

# *Carya ovata* (Mill.) K. Koch

# Shagbark Hickory

Juglandaceae Walnut family

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Shagbark hickory (*Carya ovata*) is probably the most distinctive of all the hickories because of its loose-plated bark. Common names include shellbark hickory, scalybark hickory, shagbark, and upland hickory. Shagbark hickory is evenly distributed throughout the Eastern States and, together with pignut hickory, furnishes the bulk of the commercial hickory. The tough resilient properties of the wood make it suitable for products subject to impact and stress. The sweet nuts, once a staple food for American Indians, provide food for wildlife.

## Habitat

### Native Range

Shagbark hickory (figs. 1,2) is found throughout most of the Eastern United States from southeastern Nebraska and southeastern Minnesota through southern Ontario and southern Quebec to southern Maine, southward to Georgia, Alabama, Mississippi, Louisiana, and eastern Texas, and disjunctly in the mountains of northeastern Mexico. It is largely absent from the southeastern and Gulf coastal plains and lower Mississippi Delta areas.

### Climate

Shagbark hickory grows best in a humid climate. It is one of the hardiest of the hickory species, however, and has successfully adapted to a wide range of climatic conditions. Within shagbark's natural range, average annual rainfall varies from 760 to 2030 mm (30 to 80 in) with 510 to 1020 mm (20 to 40 in) of rainfall during the growing season. Average snowfall usually is less than 3 cm (1 in) in the southern and southwestern portion of the tree's range to 254 cm (100 in) or more in northern New York and southern Ontario.

Within the range of shagbark hickory average annual temperatures vary from 4° C (40° F) in the north to nearly 21° C (70° F) in southeastern Texas. Average January temperature varies from -9° to 13° C (15° to 55° F) while mean July temperature varies from 18° to 27° C (65° to 80° F). Extreme temperatures of -40° and 46° C (-40° and 115° F) have been recorded within shagbark's natural range. The

average growing season also varies widely from about 140 days in the North to 260 days in the South.

### Soils and Topography

Sites occupied by shagbark hickory vary greatly. In the North it is found on upland (often south-facing) slopes, while farther south it is more prevalent on soils of alluvial origin (15,16). In the Ohio Valley, shagbark grows chiefly on north and east slopes of fertile uplands; in the Cumberland Mountains it is confined to the coves and the north and east slopes; and in Arkansas, Mississippi, and Louisiana it grows principally in river bottoms. Shagbark is found on better sites up to elevations of 910 m (3,000 ft) in the Blue Ridge Mountains of the Carolinas and on north- and east-facing benches at elevations above 610 m (2,000 ft) in northern Arkansas. In northern Arkansas, shagbark hickory is often very common on clayey soils derived from Mississippian and Pennsylvanian shale formations and may represent nearly half of the stocking of privately owned woodlots on these sites.

The range of shagbark hickory encompasses 7 soil orders and 14 suborders (24). Ultisols are the dominant upland soils in the southern half of the shagbark range while Alfisols and Mollisols are primary soil orders in the northern portion of the range. The soils within shagbark's range are derived from a wide variety of parent materials—sedimentary and metamorphic rocks, glacial till, and loess. The soils also represent a wide range in soil fertility, such as Alfisols and Mollisols which are high in base saturation to Ultisols which are low. Shagbark hickory is sensitive to changes in soil fertility. In the northern part of its range, the species is found on a variety of upland sites; in the southern areas, it is more common in the more fertile bottom lands and on the better north- and east-facing upland sites.

### Associated Forest Cover

Hickories are consistently present in the broad forest association commonly called oak-hickory but are not generally abundant (20). Shagbark hickory is specifically listed as a minor component in six forest cover types (7): Bur Oak (Society of American Foresters Type 42), Chestnut Oak (Type 44), White Oak-Black Oak-Northern Red Oak (Type 52), Pin Oak-Sweetgum (Type 65), Loblolly Pine-Hardwood (Type 82), and Swamp Chestnut Oak-Cherrybark

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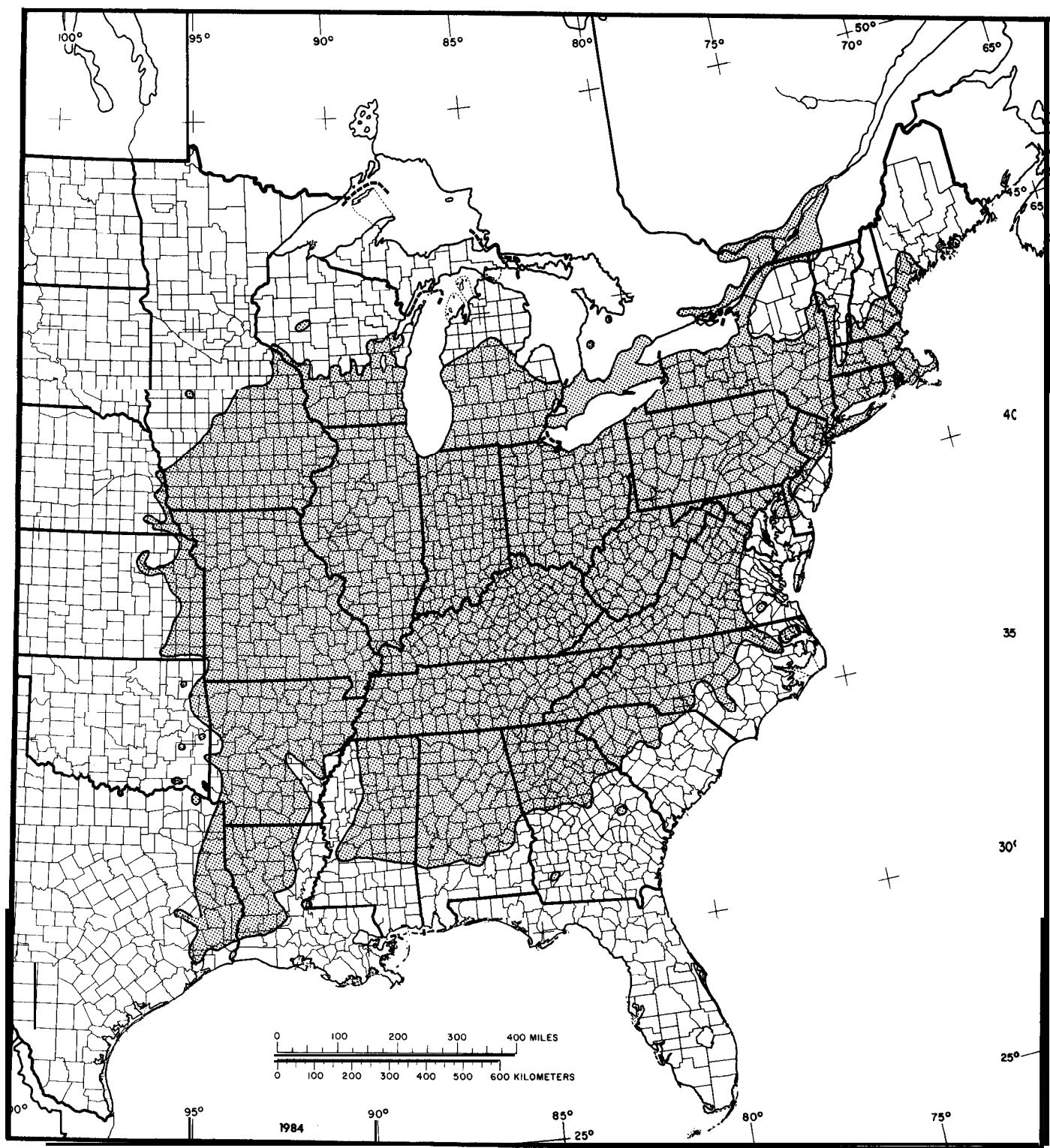


Figure 1--The native range of shagbark hickory.



Figure 2—Open-grown shagbark hickory.

Oak (Type 91). It is also a probable associate in the Eastern White Pine (Type 21), Beech-Sugar Maple (Type 60), White Oak (Type 53), and Northern Red Oak (Type 55) forest cover types. Through most of its range, shagbark hickory is associated with oaks, other hickories, and various mixed upland hardwoods. In the South it is also associated with a number of bottom-land hardwood species.

## Life History

### Reproduction and Early Growth

**Flowering and Fruiting**—Shagbark hickory is monoecious and flowers in the spring. The staminate catkins are 10 to 15 cm (4 to 6 in) long and develop from axils of previous season leaves or from inner scales of the terminal buds at the base of the current growth. The pistillate flowers appear in short spikes

about 8 mm (0.3 in) long on peduncles terminating in shoots of the current year. Flowers open when leaves are nearly full size in late March in the southwest to early June in the north and northeastern part of the range.

The fruit, a nut, is variable in size and shape. Borne 1 to 3 together, individual fruits are 3 to 6 cm (1 to 2.5 in) long, oval to subglobose or obovoid, depressed at the apex, and enclosed in a thin husk developed from the floral involucre. The fruit ripens in September and October and seeds are dispersed from September through December. Husks are green prior to maturity and turn brown to brownish black as they ripen. The husks become dry at maturity and split freely to the base into four valves along grooved sutures. The enclosed nut is light brownish white, oblong-ovate, somewhat compressed, usually prominently four-angled at the apex and rounded at the base (25). The shell is relatively thin and the kernel is sweet and edible. The bulk of the edible embryonic plant is cotyledonary tissue.

**Seed Production and Dissemination**—shagbark hickory reaches commercial seedbearing age at 40 years. Although maximum seed production occurs from 60 to 200 years, some seed is produced up to 300 years (16). Good seed crops occur at intervals of 1 to 3 years with light crops or no seed during the intervening years. Tree diameter and crown size or surface are probably the best indicators of shagbark seed production. In southeastern Ohio, 6-year seed production of dominant and codominant shagbark hickory trees with mean d.b.h. of 20.7 cm (8.1 in) (age 60 years), 26.1 cm (10.3 in) (age 90 years) and 45.1 cm (17.8 in) (age 75 years) averaged 16, 36, and 225 sound seed per tree per year, respectively (17). Some individual shagbark trees have been known to produce 53 to 70 liters (1.5 to 2 bushels) of nuts during a good year (4). The germination of fresh seed is 50 to 75 percent.

Several species of insects influence seed production by causing aborting or premature dropping of fruits or by reducing the germinative capacity of mature nuts. Especially serious are the hickory shuckworm (*Laspeyresia caryana*), pecan weevil (*Curculio caryae*), and the hickorynut curculios (*Conotrachelus affinis* and *C. hicoriae*). In good seed years about half of the total seed crop is sound, but in years of low seed production, insect depredation could be proportionally higher, and a very low percentage of sound seed is produced (17).

Shagbark nuts are heavy, averaging about 220/kg (100/lb) and are disseminated primarily by gravity with some extension of seeding range caused by squirrels and chipmunks.

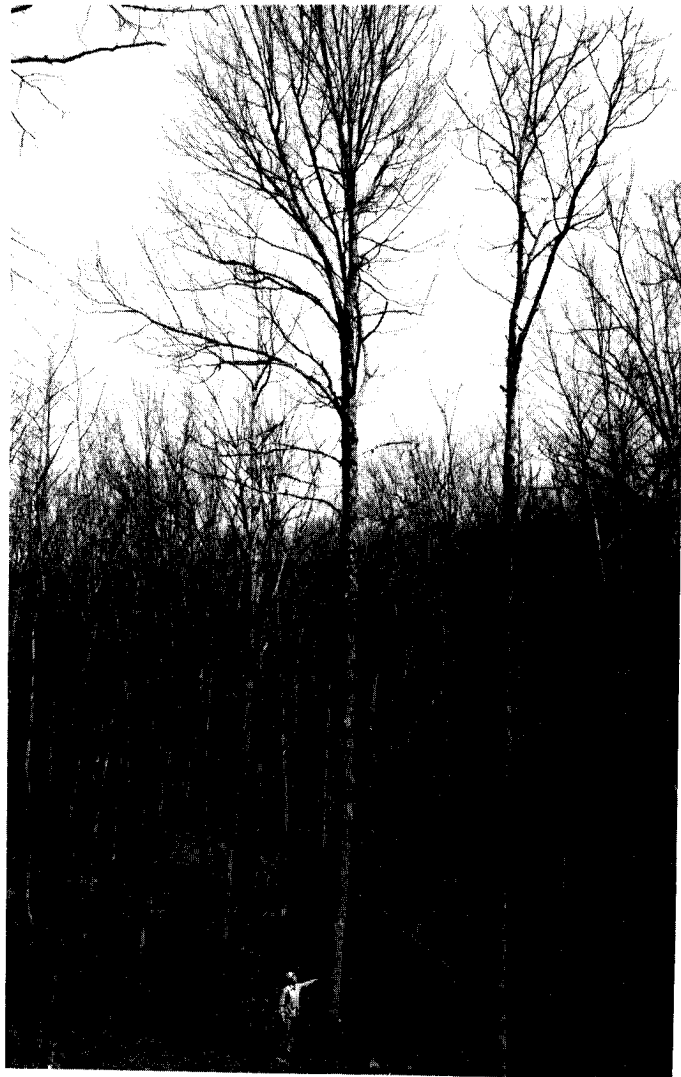
**Seedling Development**-Shagbark seeds show embryo dormancy that is overcome naturally by overwintering in the duff, or artificially by stratification in a moist medium or plastic bag at about 3° C (37° F) for 90 to 120 days (3). Shagbark nuts should be stored in airtight containers at 5° C (41° F) and 90 percent relative humidity. Nuts stored longer than 2 years have lower germination percents and require only 60 days stratification (3). In forest tree nurseries, unstratified nuts are sown in the fall and stratified nuts are sown in the spring. Mulching is recommended and protection from rodents is often required (4). Germination is hypogeal.

Shagbark seedlings normally produce a long taproot and very little top growth during early development. In the Ohio Valley, 1-year-old seedlings grown in the open or under light shade in red clay soil produced an average root length of 0.3 (1 ft) and a top height of 7 cm (2.8 in). By age 3 the taproot extended to about 0.8 m (2.6 ft) while the top increased only to 19.8 cm (7.8 in) (16).

**Vegetative Reproduction**-Shagbark hickory is a prolific sprouter. Nearly all of the cut or fire-killed hickories with stump diameters up to 20 to 24 cm (8 to 10 in) will produce sprouts. As stump diameters increase in size, stump sprouting declines, and proportion of root suckers increases (16). Young hickory sprouts are vigorous and can maintain a competitive position in the canopy of a newly regenerated stand. After 10 to 20 years the rate of sprout height growth declines and hickory will normally lose crown position to the faster growing oaks and associated species.

### Sapling and Pole Stages to Maturity

**Growth and Yield**-Shagbark hickory (fig. 3) is a medium-sized tree averaging 21 to 24 m (70 to 80 ft) tall, 30 to 61 cm (12 to 24 in) in d.b.h., and may reach heights of 40 m (130 ft) with a diameter of 122 cm (48 in). The tree characteristically develops a clear straight cylindrical bole, but there is a tendency for the main stem to fork at one-half to two-thirds of the tree height (16). Although shagbark is one of the fastest growing hickories, its growth rates are less than most of the oaks and other associated species in upland stands. Representative height and d.b.h. by age are shown in table 1 for shagbark in different geographic areas. Regional volume tables for hickory trees and even-aged hickory stands are also available (2,23). Hickory normally constitutes a small percentage of the stocking in upland hardwood stands and the most appropriate per acre yields of such stands



**Figure** *S*-Shagbark hickory in a mixed hardwood stand on a medium site. The larger tree is about 41 cm (16 in) in d.b.h. and 26 m (85 ft) tall.

are those presented by Schnur (23), Gingrich (8), and Dale (5).

**Rooting Habit**-Shagbark seedlings typically develop a large and deep taproot with few laterals. The taproot may penetrate to a depth of 0.6 to 0.9 m (2 to 3 ft) in the first 3 years with a correspondingly slow growth of seedling shoots. Shagbark is rated as windfirm on most sites.

**Reaction to Competition**-Shagbark hickory is classed as intermediate in shade tolerance. Saplings and small reproduction persist under dense overstory

**Table 1**-Average diameter and height of shagbark hickory in selected geographic areas (adapted from 2)

Age	D.b.h.		Height	
	S. Indiana and N. Kentucky <sup>1</sup>	Ohio Valley <sup>1</sup>	Cumberland Mountains <sup>2</sup>	Mississippi Valley <sup>2</sup>
yr	c m		-----m-----	
10	3	2.1	0.9	1.2
20	7	5.5	4.0	2.4
30	10	9.8	6.1	4.6
40	14	13.1	8.2	7.0
50	17	15.5	10.4	9.8
60	20	17.7	12.5	12.5
70	24	19.5	14.6	15.2
80	27	21.3	16.5	17.7
90	29	22.9	18.3	19.8
yr	in		-----ft-----	
10	1.2	7	3	4
20	2.8	18	13	8
30	4.0	32	20	15
40	5.4	43	27	23
50	6.8	51	34	32
60	8.0	58	41	41
70	9.4	64	48	50
80	10.5	70	54	58
90	11.6	75	60	65

<sup>1</sup>Second growth.  
<sup>2</sup>Virgin forest.

canopies for many years and respond rapidly when released (16). It is a climax species in much of the oak-hickory forest area. The relatively slow growth habit of shagbark (and other hickories) places it at a distinct disadvantage under the even-aged management systems presently recommended for upland hardwood stands (if rotations are less than 100 years) (19,20,21). On most sites, height growth of hickory is slower than that of oaks and associated species and by midrotation the hickories are in the subdominant crown positions and become prime candidates for removal in periodic thinnings. Since hickories are long-lived trees and have the ability to withstand shade and crowding and respond when released, they are excellent species (along with white oak) for management on long rotations (200 or more years).

**Damaging Agents**-Shagbark hickory at all ages is susceptible to damage by fire. Light fires can result in top kill of reproduction and saplings (most of which later sprout). Hotter fires may kill larger trees and wound others, making them subject to butt rot and resultant degrade of lumber, loss of sound volume, or both (15,16). Holes made through the bark by sapsuckers (birdpeck) cause a discoloration

of the wood that results in the rejection of a considerable amount of hickory lumber (18).

Hickories are affected by at least 133 known fungi and 10 other diseases (9). Most of the fungi are saprophytes but a few may cause damage to foliage, produce cankers, or cause trunk or root rots.

Canker rot caused by the fungus *Porcia spiculosa* probably is the most widespread and serious of the diseases of the true hickories. Cankers form around dead branch stubs and the wood-rotting fungus can eventually spread throughout the heartwood. Though *I? spiculosa* is the most common trunk rot species, a large number of fungi will rot the living cylinder of hickories that have been injured by fire, logging damage, etc. (9).

Other common diseases of hickory are: anthracnose, (*Gnomonia caryae*) which causes irregular purplish- or reddish-brown spots on the upper leaf surface and dull brown spots beneath. These may merge to form irregular blotches and cause defoliation in wet seasons; mildew (*Microstroma juglandis*) invades leaves and twigs and may form witches' broom by stimulating bud formation; bunch disease (virus) also will cause witches' brooms similar in appearance to those of *M. juglandis*. The virus possibly is carried by sucking insects. Heavily affected trees may die prematurely. Crown gall (*Agrobacterium tumefaciens*) is a bacterial disease which causes tumors or wartlike aberrations on roots or at the base of the trunk, resulting eventually in a gradual decline and death of the tree. A gall-forming fungus species of *Phomopsis* can produce warty excrescences ranging from small twig galls to very large trunk burls.

At least 180 species of insects and mites are reported to infest hickory trees and wood products but few cause serious damage. The hickory bark beetle (*Scolytus quadrispinosus*) is the most important insect enemy of hickory and other hardwoods in the Eastern United States (1). During drought periods, outbreaks often develop in the Southeast, and large tracts of timber are killed. At other times, damage may be confined to single trees or tops of trees. The foliage of infested trees turns red within a few weeks after attack, and the trees soon die. Control measures include felling of infested trees and destroying the bark during the winter months or storing infested logs in ponds. To be effective, this type of control should be conducted over large areas.

The twig girdler (*Oncideres cingulata*) and twig pruner (*Elaphidionoides villosus*) often will severely prune heavily infested shade and park trees and can cause distortion in seedling and saplings in newly generated stands.

## Special Uses

Hickories serve as food for many wildlife species. The nuts are a preferred food of squirrels and are eaten from the time fruits approach maturity in early August until the supply is gone. Hickory nuts also are 5 to 10 percent of the diet of eastern chipmunks. In addition to the mammals above, black bears, gray and red foxes, rabbits, and white-footed mice plus bird species such as mallards, wood ducks, bobwhites, and wild turkey utilize small amounts of hickory nuts (14). Hickory is not a preferred forage species and seldom is browsed by deer when the range is in good condition. Hickory foliage is browsed by livestock only when other food is scarce.

The bark texture and open irregular branching of shagbark hickory make it a good specimen tree for naturalistic landscapes on large sites. It is an important shade tree in previously wooded residential areas. At least one ornamental cultivar of shagbark hickory has been reported (10), but it is not planted as an ornamental to any great extent.

The species normally contributes only a very small percentage of total biomass of a given forest stand. Its adaptability to a wide range of site conditions and vigorous sprouting when cut make shagbark a candidate for coppice fuelwood. However, difficulty in planting and generally slow growth makes shagbark less attractive than many faster growing species.

Hickory has traditionally been very popular as a fuelwood and as a charcoal-producing wood. The general low percentage of hickory in the overstory of many privately owned woodlots is due in part to selective cutting of the hickory for fuelwood. Hickory fuelwood has a high heat value, burns evenly, and produces long-lasting steady heat; the charcoal gives food a hickory-smoked flavor.

The wood of the true hickories is known for its strength, and no commercial species of wood is equal to it in combined strength, toughness, hardness, and stiffness (18). Dominant uses for hickory lumber are furniture, flooring, and tool handles. The combined strength, hardness, and shock resistance make it suitable for many specialty products such as ladder rungs, dowels, athletic goods, and gymnasium equipment.

Shagbark hickory is probably the primary species, after pecan (*Carya illinoensis*), with potential for commercial nut production. The nuts have sweet kernels and fair cracking quality (which is often better in cultivars). The species can be successfully top-grafted on shagbark, and shellbark rootstocks and grafts on older rootstocks can bear in 3 to 4 years.

## Genetics

### Population Differences

Two varieties of shagbark hickory are recognized: *Carya ovata* var. *ouata*, which includes *C. mexicana* Engelm. ex Hemsl., and *C. ovata* var. *australis* (Ashe) Little, sometimes known as *C. carolinae-septentrionalis* (Ashe) Engl. & Graebner and often referred to as Carolina hickory or southern shagbark hickory (11, 12). The fruits are usually longer than 3.5 cm (1.4 in); the dark brown or black terminal bud scales and the generally lanceolate or oblanceolate terminal leaflets of var. *australis* serve to separate it from var. *ouata* with its smaller fruits (less than 3.5 cm (1.4 in) long), tan or light brown bud scales, and usually obovate terminal leaflets.

### Races

Shagbark hickory shows a wide variety in morphological characteristics throughout its natural range and typically displays considerable diversity in nut size, shape, and color, as well as in shell thickness and in sweetness of the nutmeat (16). Based on variability in size and shape of the nut and in character and amount of pubescence on leaves and branches, five additional varieties of *Carya ovata* were accepted in 1933 (22), but none of these is recognized by more recent authors (6,12).

### Hybrids

*Carya ovata* is reported to hybridize with *C. laciniosa* (*C. x dunbarii* Sarg.) and *C. cordiformis* (*C. x Zaneyi* Sarg.), and a cross between shagbark and pecan has been recorded. There are five named clones of shagbark-pecan hybrids, three cultivars for shagbark-shellbark hybrids, and seven cultivars of shagbark-bitternut hybrids (13).

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