

## Thuja

Thuja (/ˈθjuːd/ THEW-j)[1] is a genus of coniferous tree or shrub in the Cupressaceae (cypress family). There are five species in the genus, two native to North America and three native to eastern Asia.[2][3][4][5] The genus is monophyletic and sister to Thujopsis. Members are commonly known as arborvitae (from the Latin term for 'tree of life'), thujas or cedars.[6]

Thuja are evergreen trees growing from 10 to 200 feet (3 to 61 metres) tall, with stringy-textured reddish-brown bark. The shoots are flat, with side shoots only in a single plane. The leaves are scale-like and 1 to 10 mm (0.039 to 0.394 in) long, except young seedlings in their first year, which have needle-like leaves. The scale leaves are arranged in alternating decussate pairs in four rows along the twigs. The male cones are small, inconspicuous, and are located at the tips of the twigs. The female cones start out similarly inconspicuous, but grow to about 1 to 2 cm (0.39 to 0.79 in) long at maturity when 6–8 months old; they have 6-12 overlapping, thin, leathery scales, each scale bearing 1–2 small seeds with a pair of narrow lateral wings.[3]

The five species in the genus Thuja are small to large evergreen trees with flattened branchlets. The leaves are arranged in flattened fan shaped groupings with resin-glands, and oppositely grouped in 4 ranks. The mature leaves are different from younger leaves, with those on larger branchlets having sharp, erect, free apices. The leaves on flattened lateral branchlets are crowded into appressed groups and scale-like and the lateral pairs are keeled. With the exception of *T. plicata*, the lateral leaves are shorter than the facial leaves (Li et al. 2005). The solitary flowers are produced terminally. Pollen cones with 2-6 pairs of 2-4 pollen sacked sporophylls. Seed cones are ellipsoid, typically 9 to 14 mm (0.35 to 0.55 in) long, and mature and open the first year. The thin woody cone scales number from 4-6 pairs and are persistent and overlapping, with an oblong shape, they are also basifixed. The central 2-3 pairs of cone scales are fertile. The seed cones produce 1 to 3 seeds per scale, the seeds are lenticular in shape and equally 2 winged. Seedlings produce 2 cotyledons.[7][8]

A hybrid between *T. standishi* and *T. plicata* has been named as the cultivar Thuja 'Green Giant'.

Another very distinct and only distantly related species, formerly treated as *Thuja orientalis*, is now treated in a genus of its own, as *Platycladus orientalis*. The closest relatives of Thuja are *Thujopsis dolabrata*, distinct in its thicker foliage and stouter cones, and *Tetraclinis articulata* (Ancient Greek *θυάλα* or *θαλά*, formerly classed in the genus and after which Thuja is named), distinct in its quadrangular foliage (not flattened) and cones with four thick, woody scales.

The genus Thuja, like many other forms of conifers, is represented by ancestral forms in Cretaceous rocks of northern Europe, and with the advance of time is found to migrate from northerly to more southerly regions, until during the Pliocene period, when it disappeared from Europe. Thuja is also known in the Miocene beds of the Dakotas.[9]

*T. plicata*

*T. koraiensis*

*T. sutchuenensis*

*T. occidentalis*

*T. standishii*

The five extant species are:[2][12][13]

Species formerly placed in *Thuja* include:[2]

and many more

The extant species *Thuja sutchuenensis* was believed to be extinct until 1999, when a small population was discovered in southeast China.[14]

*Thuja* species are used as food plants by the larvae of some Lepidoptera species including autumnal moth, the engrailed and juniper pug. The foliage is also readily eaten by deer, and where deer population density is high, can adversely affect the growth of young trees and the establishment of seedlings.[15]

The genus *Thuja* has current populations in both North America and East Asia. *T. plicata* has wide distribution in the Pacific Northwest from Northern California to Alaska, reaching East into Idaho and central British Columbia. *T. occidentalis* has populations in the Northeastern United States, reaching north into Ontario and Quebec, with some distribution as far south as Tennessee.[16]

*T. standishii* has populations in mountainous regions of Honshu and Shikoku islands in Japan, with no recorded population in the north of the country. *T. koraiensis* is native to both North and South Korea and has a small population in the Northern Chinese province of Jilin.[17] The newly rediscovered species *T. sutchuenensis* has extremely limited distribution in the mountains of Chengkou county in southeastern China.

Current research suggests that *Thuja* originated in the Americas and migrated to East Asia via the Bering land bridge in the Miocene. Fossil records show that *Thuja* was significantly more widely distributed during the late Cretaceous and early Tertiary than we see today.[18] The oldest known *Thuja* fossil is of *T. polaris* (an extinct species) from the Paleocene of Ellesmere Island in present-day Nunavut, Canada.[17]

Other hypotheses of *Thuja* origin involved an East Asian origin, with the genus migrating twice; once east into North-western America and then west to the North-eastern America, but since no reliable fossil records of *Thuja* exist in either Western Asia or Europe, the possibility can be eliminated.[17]

*Thuja* is a monophyletic genus that sits within the order Pinales in the Cupressaceae. *Thuja* is in the Cupressoid clade and is sister to the genus *Thujopsis*. The sister relationship between *Thuja* and *Thujopsis* is supported with 100% bootstrap support and 1.0 posterior probability.[19]

Within the genus the taxonomy is in flux, but most recent research based on molecular analysis of plastomes in the genus *Thuja* showed evidence for a new grouping, with two sister clades: *T. standishii* and *T. koraiensis* together and *T. occidentalis* and *T.*

sutchuenensis together, with *T. plicata* sister to *T. occidentalis* and *T. sutchuenensis*.<sup>[19]</sup> This newest grouping is hypothesized to be the result of reticulate evolution and hybridization within the genus.

They are widely grown as ornamental trees, and extensively used for hedges. A number of cultivars are grown and used in landscapes.<sup>[20][21]</sup> Homeowners will sometimes plant them as privacy trees. The cultivar 'Green Giant' is popular as a very vigorous hedging plant, growing up to 80 cm/year when young.<sup>[22]</sup>

The wood is light, soft and aromatic. It can be easily split and resists decay. The wood has been used for many applications from making chests that repel moths to shingles. Thuja poles are also often used to make fence posts and rails. The wood of *Thuja plicata* is commonly used for guitar sound boards.<sup>[23]</sup> Its combination of light weight and resistance to decay has also led to *T. plicata* being widely used for the construction of bee hives.<sup>[24]</sup>

*T. plicata* is an important tree to the First Nations people of the Pacific Northwest and is sometimes called "Canoe Tree" because of its use as a material for Native American canoes.<sup>[citation needed]</sup>

Oil of Thuja contains the terpene thujone which has been studied for its GABA receptor antagonizing effects, with potentially lethal properties.<sup>[25]</sup> Cedarwood oil and cedar leaf oil, which are derived from *Thuja occidentalis*, have different properties and uses.<sup>[26]</sup>

The natives of Canada used the scaled leaves of *Thuja occidentalis* to make a tea that has been shown to contain 50 mg of vitamin C per 100 grams; this helped prevent and treat scurvy.<sup>[27]</sup>

In the 19th century, Thuja was commonly used as an externally applied tincture or ointment for the treatment of warts, ringworm and thrush,<sup>[28]</sup> and a local injection of the tincture was used for treating venereal warts.<sup>[29]</sup>

A 2017 trial showed that its extract effectively killed both gram-positive and gram-negative bacteria.<sup>[30]</sup>

As with many Cupressaceae, Thuja can induce allergic reactions, including skin, eye and breathing problems.<sup>[citation needed]</sup>

New World Species:

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