvard “professor of plant anatomy” examined the tree rings days after the tree was felled and pronounced it between 204 and 210 years old, making it at most 62 years old when Washington took command of the troops at Cambridge. The tree would have been a little more than two feet in diameter (at 30 inches above ground) in 1773.* [44] In 1896, an alumnus of the University of Washington, obtained a rooted cutting of the Cambridge tree and sent it to Professor Edmund Meany at the university. The cutting was planted, cuttings were then taken from it, including one planted on February 18, 1932, the 200th anniversary of the birth of George Washington, for whom Washington state is named. That tree remains on the campus of the Washington State Capitol. Just to the west of the tree is a small elm from a cutting made in 1979.* [42]

45.7.4 Washington Elm (District of Columbia)

George Washington's Elm, Washington, D.C. George Washington supposedly had a favorite spot under an elm tree near the United States Capitol Building from which he would watch construction of the building. The elm stood near the Senate wing of the Capitol building until 1948.*[41]

45.7.5 Logan Elm

The Logan Elm that stood near Circleville, Ohio, was one of the largest American elms in the world. The 65-foot-tall (20 m) tree had a trunk circumference of 24 feet (7.3 m) and a crown spread of 180 feet (55 m).*[45] Weakened by Dutch elm disease, the tree died in 1964 from storm damage.*[45] The Logan Elm State Memorial commemorates the site and preserves various associated markers and monuments.*[45] According to tradition, Chief Logan of the Mingo tribe delivered a passionate speech at a peace-treaty meeting under this elm in 1774,*[45]*[46]

45.7.6 "Herbie"



An April 21, 2008, picture of Herbie

Another notable American elm, named Herbie, was the tallest American elm in New England until it was cut down on January 19, 2010, after it succumbed to Dutch elm disease. Herbie was 110 feet (34 m) tall at its peak

and had a circumference of 20.3 feet (6.2 m), or a diameter of approximately 6.5 feet (2.0 m). The tree stood in Yarmouth, Maine, where it was cared for by the town's tree warden, Frank Knight.*[47]

When cut down, Herbie was 217 years old. Herbie's wood is of interest to dendroclimatologists, who will use cross-sections of the trunk to help answer questions about climate during the tree's lifetime.*[47]

45.7.7 Central Park stand



American elms along The Mall and Literary Walk, Central Park

New York City's Central Park is home to approximately 1,200 American elms, which constitute over half of all trees in the park. The oldest of these elms were planted during the 1860s by Frederick Law Olmsted, making them among the oldest stands of American elms in the world. The trees are particularly noteworthy along the Mall and Literary Walk, where four lines of American elms dramatically stretch over the walkway forming a cathedral-like covering. The elms are an important part of New York City's ecology by improving air and water quality, reducing erosion and flooding, and lowering the air temperature during the hottest days of the year.*[48]

While still vulnerable to the highly contagious Dutch elm disease, in the 1980s the Central Park Conservancy undertook aggressive counter-DED measures such as heavy pruning and removal of extensively diseased trees. These efforts have largely been successful in saving the majority of the trees, although several are still lost each year. Younger American elms which have been planted in Central Park since the outbreak are of the "Princeton" and "Valley Forge" variety of DED-resistant elms.*[49]

45.7.8 National champion

The USA national champion, measuring 34 metres (112 ft) high in 2010, stands at Iberville, Louisiana.*[50] Across the Atlantic, the TROBI champion grows at Avondale in Wicklow, Ireland; last measured in 2000, it was 22.5 metres (74 ft) high by 98 cm 98 centimetres (39 in) diameter at breast height.

45.7.9 The Glencorradale Elm

The Glencorradale Elm on Prince Edward Island, Canada, is a surviving 'wild' elm believed to be several hundred years old.*[51]

45.7.10 Survivor Tree



The Survivor Tree at the Oklahoma City National Memorial

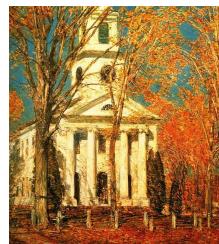
An American elm located in a parking lot directly across the street from the Alfred P. Murrah Federal Building in Oklahoma City survived the Oklahoma City bombing on April 19, 1995 that killed 168 people and destroyed the Murrah building. Damaged in the blast, with fragments lodged in its trunk and branches, it was nearly cut down in efforts to recover evidence. However, nearly a year later the tree began to bloom. Then known as the Survivor Tree, it became an important part of the Oklahoma City National Memorial, and is featured prominently on the official logo of the memorial.*[52]

45.8 *Ulmus americana* in art and photography

The nobility and arching grace of the American Elm in its heyday, on farms, in villages, in towns and on campuses, were celebrated in the books of photographs of Wallace Nutting (*Massachusetts Beautiful*, N.Y. 1923, and other volumes in the series) and of Samuel Chamberlain (*The New England Image*, New York, 1962). Frederick Childe Hassam is notable among painters who have depicted American Elm.



• Frederick Childe Hassam,
'Washington Arch, Spring' [1893]



• Frederick Childe Hassam,
'Church at Old Lyme' [1905]



• Frederick Childe Hassam,
'The East Hampton Elms in May' [1920]



• George Inness, 'Old Elm at Medfield'

45.9 See also

- List of Lepidoptera that feed on elms

45.10 Accessions

North America

- Arnold Arboretum, acc. nos. 250-53 (cult. material), 412-86 wild collected in the USA.
- Bernheim Arboretum and Research Forest, Clermont, Kentucky. No details available.
- Denver Botanic Gardens, one specimen, no details.
- Latina Nursery, Searcy, AR, two specimens, no details.
- Holden Arboretum, acc. nos. 2005-17, 65-632, 80-663, all of unrecorded provenance.
- Longwood Gardens, acc. nos. 1997-0074, L-0352, sources unrecorded.
- Missouri Botanical Garden, St. Louis, Missouri. acc. nos. 1969-6172, 1986-0206, 1986-0207, 1986-0208.

- New York Botanical Garden, acc. nos. 877/97, 944/96, 1854/99, 2111/99, 06791, all unrecorded provenance.
- Phipps Conservatory & Botanical Gardens, acc. nos. 00/1265, 99/0660.
- Scott Arboretum, acc. no. S000339, no other details available.
- U.S. National Arboretum, Washington, D.C., United States. Acc. nos. 64254, 64255, 64256, 66355, 66426, 68988, 69304, 66341.

Europe

- Brighton & Hove City Council, UK. NCCPG elm collection.
- Dubrava Arboretum, Lithuania. No accession details available.
- Hortus Botanicus Nationalis, Salaspils, Latvia. Acc. nos. 18087, 88, 89, 90, 91, 92.
- Wakehurst Place Garden, Wakehurst Place, UK. Acc. nos. 1994-67, 1994-68, 1991-1163.
- Linnaean Gardens of Uppsala, Sweden. Acc. nos. 1976-2713, 0000-2170
- Strona Arboretum, University of Life Sciences, Warsaw, Poland. No accession details available.
- Royal Botanic Garden Edinburgh, UK. Acc. no. 19901741, wild collected in Canada
- Tallinn Botanic Garden, Estonia. No accession details available.
- Thenford House arboretum, Northamptonshire, UK. No accession details available.
- University of Copenhagen, Botanic Garden. Acc. no. P1971-5201, wild collected in the USA.
- Wijdemeren City Council, Netherlands, Elm collection; U. americana 'Princeton' planted 2015 Overmeerseweg, Nederhorst den Berg, 2016; U.a. 'Patriot', Dammerweg, Nederhorst den Berg; 'New Harmony', 'Valley Forge', 'Lewis & Clark': garden City Hall, Rading 1, Loosdrecht, Netherlands.

Australazië

- Eastwoodhill Arboretum, Gisborne, New Zealand. 11 trees, accession details not known.

45.11 Notes

[1] The name "water elm" is also used for *Planera aquatica*, another species in the Ulmaceae.

45.12 References

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45.13 External links

- USDA Plants Profile of *Ulmus americana* (American elm)
- Flora of North America: profile of *Ulmus americana*
 - Flora of North America: distribution map for *Ulmus americana*
- *Ulmus americana* images
- Saving the American Elm, by Bruce Carley
- Keith Warren, J. Frank Schmidt & Son Co. (2002): 'The Status of Elms in the Nursery Industry in 2000'
- Plant atlas synonyms
- The International Plant Names Index
- Michigan State University *Plant Encyclopedia*: *Ulmus americana* fact-page and photographs pg. 1
 - Michigan State University *Plant Encyclopedia*: photographs pg. 2
- 'Elms of the Monumental Core' (Washington D.C.) —*National Park Service (2009)*, by James L. Sheridan.

Chapter 46

Ulmus rubra

“Red Elm” redirects here. For the community in the United States, see Red Elm, South Dakota.

Ulmus rubra, the **slippery elm**, is a species of elm native to eastern North America, ranging from southeast North Dakota, east to Maine and southern Quebec, south to northernmost Florida, and west to eastern Texas, where it thrives in moist uplands, although it will also grow in dry, intermediate soils.*[3] Other common names include red elm, gray elm, soft elm, moose elm, and Indian elm. The tree was first named as part of *Ulmus americana* in 1753,*[4] but identified as a separate species, *Ulmus rubra*, in 1793 by Pennsylvania botanist Gotthilf Muhlenberg. The slightly later name *U. fulva*, published by French botanist André Michaux in 1803,*[5] is still widely used in dietary-supplement and alternative-medicine information.

The species superficially resembles American elm *U. americana*, but is more closely related to the European wych elm *U. glabra*, which has a very similar flower structure, though lacks the pubescence over the seed.*[6] *U. rubra* was introduced to Europe in 1830.*[4]

gle, central seed coated with red-brown hairs, naked elsewhere.*[8]



• Downy leaf bud and flower buds of *U. rubra*



• *U. rubra* flowers



• Asymmetrical leaf of *Ulmus rubra*



• Mature trunk bark



- Downy leaf-buds of *U. rubra* and downy seed area of samarae (Pennsylvania Department of Forestry, 1901)

46.2 Pests and diseases

The tree is reputedly less susceptible to Dutch elm disease than other species of American elms,* [10] but is severely damaged by the elm leaf beetle (*Xanthogaleruca luteola*).* [11]

46.3 Cultivation

The species has not been planted for ornament in its native country. Introduced to Europe and Australasia, it has never thrived in the UK; Elwes & Henry knew of not one good specimen,* [6] and the last tree planted at Kew attained a height of only 12 m (39 ft) in 60 years.* [8] Specimens supplied by the Späth nursery to the Royal Botanic Garden Edinburgh in 1902 as *U. fulva* may survive in Edinburgh as it was the practice of the Garden to distribute trees about the city (viz. the Wentworth Elm).* [12] A specimen at RBGE was felled c.1990. The current list of Living Accessions held in the Garden *per se* does not list the plant.* [13]

46.4 Notable trees

A tree in Westmount, Quebec, Canada, measured 4.27 m in girth in 2011.* [14]* [15] The USA National Champion, measuring 38 m high in 2011, grows in Daviess County, Indiana.* [16]* [17] Another tall specimen grows in the Bronx, New York City, at 710 West 246th Street, measuring 31 m (102 ft) high in 2002.* [18] In the UK, there is no designated TROBI champion, however several mature trees survive in Brighton (see Accessions).

46.5 Cultivars

There are no known cultivars, however the hybrid *U. rubra* × *U. pumila* cultivar 'Lincoln' is occasionally listed as *Ulmus rubra* 'Lincoln' in error.

46.6 Hybrids

In the central United States, native *U. rubra* hybridizes in the wild with the Siberian elm (*U. pumila*),* [19]* [20] which was introduced in the early 20th century and which has spread widely since then, prompting conservation concerns for the former species.* [21]

46.7 Hybrid cultivars

U. rubra had limited success as a hybrid parent in the 1960s, resulting in the cultivars 'Coolshade', 'Fremont', 'Improved Coolshade', 'Lincoln', 'Rosehill', and probably 'Willis'.* [22] In later years, it was also used in the Wisconsin elm breeding program to produce 'Repura' and 'Revera'* [23] although neither is known to have been released to commerce.

46.8 Etymology

The specific epithet *rubra* (red) alludes to the tree's reddish wood, whilst the common name "slippery elm" alludes to the mucilaginous inner bark.

46.9 Uses



Cross-sections of moose elm from *The American Woods*

46.9.1 Medicinal

Ulmus rubra has various traditional medicinal uses. The mucilaginous inner bark of the tree has long been used as a demulcent, and is still produced commercially for this purpose in the United States with approval for sale as an over-the-counter demulcent by the U.S. Food and Drug Administration.*[24] Sometimes leaves are dried and ground into a powder, then made into a tea.

46.9.2 Timber

The timber is not of much importance commercially, and is not found anywhere in great quantity.*[6] Macoun considered it more durable than that of the other elms,*[25] and better suited for railway ties, fence-posts, and rails, while Pinchot recommended planting it in the Mississippi valley, as it grows fast in youth, and could be utilized for fence-posts when quite young, since the sapwood, if thoroughly dried, is quite as durable as the heartwood.*[26] The wood is also used for the hubs of wagon wheels, as it is very shock resistant owing to the interlocking grain.*[27] The wood, as 'red elm', is sometimes used to make bows for archery. The yoke of the Liberty Bell, a symbol of the independence of the United States, was made from slippery elm.

46.9.3 Baseball

Though now outmoded, slippery elm tablets were chewed by spitball pitchers to enhance the effectiveness of the saliva applied to make the pitched baseball curve.*[28]

46.9.4 Miscellaneous

The tree's fibrous inner bark produces a strong and durable fiber that can be spun into thread, twine, or rope*[27] useful for bow strings, ropes, jewellery, clothing, snowshoe bindings, woven mats, and even some musical instruments. Once cured, the wood is also excellent for starting fires with the bow-drill method, as it grinds into a very fine flammable powder under friction.

46.10 Accessions

North America

- Arnold Arboretum. Acc. nos. 737–88, 738–88, both of unrecorded provenance.
- Bernheim Arboretum and Research Forest , Clermont, Kentucky. No details available.
- Brenton Arboretum, Dallas Center, Iowa. No details available.

- Chicago Botanic Garden, Glencoe, Illinois. 1 tree, no other details available.
- Dominion Arboretum, Ottawa, Canada. No acc. details available.
- Longwood Gardens. Acc. no. L-3002, of unrecorded provenance.
- Nebraska Statewide Arboretum. No details available.
- Smith College. Acc. no. 8119PA.
- U S National Arboretum , Washington, D.C., United States. Acc. no. 77501.

Europe

- Brighton & Hove City Council, NCCPG Elm Collection.*[29] Carden Park, Hollingdean (1 tree); Malthouse Car Park, Kemp Town (1 tree).
- Grange Farm Arboretum, Sutton St James, Spalding, Lincolnshire, UK. Acc. no. 522
- Hortus Botanicus Nationalis, Salaspils, Latvia. Acc. nos. 18168, 18169, 18170.
- Linnaean Gardens of Uppsala, Sweden. As *U. fulva*. Acc. no. 1955–1052.
- Royal Botanic Gardens Wakehurst Place. Acc. no. 1973–21050.
- Thenford House arboretum, Northamptonshire, UK. No details available.
- University of Copenhagen Botanic Garden. No details available.

Australasia

- Eastwoodhill Arboretum , Gisborne, New Zealand. 1 tree, no details available.

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46.12 External links

- "Ulmus rubra". Natural Resources Conservation Service PLANTS Database. USDA.
- Dr. Duke's Databases: List of Chemicals in *Ulmus rubra*
- Ohio DNR.gov: Slippery Elm
- Bioimages.vanderbilt.edu: *Ulmus rubra* photo gallery
- "Herbarium specimen - E00824848". *Herbarium Catalogue*. Royal Botanic Garden Edinburgh. Sheet described as *U. fulva*
- "Herbarium specimen - E00824847". *Herbarium Catalogue*. Royal Botanic Garden Edinburgh. Sheet described as *U. fulva*, RBGE specimen from Späth nursery 1902

Chapter 47

Viburnum prunifolium

Viburnum prunifolium (known as **blackhaw** or **black haw**, **blackhaw viburnum**, **sweet haw**, and **stag bush**) is a species of *Viburnum* native to eastern North America, from Connecticut west to eastern Kansas, and south to Alabama and Texas.* [1]

47.1 Growth



Flowers

It is a **deciduous shrub** or small **tree** growing to 2–9 metres (7–30 ft) tall with a short crooked trunk and stout spreading branches; in the northern parts of its range, it is a shrub, becoming a small tree in the southern parts of its range. The **bark** is reddish-brown, very rough on old stems. The branchlets are red at first, then green, finally dark brown tinged with red. The winter **buds** are coated with rusty **tomentum**. The flower buds ovate, 1 cm long, much larger than the axillary buds. The **leaves** are simple, up to 9 cm long and 6 cm broad, oval, ovate or orbicular, wedge-shaped or rounded at base, serrate, acute, with serrated edges with a grooved and slightly winged red petiole 1.5 cm long; they turn red in fall. The leaves are superficially similar to some species of *Prunus* (thus "*prunifolium*"); they come out of the bud involute, shining, green, tinged with red, sometimes smooth, or clothed with rusty tomentum; when full grown dark green and smooth above, pale, smooth or tomentose beneath.* [2]*[3]*[4]*[5]

47.2 Characteristics

The **flowers** are creamy white, 9 mm diameter; the calyx is urn-shaped, five-toothed, persistent; the **corolla** is five-lobed, with rounded lobes, imbricate in bud; the five stamens alternate with the corolla lobes, the filaments slender, the anthers pale yellow, oblong, two-celled, the cells opening longitudinally; the ovary is inferior, one-celled, with a thick, pale green style and a flat stigma and a single ovule. The flowers are borne in flat-topped cymes 10 cm in diameter in mid to late spring. The **fruit** is a **drupe** 1 cm long, dark blue-black with glaucous bloom, hangs until winter, becomes edible after being frosted, then eaten by birds; the stone is flat and even, broadly oval. Wherever it lives, black haw prefers sunny woodland with well-drained soil and adequate water.* [2]*[3]*[4]*[5]

47.3 Uses

It has both value in the pleasure garden, providing good fall color and early winter provender for birds, and medicinal properties.

It has hybridized with *Viburnum lentago* in cultivation to give the garden hybrid *Viburnum × jackii*.

The **wood** is brown tinged with red; heavy, hard, close-grained with a density of 0.8332.* [4]

47.3.1 Medicinal uses

For centuries, black haw has been used for medical purposes, mainly for **gynecological** conditions. The bark is the part of the plant used in treatments.* [3]

The active components include scopoletin, aesculetin, salicin, 1-methyl-2,3 clibutyl hemimellitate, and viburnin. Tannin is another chemical component of black haw.* [3]

Native Americans used a decoction of black haw to treat gynecological conditions, including menstrual cramps, aiding recovery after **childbirth**, and in treating the effects of menopause.* [5] As a folk remedy, black haw has been used to treat menstrual pain, and morning sickness.

Due to its antispasmodic properties, the plant may also be of use in treating cramps of the digestive tract or the bile ducts.* [3]

Black haw's primary use was to prevent miscarriages.* [3] American slaveholders also used the plant to prevent abortions. Slaves were a valuable asset, and their owner also owned their offspring, so ensuring that female slaves gave birth was of paramount importance. In defiance, some slave women would attempt to use cotton seeds to cause a miscarriage. The slaveowners would therefore force pregnant slaves to drink an infusion of black haw to prevent that.* [5]

The primary use of black haw today is to prevent menstrual cramps. The salicin in black haw may also be of use in pain relief.* [5]

47.3.2 Safety issues

Like many other plants, including many food plants and those used as culinary herbs, black haw contains salicin, a chemical relative of aspirin. Those who are allergic to that substance should not use black haw.* [3] In addition, due to the connection between aspirin and Reye syndrome, young people or people afflicted with a viral disease should not use black haw.

The chemicals in black haw do relax the uterus and therefore probably prevent miscarriage; however, the salicin may be teratogenic. Consequently, pregnant women should not use black haw in the first two trimesters.* [5] Furthermore, anyone using herbs for medical reasons should only use them under the supervision of a qualified medical professional.

Black haw is not on the “generally recognized as safe list” of the U.S. Food and Drug Administration (FDA).* [6]

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47.5 Text and image sources, contributors, and licenses

47.5.1 Text

- **Acer negundo** *Source:* https://en.wikipedia.org/wiki/Acer_negundo?oldid=782029450 *Contributors:* Magnus Manske, Bryan Derksen, Nonenmac, Stan Shebs, Charles Matthews, Marshman, Hyacinth, SEWilco, RedWolf, Moondyne, UtherSRG, MPF, Bradeos Graphon, Solipsist, Keith Edkins, Antandrus, JoJan, Mzajac, Neutrality, Famartin, Stepp-Wulf, DanielCD, Fungus Guy, Closeapple, Alex3917, CanisRufus, Circeus, Giraffedata, Vanished user 19794758563875, Hesperian, Alansohn, Velella, Rick Sidwell, RyanGerbil10, Stemonitis, Tabletop, Schzmo, WBardwin, Magister Mathematicae, Kalmia, JIP, Ihk, Ricardo Carneiro Pires, FlaBot, Eubot, RexNL, Roby-Wayne, DVdm, Gdrbot, YurikBot, RobotE, Hede2000, Ormanbotanigi, BOT-Superzerocool, Asarelah, Mmcannis, Pompiliid, Smack-Bot, Cazort, Psiphiorg, Chris the speller, SB Johnny, Dlohcierekim's sock, MTSbot~enwiki, Hu12, Lavateraguy, Baskaufs, Cydebot, Tommyallen789, Casliber, Thijs!bot, Epbr123, Mad Scientist, MojoXN, KP Botany, N7bsn, D V S, JAnDbot, Altairisfar, Avjoska, Peter coxhead, Drm310, Vcpeters, R'n'B, Boston, Adavidb, PatríciaR, Skumarlabot, VonTasha, M-le-mot-dit, SriMesh, Nadiatalent, STBotD, Spiesr, Kmanblue, Black Walnut, Jgosteli, Squids and Chips, Idioma-bot, VolkovBot, Jmrowland, Bob103051, Jaguarlaser, Alcmaeonid, Monty845, Scottclark, Bfpage, Eewilson, ClueBot, The Thing That Should Not Be, Jd.101, LarryMorseDCOhio, La Pianista, ClintGoss, DumZiBoT, Addbot, DOI bot, Alexalexspb, LaaknorBot, Numbo3-bot, Erantuon, Lightbot, First Light, Zorrobot, StercusAccidit181, Yobot, AnomieBOT, Tom87020, Citation bot, Xqbot, Weepingraf, Gmihail, GrouchoBot, Martin Gazdik, Potejam, FrescoBot, Andrewmgaa, Citation bot 1, DrilBot, Pinethicket, Trappist the monk, Stinawp, Ripchip Bot, EmausBot, Look2See1, Peterusso, Djembayz, Rcsprinter123, ChuispastonBot, عَمَّرُو بْنُ قَلْثَوْنٍ, ClueBot NG, O.Koslowski, Plantdrew, CitationCleanerBot, Hendrick04, YFdhyh-bot, Sminthopsis84, ArmbrustBot, Nightphoenix90, Trixie05, Stamptrader, Joseph Laferriere, Impuls666666, Kasekris, Apaffra1, InternetArchiveBot, Manoudouz, GreenC bot, Tjreaume, Magic links bot and Anonymous: 60
- **Acer platanoides** *Source:* https://en.wikipedia.org/wiki/Acer_platanoides?oldid=782029507 *Contributors:* Tarquin, William Avery, Ahoerstemeier, Julesd, Franz Xaver, Marshman, Inc, Dcsohl, Eugene van der Pijll, Kdebisschop, Robbot, RedWolf, M1shawhan, Angilbas, Srtxg, MPF, Varlaam, Yath, Quadell, JoJan, Neutrality, Famartin, Atrian, Bender235, Closeapple, JoeSmack, Hapsiainen, Shanes, Circeus, Hesperian, Ricky81682, Algirdas, Denniss, Matthias5, Shoefly, Stemonitis, Richard Barlow, Jean-Pol Grandmont, Kalmia, Rjwilmsi, Nihiertes, Gdrbot, YurikBot, Eupator, Epolk, Ormanbotanigi, Nlu, Majkl82, Lt-wiki-bot, Hirudo, N3362, West Virginian, Mangoe, Aelfthrytha, Bomac, Kilo-Lima, Gaff, Gilliam, Skizzik, Rkitko, Hibernian, Rrburke, Kingdon, Dcruz01, MTSbot~enwiki, Kaarel, Coffeezombie, Baskaufs, Cydebot, Dipics, Rosser1954, Thijs!bot, Luna Santin, Storkk, JAnDbot, WANAX, DuncanHill, Plantsurfer, Whilom, Magioladitis, Peter coxhead, Vcpeters, CommonsDelinker, Wiki Raja, J.delanoy, Athaenara, Knulclunk, Nadiatalent, Idioma-bot, VolkovBot, David Stang, Poshmoog, TXiKiBoT, FlyingAce, Rei-bot, GcSwRhIc, OverToasty, Jaguarlaser, Falcon8765, Truthanado, SieBot, Phe-bot, IvanTortuga, Fangjian, ClueBot, Panellet, Romney yw, Qwfp, SilvonenBot, Joshnadler, Addbot, Erantuon, Zorrobot, Yobot, Ptbotgourou, AnomieBOT, Citation bot, ArthurBot, Xqbot, Weepingraf, Gigemag76, GrouchoBot, RibotBOT, Potejam, Eisfbnre, FrescoBot, Longrim, SPULLAX, Pinethicket, Micromesistius, Kalervo, RedBot, Trappist the monk, Dinamik-bot, RjwilmsiBot, TjBot, DASHBot, EmausBot, WikitanvirBot, Look2See1, Faolin42, Slightsmile, Dcirovic, Kmoksy, AvicBot, Rcsprinter123, ClueBot NG, Widr, Reify-tech, BG19bot, NotWith, DRGert, Darorcilmir, YFdhyh-bot, ArmbrustBot, PhDMBA, InTheTrees, Trixie05, Adqlth, A6tf3t, Uisce135, Joseph Laferriere, Jayakumar RG, Impuls666666, Kinetic37, Giovanni Caudullo, Theblakedestroyer, Kim Gifford, InternetArchiveBot, GreenC bot, Delaneym80, Nina Lauridsen, Magic links bot and Anonymous: 90
- **Acer rubrum** *Source:* https://en.wikipedia.org/wiki/Acer_rubrum?oldid=775095560 *Contributors:* Malcolm Farmer, Danny, Nonenmac, Camembert, Edward, Ixfd64, Ahoerstemeier, Pollinator, Kdebisschop, Angilbas, MPF, Chowbok, Yath, Gzuckier, JoJan, Famartin, Mike Rosoft, Discospinster, Rich Farmbrough, Fungus Guy, Closeapple, Swid, Jpgordon, Bobo192, Circeus, Hesperian, Alansohn, Djileyton4, Shoefly, Stemonitis, Firsfron, Mindmatrix, Schzmo, BD2412, Rjwilmsi, The wub, Gurch, Samwisebruce, CiaPan, Gdrbot, YurikBot, RobotE, Hede2000, C777, Gaius Cornelius, Curtis Clark, Dysmorodrepanis~enwiki, Closedmouth, Mmcannis, Hirudo, Mejor Los Indios, Sychtos, SmackBot, Amcbride, Eventer, Hardyplants, Canthusus, Cazort, Pcrooker, Andy M. Wang, Rkitko, SB Johnny, Bazonka, Red-Hillian, Noles1984, Rklawton, Dcruz01, Minna Sora no Shita, Darry2385, Iridescent, Baskaufs, Neelix, Cydebot, Teratornis, Kozuch, Casliber, Thijs!bot, Epbr123, Headbomb, Marek69, Vertium, Bobblehead, James086, E. Ripley, AntiVandalBot, Storkk, Altairisfar, Whilom, LeRoc, AuburnPilot, JamesBWatson, Ling.Nut, CTF83!, Edward321, Peter coxhead, Vcpeters, R'n'B, Vox Rationis, Masebrock, J.delanoy, Warren Lee, Uncle Dick, Floaterfluss, Nadiatalent, KylieTastic, CardinalDan, Funandtrvl, VolkovBot, TreasuryTag, Vlmastra, Vipinhari, Rei-bot, Karmos, Modal Jig, Corvus coronoides, Liz de Quebec, Ajrocke, Motorrad-67, Malcomxl5, Legion fi, Taxodium, Keilana, Tiptoety, Lightmouse, IvanTortuga, ImageRemovalBot, Sfan00 IMG, ClueBot, Pan narrans, Mild Bill Hiccup, CounterVandalismBot, Iksnyzrog, Excirial, Ludwigs2, Rob rohrer, Thinggg, Amaltheus, Berean Hunter, Epiphaross, Wikiuser100, Addbot, DOI bot, Download, Deinocheirus, Bencohooh, Erantuon, Lightbot, Fabiano Tatsch, Yobot, EdwardLane, 2D, Bunnyhop11, Cfml001, Blueraspberry, Citation bot, LilHelpa, Capricorn42, Jpon9, TonyHagale, Potejam, SlurrryMaster, Citation bot 1, DigbyDalton, Pinethicket, Jonesey95, Trappist the monk, MApandr, Ewebs, DASHBot, Ftombardo, Look2See1, Solarra, ZéroBot, Traxs7, H3llBot, عَمَّرُو بْنُ قَلْثَوْنٍ, ClueBot NG, Awwalter, Northamerica1000, Rubypeaches, Sheaden, Solistide, BattyBot, Darorcilmir, YFdhyh-bot, Khazar2, Sminthopsis84, Promethean12232, Itc editor2, Nightphoenix90, Stamptrader, Joseph Laferriere, Monkbot, Spizaetus, Faune7, Sarr Cat, Deunanknute, Lena Key, Adam9007, GreenC bot, Bender the Bot, JStokes, EllenCat, Imminent77 and Anonymous: 129
- **Ailanthes altissima** *Source:* https://en.wikipedia.org/wiki/Ailanthes_altissima?oldid=782108862 *Contributors:* Danny, Rmhermen, Edward, Dcljr, Pagingmrherman, Stan Shebs, Jeandre du Toit, SEWilco, Davidcannon, Alan Lifting, DocWatson42, MPF, Everyking, Michael Devore, Utcursh, Keith Edkins, J. 'mach' wust, Sonjaaa, MisfitToys, Icairns, Zfr, Neutrality, Famartin, Bender235, MisterSheik, Kwamikagami, Art LaPella, Bobo192, Circeus, 9SGjOSfyHJaQVsEm9YNS, Hesperian, Hamah hanuka, Alansohn, Gary, Anthony Appleyard, Djileyton4, Ilse@, Firsfron, The Lightning Stalker, Prashanthns, Ryong122, Cuvtxo, Kalmia, BD2412, Ketiltrot, Rjwilmsi, Quiddity, Eubot, RobertG, Who, Darranc, Chobot, Gdrbot, RussBot, Gaius Cornelius, NawlinWiki, Mattsop, Peter Delmonte, Scs, Ospalh, AjaxSmack, Pegship, Leptictidium, Omtnay38, Wsiegmund, BorgQueen, Moomoomoo, Hirudo, Paul Erik, Anthony717, West Virginian, SmackBot, CompuHacker, Yuriy75, Od Mishehu, ScaldingHotSoup, Nil Einne, Cazort, Plaidfury, Gilliam, Fogster, Chris the speller, Rkitko, SB Johnny, Melburnian, TheLeopard, CSWarren, MJCdetroit, JDIPierro, Abrahami, Kingdon, BinaryTed, Nishkid64, Harry-boyles, Valfontis, Lisapolisson, Sannab, Dabean, Sangerharris, West coast, DavidOaks, Wspencer11, BeenAroundAWhile, N2e, Baskaufs, ShelfSkewed, Simply south, Pro bug catcher, Wohali, Mato, Ruigeroeland, Cahrichak, Casliber, JamesAM, TheYmode, EjLucas, Head-bomb, Bobblehead, Ufwuct, SusanLesch, Christopher~enwiki, KP Botany, Noroton, Smartse, Harborsparrow, Sluzelin, JAnDbot, Deflective, Altairisfar, OhanaUnited, TAnthony, MegX, Joshua, Bongwarrior, AuburnPilot, Wonx2150, Hekerui, 28421u2232nfencenc, Jung-shin, Azalea pomp, DerRichter, Wlodzimierz, DrKay, Darthvader1, JoDonHo, Katalaveno, Margareta, Kloisia, FOTEMEH, Cometstyles, Treisijs, Oscargsol, Idioma-bot, The Duke of Waltham, Tesscass, Philip Trueman, TXiKiBoT, Birdiefromlisnews, GcSwRhIc, Globegores, UnitedStatesian, Jaguarlaser, HansHermans, LOTRrules, SieBot, Laoris, Oldag07, Dawn Bard, MeegsC, Bentogoa, Shdamberger,

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- **Amelanchier arborea** *Source:* https://en.wikipedia.org/wiki/Amelanchier_arborea?oldid=681305607 *Contributors:* Nonenmac, Gren-delkhan, MPF, Foobar, Gdr, DanielCD, Fungus Guy, Fledgeling, TheAlphaWolf, Ricardo Carneiro Pires, Eubot, Gdrbot, RussBot, Mm-cannis, West Virginian, Rkitko, Copysan, Langhorner, Baskaufs, Cydebot, Mad Scientist, Visik, ShadowKinght, Altairisfar, Magioladitis, IP Singh, Masebrock, VonTasha, Nadiatalent, Antonio Lopez, IvanTortuga, Shadbush, Berean Hunter, Addbot, Wkrocek, Flakinho, Cpt-Taco, LucienBOT, Pinethicket, Fepup, Mishae, AvicBot, ZéroBot, SporkBot, Declangi, Sminthopsis84, ArmbrustBot, Nightphoenix90 and Anonymous: 3
- **Asimina triloba** *Source:* https://en.wikipedia.org/wiki/Asimina_triloba?oldid=782530208 *Contributors:* Nonenmac, Thue, Pollinator, MPF, Mboverload, Fungus Guy, YUL89YYZ, Bender235, Hesperian, Rd232, BDD, Drbreznjev, BlueCanoe, Stemonitis, Richard Arthur Norton (1958-), Woohookitty, PoccilScript, TheAlphaWolf, Miwasatoshi, BD2412, Rjwilmsi, Ricardo Carneiro Pires, FlaBot, Eubot, Nihiltres, Bgwhite, Chris Capoccia, Billspry, Asarelah, Kslays, Gilliam, Hmains, RDBrown, Guypersonson, Abrahami, Kingdon, Valfontis, Ayates, Agathman, Baskaufs, Cydebot, Indeterminate, Headbomb, Slaweks, JAnDbot, LeRoc, Wreader, Peter coxhead, Aaronshaw, ChemNerd, Niclisp, Masebrock, Peter Chastain, John2510, Kmanblue, Geekdiva, Squids and Chips, GcSwRhlc, WereSpielChequers, Ivan-Tortuga, Wikievil666, Yoshi Canopus, Blandercrowder, PixelBot, LarryMorseDCOhio, SchreiberBike, Graham1973, Dthomsen8, Ost316, Addbot, DOI bot, Jarble, Yobot, Amirobot, KamikazeBOT, AnomieBOT, Ulric1313, Xqbot, Zefr, Hamamelis, FrescoBot, GreenZmi, LucienBOT, Citation bot 1, Pinethicket, Miguel Escopeta, Vphotog, DASHBot, EmausBot, John of Reading, Convallaria majalis, Look2See1, Solarra, ZéroBot, Rcsprinter123, Sahimrobot, ClueBot NG, BarrelProof, Kresensha, Widr, Helpful Pixie Bot, Plantdrew, BG19bot, PhnomPencil, Lastcastle, BattyBot, MangoMania69, Cyberbot II, YFdyh-bot, Sundevyl, ArmbrustBot, Nightphoenix90, GGreggW, Oxalis51, Lyttle-Wight, Monkbot, Ethelred umraed, Sangdeboeuf, Jacob7619, Senira Gunatilleke, GreenC bot, Magic links bot and Anonymous: 46
- **Carpinus caroliniana** *Source:* https://en.wikipedia.org/wiki/Carpinus_caroliniana?oldid=749344850 *Contributors:* Nonenmac, Ram-Man, GTBacchus, SEWilco, Wetman, MPF, JoJan, Discospinster, Fungus Guy, Sunborn, Circeus, Stemonitis, Eubot, Gdrbot, YurikBot, Dysmorodrepanis~enwiki, Moe Epsilon, Warfreak, West Virginian, Rkitko, Gruzd, Cjottawa, GoodDay, The ed17, Baskaufs, Mad Scientist, Frank, Altairisfar, R'n'B, Jerry, LordAnubisBOT, TXiKiBOT, Nono le petit robot~enwiki, Hqb, Seb az86556, Modal Jig, Jaguarlaser, IvanTortuga, Jbening, Berean Hunter, Tdsk, Addbot, Flakinho, Erutuon, Yobot, Ulric1313, Citation bot, Xqbot, LucienBOT, Pinethicket, Mejkravitz, Keteleeria, ZéroBot, Stainless steel cat, Rcsprinter123, Fitzgeoff, ChuispastonBot, Plantdrew, Arcandam, ArmbrustBot, Nightphoenix90 and Anonymous: 22
- **Carya cordiformis** *Source:* https://en.wikipedia.org/wiki/Carya_cordiformis?oldid=778082380 *Contributors:* Nonenmac, MPF, Fungus Guy, Circeus, Eubot, Gdrbot, Ytrottier, IceCreamAntisocial, Open2universe, West Virginian, Eug, Rkitko, Baskaufs, WeggeBot, Cydebot, Altairisfar, Soulscanner, Tomstrees, Kmanblue, Safemariner, GlassCobra, IvanTortuga, Berean Hunter, Johnuniq, Addbot, Erutuon, Xqbot, PigFlu Oink, Pinethicket, HRoestBot, Rushbugled13, Winteam, Look2See1, ZéroBot, Dgrootmyers, Plantdrew, Arcandam, ArmbrustBot, Nightphoenix90 and Anonymous: 13
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- **Carya tomentosa** *Source:* https://en.wikipedia.org/wiki/Carya_tomentosa?oldid=758861291 *Contributors:* Nonenmac, Topbanana, Dmadeo, Quadell, Xezbeth, RJHall, Guettarda, Circeus, RJFJR, Woohookitty, Rjwilmsi, Eubot, Choess, Gaius Cornelius, Grafen, Ice-CreamAntisocial, West Virginian, SmackBot, Chris the speller, Rkitko, Kingdon, Takowl, Cydebot, PKT, JamesAM, TonyTheTiger, Mmcknight4, Nick Number, KP Botany, Arch dude, LeRoc, Peter coxhead, Anaxial, R'n'B, Masebrock, Skimx, Kmanblue, Pdcok, Safemariner, Drawn Some, Esoxid, Berean Hunter, Chhe, Addbot, Yobot, Tohd8BohaiithuGh1, Pinethicket, Pzrmd, SnickeringBear, John of Reading, Look2See1, ZéroBot, ClueBot NG, Xenophonia, Plantdrew, Rubypeaches, Meatsgains, Nightphoenix90, Sanddollarmoon, Djadjko, Wasp32 and Anonymous: 11
- **American chestnut** *Source:* https://en.wikipedia.org/wiki/American_chestnut?oldid=782299113 *Contributors:* AxelBoldt, Vicki Rosen-zweig, William Avery, Azhyd, Nonenmac, Jaknouse, Isis~enwiki, Cyde, Dysprosia, Tjunier, Radiojon, Wiwaxia, Wetman, Eugene van der Pijll, Vanvitlp, Seglea, Sheridan, Angilbas, JamesMLane, DocWatson42, MPF, Jason Quinn, Gyrofrog, Bcameron54, Allisson, DanielCD, Fungus Guy, Cfalde, Martpol, Bender235, Kbh3rd, Guettarda, Circeus, Osbojos, Zantastik, Gene Nygaard, Stemonitis, Schzmo, Rjwilmsi, Lockley, Jivecat, The wub, Daderot, Eubot, Srleffler, Gdrbot, Bgwhite, Wavelength, DanMS, Gaius Cornelius, Rsrikanth05, Jrbouldin, Badagnani, Abb3w, Asarelah, Tachs, AjaxSmack, Arthur Rubin, BorgQueen, Dandube, Mmcannis, West Virginian, SmackBot, Mrgate3, Chris the speller, Shadowcat60, Rkitko, EncMstr, Nbarth, Stevenmitchell, Abrahami, Fuhghettaboutit, Nakon, Zzorse, Keyesc, Ohconfucius, IGod, Gobonobo, IronGargoyle, Norm mit, Krome-Dishie, Iridescent, Puffin10, Civil Engineer III, Caesar Rodney, Baskaufs, Ken Gallagher, Cydebot, Peter-T, Cheapestcostavoide, HannahBana, Luna Santin, Tstrobaugh, PhilKnight, Magioladitis, Wmjjaeger, Python27, Kjmoran, Jschibig, Sylfred1977, DadaNeem, Cosnahang, Million Moments, Widders, GcSwRhlc, Wiae, Jaguarlaser, SylviaStanley, Dlfreem, Nathan, Flyer22 Reborn, Crom1, Lightmouse, Npd2983, ClueBot, Wapowell, PipepBot, The Thing That Should Not Be, Nnemo, Blanchardb, Stylteralmaldo, SchreiberBike, Berean Hunter, Trulystand700, Dthomsen8, Whocares81, Good Olfactory, Addbot, Tergenev,

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- **Celtis occidentalis** *Source:* https://en.wikipedia.org/wiki/Celtis_occidentalis?oldid=762850943 *Contributors:* Nonenmac, Pagingmrherman, Bogdangiusca, SEWilco, JoJan, Fungus Guy, BlueCanoe, Ricardo Carneiro Pires, The wub, Eubot, Dysmorodrepanis~enwiki, Asarelah, Mmcannis, West Virginian, Eskimbot, Jab843, Cazor, Bluebot, Rkitko, SB Johnny, Bejar, Khono, Number36, Vonvon, Ams100272, CmdrObot, Cydebot, LordHuffNPuff, Casliber, Epbr123, Altairisfar, Masebrock, STBotD, Kmanblue, Jdcrutch, Liz de Quebec, Jaguarlaser, Lightmouse, IvanTortuga, SchreiberBike, El bot de la dieta, Chhe, Addbot, Cuaxdon, Sapphosyne, Flakinho, Erutuon, Luckas-bot, Yobot, Rubinbot, Citation bot, Gmihail, Martin Gazdik, Hamamelis, GreenZmiy, Dger, Pinethicket, I dream of horses, Wedson~enwiki, Dinamik-bot, Rcsprinter123, Anishnaadoc, Plantdrew, BG19bot, JingjingLiang, Nightphoenix90, Hrokko, Anon685, Monkbot, Overtures, Equinox, InternetArchiveBot, GreenC bot, Bender the Bot, Phloem48 and Anonymous: 20
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- **Paulownia tomentosa** *Source:* https://en.wikipedia.org/wiki/Paulownia_tomentosa?oldid=778491403 *Contributors:* Naddy, Gidonb, MPF, Ezhiki, Neutrality, Fanghong-enwiki, Famartin, Cayte, Hesperian, Ogress, Ceyockey, Stemonitis, Pixeltoo, Jean-Pol Grandmont, BD2412, Miq, Eubot, Gdrbot, Rosieredfield, Badagnani, Apokrytaros, TDogg310, Zwobot, West Virginian, Maxima m, Chris the speller, Toddisonbee, SB Johnny, Abrahami, Kingdon, Kaarel, Martin Kozák, Americasroof, Baskaufs, Neelix, Thijs!bot, JAnDbot, Altairisfar, Nono64, Igno2, Plasticup, VolkovBot, Piepcker, Jaguarlaser, SieBot, Ibsinc, Invertzoo, Tlustulimu, Jboltonnal, Muro Bot, Chhe, Meneerke bloem, Addbot, Flakinho, Tide rolls, Lightbot, Luckas-bot, Yobot, TaBOT-zerem, Amirobot, AnomieBOT, Materialscientist, ArthurBot, SassoBot, Hamamelis, Brettastic, Lotje, Tom Hulse, EmausBot, WikitanvirBot, MerIwBot, Plantdrew, NotWith, Darorcilmir, Ajaxfiore, ArmbrustBot, HHubi, Andraman123, Marrrrrra, Arbor Fici, MereTechnicality, Wpbgrenoble and Anonymous: 27
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- **Prunus serotina** *Source:* https://en.wikipedia.org/wiki/Prunus_serotina?oldid=781886965 *Contributors:* Nonenmac, Jaknouse, Mdebets, Emperor, Bogdangiusca, Alan Lifting, MPF, Ferkelparade, Dick Bos, Famartin, YUL89YYZ, Sligocki, Matthias5, Brookie, Ylem, Kralizec!, BD2412, Mendaliv, Ketiltrot, Rjwilmsi, Ricardo Carneiro Pires, The wub, Eubot, Gdrbot, RussBot, Dysmorodrepanis~enwiki, Wiki alf, Complainier, Badagnani, Carabinieri, Mmcannis, Strz3, DVD R W, Tom Morris, West Virginian, SmackBot, Krychek, Brya, Melchoir, Hardyplants, Gilliam, Wellspring, Can't sleep, clown will eat me, OrphanBot, Cybercobra, Bigturtle, Alcuin, Kevmin, Allencas1no, Kaarel, Baskaufs, WeggeBot, Cydebot, Thijs!bot, PEJL, Jj137, TimVickers, DuncanHill, Altairisfar, TheEditrix2, VoABot II, Halogenated, Peter coxhead, Jerem43, Vicpeters, Mschel, Masebrock, Acalamari, Cadwaladr, Nadiatalent, WJBscribe, Kmanblue, Idioma-bot, Lights, Spudtu, Bearian, January2007, Liz de Quebec, LuigiManiac, Krinos2, Jojalozzo, Crymerci, IvanTortuga, Atif.t2, Elassint, ClueBot, Quisqualis, Berean Hunter, Chhe, Jack Bauer00, Addbot, Ronkonkaman, Arjuno3, Flakinho, Erutuon, Krano, Luckas-bot, 2D, AnomieBOT, Golb12, Citation bot, LilHelpa, Xqbot, Gigemag76, SassoBot, Hamamelis, Shadowpuppet23, Pinethicket, AmphBot, DASHBot, EmausBot, WikitanvirBot, Look2See1, The Mysterious El Willstro, Dcirovic, ZéroBot, Wingman417, Erianna, Rcsprinter123, Magnostreak, Donner60, ClueBot NG, Plantdrew, BG19bot, Dexbot, Sminthopsis84, Zuel660, RotlinkBot, Corn cheese, ArmbrustBot, Nighthoenix90, Ms. Kstax, Adqlth, JaconaFrere, Joseph Laferriere, Monkbot, Impuls666666, Adenin, Morphdog, CAPTAIN RAJU, InternetArchiveBot, GreenC bot, Prahlad balaji and Anonymous: 78
- **Quercus alba** *Source:* https://en.wikipedia.org/wiki/Quercus_alba?oldid=778474379 *Contributors:* Vicki Rosenzweig, DavidLevinson, Nonenmac, Jaknouse, Ahoerstemeier, StAkAr Karnak, SEWilco, Nixve, Pollinator, Owen, UtherSRG, MPF, Bkonrad, Sca, Williamb, Famartin, Rich Farmbrough, Vsmith, Brian0918, Pjrich, Mwanner, Circeus, Alansohn, Keenan Pepper, Flyspeck, Djlayton4, Vellela, RyanGerbil10, Stemonitis, RM, Woohookitty, Mindmatrix, Eken, Schzmo, Dysepson, BD2412, The wub, Taskinen, Gdrbot, UkPaolo, YurikBot, Wavelength, Sceptre, RussBot, CambridgeBayWeather, Dysmorodrepanis~enwiki, Badagnani, TDogg310, Lockesdonkey, Barryob, Katieh5584, Mmcannis, West Virginian, Yvww, SmackBot, Unschoold, Jfurr1981, HalfShadow, Chris the speller, Bluebot, Frutti di Mare, Rkitko, Thumperward, Bruce Marlin, Lesnail, Adamantios, Decltype, Gruznov, Thor Dockweiler, Kuru, SilkTork, Jim Derby, Geerjm, Iridescent, Skapur, Freeagent24, JForget, RSido, RCopple, 850 C, Eric, JohnCD, Baskaufs, Flynnbar, Cydebot, Besieged, Gogo Dodo, Tawkerbot4, Daven200520, PoolDoc, Thijs!bot, Mad Scientist, John254, AntiVandalBot, Harborsparrow, JAnDbot, Altairisfar, Brooksbtz, Jommeke, Valerius Tygart, Azalea pomp, Masebrock, Adavidb, Xuehxolotl, KylieTastic, Antepenultimate, Kmanblue, Idioma-bot, Indubitably, Tesscass, TXiKiBoT, Oshwah, Disputantum, Jaguarlaser, Spinningspark, Tag3rs, WereSpielChequers, Lucasbfrbot, Ivan-Tortuga, Ii386, TheCatalyst31, Sfan00 IMG, ClueBot, Jackollie, CounterVandalismBot, Piledhigheranddeeper, Excirial, Sun Creator, We-jahddub, Muro Bot, SpartanPhalanx, Nasion, Berean Hunter, Trumpet718, Joshnadler, Addbot, Matthew Gibson, LinkFA-Bot, Flakinho, Erutuon, Legobot, Yobot, AnomieBOT, Sagaci, Jim1138, LilHelpa, Goblineat4, Obersachsebot, Jeffrey Mall, DSisypheBot, Dcrjsr, SD5, FrescoBot, Nimloth250, Remotelysensed, Citation bot 1, Pinethicket, MastiBot, Serols, Jedi94, Nmc94, Woodlot, RjwilmsiBot, EmausBot, Acather96, WikitanvirBot, Look2See1, GoingBatty, Dcirovic, Josve05a, Jshutton, Rcsprinter123, Donner60, Chuck Entz, ClueBot NG, Krobertson1970, Lifeonahilltop, Ryan Vesey, Helpful Pixie Bot, Plantdrew, BG19bot, Rubypeaches, NotWith, Cliff12345, Sttown3, Cyberbot II, EuroCarGT, Dexbot, Jakec, ArmbrustBot, Nighthoenix90, HalfGig, Joseph Laferriere, Sudhindranath, HakanIST, MCELLis, Tramroad999, Ninefive6, GreenC bot, Bender the Bot and Anonymous: 154
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- **Quercus montana** *Source:* https://en.wikipedia.org/wiki/Quercus_montana?oldid=774114282 *Contributors:* Vicki Rosenzweig, William Avery, Jaknouse, SEWilco, Auric, MPF, DanielCD, Xezbeth, Mwanner, RoyBoy, Circeus, Stemonitis, The wub, Eubot, Gdrbot, Gaius Cornelius, Mmcannis, West Virginian, Rkitko, Persian Poet Gal, Lesnail, Baskaufs, Flynnbar, Cydebot, PoolDoc, Thijs!bot, Altairisfar, PAK Man, Bobba2194, TXiKiBoT, GcSwRhIc, Nathan, Cthomas3, TheCatalyst31, ClueBot, LarryMorseDCOhio, Columbiabotany,

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