



## **Important Tree Species -- American Chestnut: A Deposed King.**

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American chestnut (*Castanea dentata*) ecologically dominated forests of Eastern North America for millennium. It comprised a majority of trees on many upland forest sites, relegating oaks and hickories to associate status. The chestnut guild of other animals and plants (including humans) were common and successful because of their ecological patron, American chestnut. Major ecological energy grids developed by these genetic systems have now been destroyed. The history of American chestnut in some ways parallels the rise and fall of the Roman empire in history.

### Family Names

American chestnut was found by native people to be a staff of life. The Native American words for chestnut among many tribes were similar: chinkapin, chinquapin, chincapin, chincopin, and chechinquamin, as translated into European languages. European chestnuts were common in homelands of European explorers and the new North American species were called American chestnut or simply chestnut. The scientific name for American chestnut is *Castanea dentata*, derived from the classic Greek and Latin names for chestnut, and the toothed margins of the leaves.

### Family Matters

Chestnuts belong to the beech family (Fagaceae) which include: oak (*Quercus*) >200 species across temperate Northern hemisphere and high altitude tropics; beech (*Fagus*) 10 species in the Northern hemisphere; Southern beech (*Nothofagus*) 17 species of the Southern hemisphere; evergreen chinkapin (*Castanopsis*) 30 species of southeast Asia and one in Western US; tan-oak (*Lithocarpus*) 100 species of southern and eastern Asia, and one in Western US; and, chestnut (*Castanea*) ~16 species in the Northern hemisphere. There are eight genera and more than 1000 species within this family.

The genus *Castanea* contains four trees native to North America (not including hybrids) and twelve trees found across the North temperate regions of Earth. Chestnut species can be found in North America and across Southern Europe, North Africa, and most of Asia to China, Japan, and Korea. Of the four native species in the US, three are medium to small trees and shrubs, and one is the large forest and shade tree called American chestnut. Evergreen chinkapins -- genus *Castanopsis* (literally meaning “resembling chestnut”) – contains an exotic medium sized evergreen tree easily mistaken for a chestnut.

### Leaves

The leaves of American chestnut are thin and papery with straight, parallel lateral veins ending in coarse, sharp, regularly distributed marginal teeth. Each marginal tooth is relatively long and curved, ending with a bristle tip. Leaves are simple, deciduous, and alternately attached to twigs. Leaves are narrow elliptical or oblong in shape. The leaf base narrows to a wedge-shaped point along the petiole (cuneate). Leaf stalks (petioles) are ½ inch long, stout, slightly angled or edged, and tinged with red. Stipules are ½ inch long and yellow-green in color.

Leaves are 5-10 inches long and 1 ¾ - 3 inches wide. Leaves developed in shade can be slightly larger. Both upper and lower leaf surfaces are smooth and without tricomes (hairless) when leaves are fully expanded and mature. The upper surface of leaves are shiny dark yellowish-green. The lower surface is paler with yellow mid-rib and main veins. Fall leaf color is a bright yellow to a golden yellow. Some describe a chestnut leaf as resembling a beach leaf, except the chestnut leaf is larger and much more elongated. Leaves on young chestnuts, and growing from immature sprouts, do not effectively abscise in fall but die and stay attached to the tree until Spring.

## Flowers

Chestnut has a noticeable and unique flowering pattern. Chestnut is dominantly monoecious species with small, separate male and female flowers with no petals. Both sexes of flowers develop from new wood on the same tree. Chestnuts are self-sterile and require cross-pollination for viable seeds and successful seed crops.

There are two types of showy, long, slender, stiff, upright catkins growing from leaf axils. The first type of catkin carries only male flowers and arises near the base of flowering twigs. These flower holding stalks are 6-8 inches long and tend to be first to develop and flower in Spring. The second type of flower stalk or catkin is somewhat shorter and has both male and female flowers. This second catkin type arises from leaf bases near end of twigs. Many separate male flowers dominate most of the length of this second catkin type with 1-3 female flowers near its base. These bisexual catkins tend to develop slightly later than all-male catkins on the same tree. Female flowers are compact, greenish, and 3/8 inch long with six individual sub-units (ovaries / styles).

Flower stalks are green but covered with many yellowish-white male flowers. The bottom third of the flower stalk tends to be more green while the top third has more reddish tints. Male flower color comes from 10-20 white-filament stamens with yellow anthers. There is a strong fragrance associated with the flowers. Chestnut blooms from May into the first part of June after leaves have fully opened.

## Fruit

Chestnut fruit has been described as a ball of needles. Nuts are completely enclosed in a light tan to brown colored, short stocked husk or bur, 2 - 2 ½ inches in diameter which has prickly, sharp, slender, branched spines covering its surface. The husk interior is densely wooly and soft. Fruit matures in one growing season by September to October. When mature, the bur splits open along 2-4 sutures or cracks. Seeds are moisture sensitive and should be harvested for planting immediately upon fruit maturity.

## Nuts

Inside a chestnut fruit (bur) is usually 2-3 seeds (1-3 seeds are possible). Seeds or nuts are round to egg-shaped, flattened on one side, shiny dark brown to deep reddish brown, and ½ - 1 inch in diameter. The nut is coated from its pointed tip to its middle with a whitish film (waxy bloom) and tiny tricomes (hairs). The inside of the nut shell is lined with soft wooly tricomes. Nut meats are edible, sweet, and quickly consumed by a variety of animals. The nut represents a “perfect” food, having all required nutrients needed for life. Chestnut nut meats are similar to high lysine corn meal in nutritive values. The nut is starchy rather than oily.

Nuts can be stored for growing new chestnuts as long as six months, if moisture contents inside the nut are maintained at 45% relative humidity or higher. Nuts dry fast and can become unviable within a week. Sown nuts usually germinate with a 80% success level if they are pre-chilled under high moisture conditions for 40 days. If no pre-chilling is available, immediately sow in moist, mineral soil and protect from vertebrate pests. Grading nuts for planting is essential since in some years a majority of the nuts can be damaged / infested with weevils.

## Twigs & Buds

Chestnut twigs are round, smooth, glossy, reddish-brown to greenish-brown in color and may have a purple cast. Twigs tend to be slightly 3-sided or fluted below buds / leaves (nodes). Twigs appear to zig-zag along their length due to chestnut’s false terminal bud morphology. Twigs have many whitish lenticels. Leaf bundle scars are usually three in number when distinct, occasionally showing more. Leaf scars are half round to oval in shape and raised. Pith is continuous with a five-pointed star-

shape (stellate) cross-section. There can be thin, narrow, ring-like scars at the bud bases on twigs (stipular scars).

American chestnuts have buds covered with a total of 4 bud scales, only 2-3 of the scales being visible. Buds are smooth, hairless, oval, dark brown and 1/4 inch long. In Winter, the terminal bud is absent which allows near-terminal lateral buds to control twig growth the following season. This generates a zig-zag looking twig arrangement.

#### Bark / Periderm

Chestnut periderm on young stems and sprouts is smooth. Mature periderm is dark grayish-brown to dark brown in color. Stem periderm is relatively thick with shallow furrows separating smoother flattened plates. Chestnut periderm is similar to red oak group periderm. Chestnut periderm was once the chief source for tannins used in leather tanning in Eastern North America.

#### Wood & Other Uses

American chestnut wood is ring-porous. Heartwood is durable, soft, workable, and reddish-gold in color. It was traditionally used for furniture framing pieces, caskets, paneling, musical instruments, fence posts, railroad ties, and poles. The color and decay resistance of the wood was key to its many uses. Chestnut wood, termed "wormy chestnut" is still being harvested today from old logs.

Chestnut periderm was a major source for leather tanning tannins. Nuts were valuable for animal and human consumption. Chestnut was one of the first trees ever transplanted into growing cities as a shade tree. It also became one of the greatest tragedies of shade tree loss in the world when a pathogen quickly destroyed cultivated and native tree populations.

#### Tree Habit & Habitat

American chestnuts were large trees in the 19<sup>th</sup> century and before. They had a broad spreading habit reminiscent of live oaks in the Southern Coastal plain although not as massive. Large scaffold branches, wide rounded crowns, and short, single trunks made American chestnut a centerpiece both in nature and when planted on courthouse squares and along city streets. American chestnuts could attain 50 - 90 feet in height and spread, and 2-4 feet in diameter. Shade cast from heavy foliage held on horizontal branches was dense. Trees of this form are extremely rare today, and usually found outside the native range of chestnut. Today, American chestnuts are known primarily through stump sprouts in oak / hickory forests.

Chestnuts were considered fast-growing, long-lived (~250 years) and intermediate in tolerance to site resource constraints. American chestnut was successional dominant or climax on most sites it occupied. It vegetatively reproduced from stump sprouts as well as colonizing new areas sexually with seeds. Root systems were long and wide spreading, with a juvenile tap root as well as a large root plate at the trunk base. Chestnuts require effective root pruning when young for successful transplanting.

American chestnut grows well on many varied soil types, most of which are dominated by oaks and hickories. It grows on rocky / stoney, well-drained, rich slopes of the Appalachians and rolling hills of the Piedmont at less than 4,000 feet in altitude. It survives on dry ridges, but thrives in moist, well-drained sites. Chestnut is a prolific sprouter and will continue to send up stump sprouts for decades.

#### Native Range

Chestnut ranges from Ontario, Canada and Southern Maine, South to Mississippi and Alabama. Figure 1. Its cold hardiness zone ranges from zones 5-8. Its heat tolerance ranges from zone 4-9. The peak population occurrences are (were) along the Appalachians and into the Piedmont. Native range in Georgia could be described as heavily represented in the Northern / Northwestern 1/4 of the state with

scattered occurrence in the top ½ to 2/3s of the state. Chestnut drops onto the coastal plain along the Georgia / Alabama line.

### Terminal Pest Problem

American chestnut has been obliterated as a species by an introduced fungal pathogen called “chestnut blight.” In approximately 1904, in the Port of New York City, an Asian pathogen (an ascomycete) was introduced to the continent. The pathogen was Cryphonectria parasitica (Endothia parasitica). It took about 50 years to spread throughout the native range of American chestnut, killing all trees contacted. No known resistance was identified in any American chestnut population.

This exotic pathogen remains in the forest of today, preventing reintroduction and growth of American chestnut. The pathogen is a resident in oak forests causing occasional branch death. Quercus alba - white oak, Quercus coccinea - scarlet oak, Quercus oglethorpensis - Oglethorpe oak, Quercus stellata - post oak, Quercus virginiana - live oak, Castanopsis spp. - chinkapins, Carya ovata - shagbark hickory, Acer rubrum - red maple, and Rhus typhina - staghorn sumac can all be stressed by the disease and act as carriers. In the case of post oak (Quercus stellata), disease damage can be significant. In the case of Oglethorpe oak (Quercus oglethorpensis), damage can be severe and life-threatening.

Isolated chestnuts still survive both within and outside of the native range of American chestnut and beech family members. No significant native genetic resistance has been found to the pathogen among chestnut, although seed from isolated trees are collected as potentially tolerant. Isolates / escapes from attack are not necessarily resistant, just currently lucky. Chestnut stump sprouts continue to grow but are killed back as they reach sexual maturity (~25 feet tall, 5 inches in diameter). Breeding programs have existed and continue to exist to develop resistance in American chestnut, or to handicap the pathogen. Breeding work centers around gene sets from Asian chestnuts which are biologically resistant to attack by the pathogen.

### The Future

Hope remains strong for American chestnut gene sets surviving in some form, but recovering the romantic form of the spreading chestnut of the 19<sup>th</sup> century is dim. Chestnuts, both trees and nuts, evoke romantic memories of holidays, blacksmith shops, and community life at the end of the 19<sup>th</sup> century. As chestnut blight destroyed our social and ecological legacies surrounding chestnuts, more people became interested in new chestnut species and hybrids. Breeding programs aimed at recovering native but disease resistant gene sets were established. The rare find of an isolated mature American chestnut still sets-off investigators looking for that one blight resistant gene combination which will let us recover the massive spreading chestnut.

Chestnuts (Castanea spp.) are difficult to differentiate because of the mix of native species and exotics commonly planted. Old homesite, cemeteries, and 1880-1925 vintage home landscapes have all grown different types of chestnut trees from a varieties of places and breeding programs. Just because a tree is large or old does not necessarily mean it is a native American chestnut (Castanea dentata). Isolated mature American chestnuts are still rarely found, but mature hybrids and Asian species are more common.

Because of its rarity in mature form, a tendency to form natural hybrids, and an influx of exotic species, identification of chestnuts can be difficult and confusing. One exotic species, Chinese chestnut (Castanea mollissima) has escaped cultivation and is now reproducing on its own in Eastern North America. Blight resistance breeding programs spawned a number of partially resistant trees which were planted widely. Old home sites, now covered in woods, may have large hybrid trees growing. Large or old trees do not represent only native American chestnuts, but can be any one of a variety of chestnut species, varieties, or hybrids.

Isolated individual chestnuts and population pockets still survive both within and outside of the native ranges of chestnut and beech family members. Chestnut stump sprouts continue to grow from root stocks but are killed back after a few years. Little significant native genetic resistance has been found to the pathogen among North American chestnuts, although seeds from isolated trees and populations are collected as potentially tolerant. Cross breeding of North American species with blight resistant exotic species has shown some success.

### All Along The Genus

There is a strong gradation of characteristics among various chestnuts. Sometimes accurate identification is difficult. Usually a percentage of various attributes are provided (i.e. 75% Castanea X; 15% Castanea Y; 10% Castanea Z.) in any identification. Table 1 provides a list of the most common chestnut species found in landscapes or in breeding programs. Under each species name are additional species names used in the past, and in other places around the world, which you may still see discussed. Table 2 provides a list of common hybrids among chestnuts, including named hybrids developed as resistant to chestnut blight. Figure 2 graphically demonstrates species crossing patterns in common chestnut hybrids.

### Conclusions

Hope remains within a laboratory, or hidden from view in a forest, that an American chestnut gene sets with resistance to chestnut blight exists. This great biological and cultural heritage tree of the Eastern United States needs to be more than trivial pursuit and a footnote today. The king is dead, but maybe we can generate a new monarch from the genes of the old.



Figure 1: General range map of American chestnut (*Castanea dentata*).

Table 1: Selected chestnut species.

scientific name (alternative species name)	common name(s) / comments
<b><u>Castanea alnifolia</u></b> <b><u>floridana</u></b> <b><u>pumila</u></b>	<b>Florida chinkapin, trailing chinkapin, running chinkapin, bush chinkapin, downy chinkapin, alder-leaf chinkapin. Native low shrub up to 3 feet tall on the Coastal Plain.</b>
<b><u>Castanea ashei</u></b> <b><u>pumila</u></b>	<b>Ashe chinkapin, Coastal Plain chinkapin, Florida chinkapin. Native small tree to 25 feet tall on well-drained areas of Coastal Plain.</b>
<b><u>Castanea crenata</u></b> <b><u>chinensis</u></b> <b><u>japonica</u></b> <b><u>kusakuri</u></b> <b><u>pubinerus</u></b> <b><u>stricta</u></b>	<b>Japanese chestnut. Small tree to large shrub, 35 feet tall, from Japan.</b>
<b><u>Castanea dentata</u></b> <b><u>americana</u></b>	<b>American chestnut. Native large tree in the past (90 feet tall), now sprouts to 25 feet tall all along Appalachians &amp; Piedmont of Eastern United States.</b>
<b><u>Castanea floridana</u></b> <b><u>alnifolia</u></b> <b><u>pumila</u></b>	<b>Florida chinkapin, Florida chestnut. Native small tree up to 25 feet tall.</b>
<b><u>Castanea henryi</u></b> <b><u>fargesii</u></b> <b><u>vilmoriniana</u></b>	<b>West China chestnut, Henry's chestnut, Chinese chinkapin. Medium to large tree, 70 feet tall, from central and West China.</b>

Table 1 (continued): Selected chestnut species.

scientific name (alternative species name)	common name(s) / comments
<p><b><u>Castanea mollissima</u></b>  <b><u>bungeana</u></b>  <b><u>duclouxii</u></b>  <b><u>formosana</u></b>  <b><u>hupehensis</u></b>  <b><u>sinensis</u></b>  <b><u>yunnanensis</u></b></p>	<p><b>Chinese chestnut. Medium to large tree 60 feet tall from China and Korea. Now naturalized in the Eastern United States.</b></p>
<p><b><u>Castanea ozarkensis</u></b>  <b><u>alabamensis</u></b>  <b><u>arkansana</u></b></p>	<p><b>Ozark chinkapin, Ozark chestnut. Native medium sized tree, 50 feet tall centered in Northern Arkansas.</b></p>
<p><b><u>Castanea pumila</u></b>  <b><u>alnifolia</u></b>  <b><u>ashei</u></b>  <b><u>chincapin</u></b>  <b><u>floridana</u></b>  <b><u>margaretta</u></b>  <b><u>nana</u></b>  <b><u>paucispina</u></b></p>	<p><b>Allegheny chinkapin, Eastern chinkapin, bush chinkapin, dwarf chestnut. Native small tree or large shrub to 20 feet tall on the Piedmont &amp; Coastal Plain.</b></p>
<p><b><u>Castanea sativa</u></b>  <b><u>castanea</u></b>  <b><u>prolifera</u></b>  <b><u>vesca</u></b>  <b><u>vulgaris</u></b></p>	<p><b>sweet chestnut, Spanish chestnut, European chestnut. Large tree up to 80 feet tall. Ancient trade routes moved it all over Southern Europe, West Asia, &amp; North Africa.</b></p>
<p><b><u>Castanea sequinii</u></b>  <b><u>dauidii</u></b></p>	<p><b>East China chestnut, Sequin's chestnut. Small tree or large shrub to 30 feet tall of Eastern &amp; central China.</b></p>

hybrid scientific name	hybrid lineage
<b><u>Castanea X alabamensi</u></b>	<b>(<u>Castanea alnifolia</u> &amp; <u>Castanea dentata</u>)</b>
<b><u>Castanea X blaringhemii</u></b>	<b>(<u>Castanea sativa</u> &amp; <u>Castanea dentata</u>)</b>
<b><u>Castanea X burbankii</u></b>	<b>(<u>Castanea mollissima</u> &amp; <u>Castanea pumila</u>)</b>
<b><u>Castanea X coudercii</u></b>	<b>(<u>Castanea crenata</u> &amp; <u>Castanea sativa</u>)</b>
<b><u>Castanea X endicottii</u></b>	<b>(<u>Castanea crenata</u> &amp; <u>Castanea dentata</u>)</b>
<b><u>Castanea X fleetii</u></b>	<b>(<u>Castanea crenata</u> &amp; <u>Castanea pumila</u>)</b>
<b><u>Castanea X morrisii</u></b>	<b>(<u>Castanea mollissima</u> &amp; <u>Castanea alnifolia</u>)</b>
<b><u>Castanea X neglecta</u></b>	<b>(<u>Castanea pumila</u> &amp; <u>Castanea dentata</u>)</b>
<b><u>Castanea X pulchella</u></b>	<b>(<u>Castanea sativa</u> &amp; <u>Castanea pumila</u>)</b>
<b>“Clapper” hybrid</b>	<b>((<u>Castanea mollissima</u> &amp; <u>Castanea dentata</u>) &amp; <u>Castanea dentata</u>)</b>
<b>“Dunstan” hybrid</b>	<b>((<u>Castanea dentata</u> &amp; <u>Castanea mollissima</u>) &amp; <u>Castanea dentata</u>)</b>
<b>“Graves” hybrid</b>	<b>((<u>Castanea crenata</u> &amp; <u>Castanea dentata</u>) &amp; <u>Castanea mollissima</u>)</b>

Table 2: Selected identified chestnut hybrids.

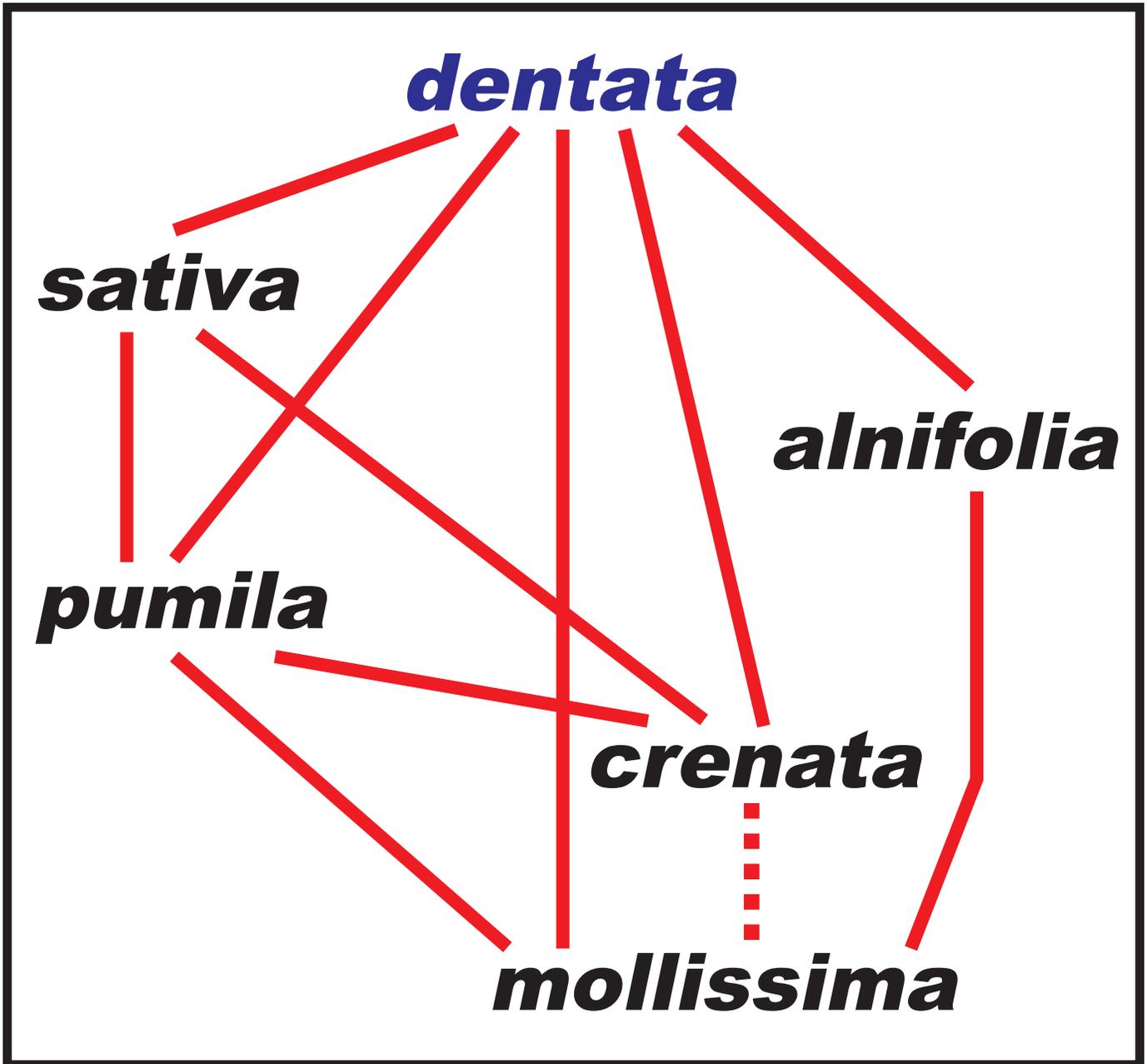


Figure 2: Species crossing pattern of common chestnut hybrids.



# Outreach

*Warnell School of Forestry & Natural Resources*

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