FagaceaeCBeech family

Castanea P. Mill.

chestnut

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Growth habit, occurrence, and use. The genus *Castanea*, the chestnuts, comprises 11 species of small to medium-sized deciduous trees found in southwestern and eastern Asia, southern Europe, north Africa, and the eastern United States. Five species are covered in this chapter; only 2 are native to the United States (table 1). American chestnut formerly ranked as one of the most valuable timber species in the Appalachian region, and the nuts were an important wildlife food as well as being extensively marketed for human consumption. In the years since the chestnut blightC*Cryphonectria parasitica* (Murr.) BarrCwas discovered in New York in 1904, the disease has spread throughout the range of the American chestnut and completely destroyed it as a commercial species. Many rootstocks still survive and send up multiple sprouts that grow to the size of a small tree (table 2) before dying. Some of these sprouts occasionally produce a few seeds, but they usually do not live long enough for significant production (Sander 1974).

Japanese, Chinese, and European chestnuts (table 1) were introduced into the United States in the 18th and 19th centuries (Anagnostakis 1990; Sander 1974). The Asian species demonstrated good resistance to the chestnut blight, and breeding programs were started as early as the 1890's to transfer the resistance to American chestnut (Jaynes 1975). Chinese chestnut, the most promising of these introductions, has been widely planted throughout the eastern United States, mostly in orchards for nut production. Allegheny chinkapin is somewhat resistant to the blight and might be useful as a rootstock in grafting; its other good features are small size, precocity of fruiting, and heavy seed crops (Payne and others 1994). Breeding for resistance has not been highly successful, but recent advances in tissue culture offer new promise (Dirr and Heuser 1987).

Flowering and fruiting. Chestnuts are monoecious, but some trees produce bisexual catkins also (Sander 1974). Unisexual male catkins, 15 to 20 cm long, appear near the base of the flowering branches. The pistillate flowers occur singly or in clusters of 2 to 3, near the end of the branches (Brown and Kirkman 1990; Sander 1974), with the female catkins at the base of the shoot (Payne and others 1994). Flowering begins in April or May in the Southeast (Hardy 1948) and in June in the Northeast (Sander 1974).

Chestnut fruits are spiny, globose burs, from 2.5 to 7.5 cm in diameter, borne singly or in spikelike clusters (Sander 1974; Vines 1960). The fruits each contain from 1 to 3 seeds (nuts); Allegheny chinkapins have 1 seed and American chestnuts (figure 1) have 3 seeds/fruit (Brown and Kirkman 1990; Sander 1974). The nuts are flattened on one side and range from light to dark brown or black in color (Brown and Kirkman 1990; Rehder 1940). Nuts of American chestnut are 12 to 25 mm wide and about 25 mm long. The exotic chestnuts bear larger nuts that are 19 to 38 mm wide (Sander 1974). Food reserves, primarily starch, are stored in the large cotyledons (figure 2). Fresh

nuts are 40 to 45% starch by weight, with very little lipid content (Jaynes 1975; Payne and others 1994; Wainio and Forbes 1941). Seeds ripen in August to October, depending on species and location (Hardy 1948, Sander 1974). Seed weights are listed in table 2.

Superior strains and hybrids. There are no identified superior strains of native chestnuts, but many cultivars and hybrids have been developed with the exotic chestnuts, primarily in Europe. The search for blight-resistant American chestnuts continues, however, with breeding, tissue culture, and innovative budding and grafting techniques (Ackerman and Jayne 1980).

Collection of fruits. Chestnuts can be picked from the trees, collected from the ground by hand, or shaken from the trees onto ground cloths. Burs of Allegheny chinkapin do not open widely, and the seeds are difficult to shake out. Some remain on the trees throughout winter (Payne and others 1994). Harvesting should begin as soon as the burs begin to split open. The nuts are intolerant of desiccation (recalcitrant) (Aldous 1972; Pritchard and Manger 1990), so collections from the ground should be done very soon after dissemination to prevent excessive drying. Frequent collection is especially important if the weather is hot and dry, as nuts can lose viability within a week on the ground (USDA 1951). If the weather is wet, Allegheny chinkapins will sometimes germinate on the trees (Payne and others 1994).

Storage of seed. Because of their recalcitrant nature, chestnuts are normally stored no longer than 6 months (overwinter). With good care, however, storage for 18 months is not difficult, and some have been successfully stored for 3.5 years (Jaynes 1975). Immediately after collection, the nuts should be floated in water to remove trash and immature and damaged nuts. If collected from the ground in a dry condition, they should be left in water overnight to restore their naturally high moisture content. Upon removal from water, the nuts should be spread to dry in a cool, well-ventilated place to remove all surface moisture. The nuts should be placed in containers that inhibit drying, such as polyethylene bags, and stored at 1 to 3 ˚C; however, the containers should not be airtight so that some gas exchange between nuts and the storage atmosphere is possible. Moisture content of the nuts should be about 40 to 45% during storage (Sander 1974). Too much moisture can result in loss of seeds to microorganisms (Woodruff 1963).

Pregermination treatments. Chestnut seeds are dormant and require a period of cold, moist stratification for prompt germination. In normal nursery practice, overwinter storage of fully imbibed nuts at 1 to 3 ˚C will satisfy the chilling requirement to overcome dormancy. For nuts that have not been stored moist, or if a deeper dormancy than usual is suspected, then stratification should be used; 1 to 3 months is the recommended period for American and Chinese chestnuts (Dirr and Heuser 1987; Jaynes 1975). If nuts are planted in the fall, stratification is not necessary, but the nuts should be kept in cold storage until planted (Sander 1974).

Chestnuts are commonly infested with the larvae of the seed weevils *Curculio sayi* Gyllenhall and *C. caryatrypes* Bohemon (Gibson 1985). A simple method to kill the larvae is to submerge the nuts for 45 minutes in water at 52 ˚C (Payne and Wells 1978).

Germination tests. The standard laboratory testing procedure for European chestnut is to (1) soak the seeds in water for 24 hours; (2) cut off a third of the seed at the cup-scar end; (3) remove the testa; and (4) germinate the seeds for 21 days in or on top of sand at the standard test regime of alternating 20 and 30 ˚C (ISTA 1993). If only constant temperatures are available, 28 ˚C is recommended for this species, which also has no specific light requirement of germination (Pritchard and Manger 1990). Data are lacking on other chestnut species with this procedure, but it quite likely will work for any of them. There are alternate procedures for whole nuts. Stratified nuts of Chinese chestnut have been germinated in a moist medium at 15 to 21 ˚C; germination reached

100% in 42 days (Berry 1960).

Nursery practice. Chestnuts may be planted in either the fall or in the spring. Nuts that have been kept in cold storage from the time they are harvested should be planted in September or October (Sander 1974). Fall-sown beds should be mulched and protected as much as possible against rodents (Williams and Hanks 1976). Nuts for spring planting should be stratified for 2 to 3 months.

In both fall and spring plantings, nuts should be sown 2 to 4 cm (: to 1 2 in) deep and spaced 7.5 to 10 cm (3 to 4 in) apart in rows 7.5 to 15 cm (3 to 6 in) apart in the nursery beds. Nuts can be either sown or drilled by hand, or broadcast mechanically (Sander 1974; Williams and Hanks 1976). Some growers recommend planting by hand so that the nuts can be placed on their sides to promote better seedling form (Jaynes 1975). European chestnuts are normally broadcast at a density of 100 nuts/m^2 (9 to 10/ft^2) (Aldous 1972). One should expect 75 to 80% germination in beds with good seeds (Aldous 1972; Sander 1974). A study with Chinese chestnuts found that grading nuts by size had no influence on time of emergence, although larger seeds did tend to produce larger seedlings (Shepard and others 1989).

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Table 1C *Castanea,* chestnut: nomenclature and occurrence

Scientific name	Common name	Occurrence
***C. crenata* Siebold & Zucc.**	**Japanese chestnut**	Japan
***C. dentata* (Marsh.) Borkh.**	**American chestnut** S Mississippi & Georgia	S Maine to Michigan; S to
***C. mollissima* Blume**	**Chinese chestnut**	China & Korea
***C. pumila* (L.) P. Mill.**	**Allegheny chinkapin** & W to E Texas & Oklahoma	Pennsylvania S to central Florida
***C. sativa* P. Mill.**	**European chestnut,** Spanish chestnut	S Europe, W Asia, & N Africa

Sources: Little (1979), Sander (1974).

Table 2*C Castanea,* chestnut: height, year first cultivated, and seed weights

Species	Height at cultivated maturity (m)	Year first Cleaned seeds/wt in US	/kg	/lb
C. crenata	10	1876	33	15
C. dentata	20B25*	1800	220B360	100B162
*C. mollissima*H	21	1853	50B220	23B100
C. pumilla	15	C	300	136
C. sativa	21	Before 1880	33	15

Sources: Payne and others (1994), Sander (1974).
* Height refers to sprouts from living rootstocks of trees killed by the blight; before the blight this species obtained heights of 21 to 30 m.
H Bears large crops annually in orchards beginning at about 8 years of age.