# *Carya cordiformis* (Wangenh.) K. Koch Bitternut Hickory

**Juglandaceae Walnut family**

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Bitternut hickory *(Carya cordiformis)*, also called bitternut, swamp hickory, and pignut 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. The dark brown close-grained hardwood is highly shock resistant which makes it excellent for tools. It also makes good fuel wood and is planted as an ornamental.

## Habitat

### Native Range

Bitter-nut hickory (figs. 1, 2) is probably the most abundant and most uniformly distributed of all the hickories. It 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 *(6,23,26)*.

### Climate

Throughout the range of bitternut hickory, the mean annual precipitation ranges from 640 to 1270 mm (25 to 50 in) except for a small area in the southern Appalachians where about 2030 mm (80 in) is common. In the northern part of the range, snowfall averages 203 cm (80 in) per year, but in the southern extreme of the range, it rarely snows. During the growing season, from April to September, the precipitation ranges from 510 to 1020 mm (20 to 40 in).

Annual temperatures range from about 4" to 18" C (40° to 65" F), July temperatures from about 18" to 27" C (65" to 80° F), and January temperatures from -15" to 12" C (5" to 54" F). Extremes of 46" to -40" C (115" to -40" F) have occurred within the range. Bitter-nut seldom grows in areas where the growing season is less than 120 or more than 240 days long *(30,34)*.

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### Soils and Topography

Bitter-nut 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 *(10)*.

In the northern part of its range, bitternut hickory is found on a variety of sites. It grows on rich, loamy, gravelly soil in low wet woods, and along the borders of streams in Michigan, but it is also found on dry uplands. In the southern part of its range, bitternut is more restricted to moist sites. It reaches its largest size on the rich bottom lands of the lower Ohio River Basin, In the southeastern part of its range, bitternut grows on overflow bottom land, but in its southwestern range, it is common on poor, dry, gravelly upland soils. Bitternut is not found in the mountain forests of northern New England and New York, nor at higher elevations in the Appalachians (23).

Bitternut hickory grows primarily on Ultisols that occupy about 50 percent of its geographic range (33). These soils are low in nutrients and are found primarily in the southern to mid-Atlantic region on gentle to steep slopes. Along the mid-Atlantic, southern, and western ranges, bitternut hickory grows on a variety of soils on slopes of 25 percent or less, including combinations of fine to coarse loams and well-drained quartz sands. On slopes steeper than 25 percent, bitternut hickory grows on coarse loams.

Inceptisols occupy about 15 percent of the bitternut hickory range, dominating the Appalachian portion of the geographic range. On gently to moderately sloped topography, the hickories are found on fine loams with a fragipan. On steep slopes, they are more commonly found on coarse loams. These soils are moderate to high in nutrients and water is available to plants during more than half of the year or more than 3 consecutive months during the warm season.

Mollisols occupy an estimated 20 percent of the bitternut hickory range primarily in western areas (33). These soils typically have a dark, deep, fertile surface horizon more than 25 cm (10 in) thick. Mollisols form under grass in climates that have moderate seasonal precipitation. Bitternut grows on a variety of soil combinations such as wet, fine loams, and sandy-textured soils that often have been burned, plowed, and pastured.

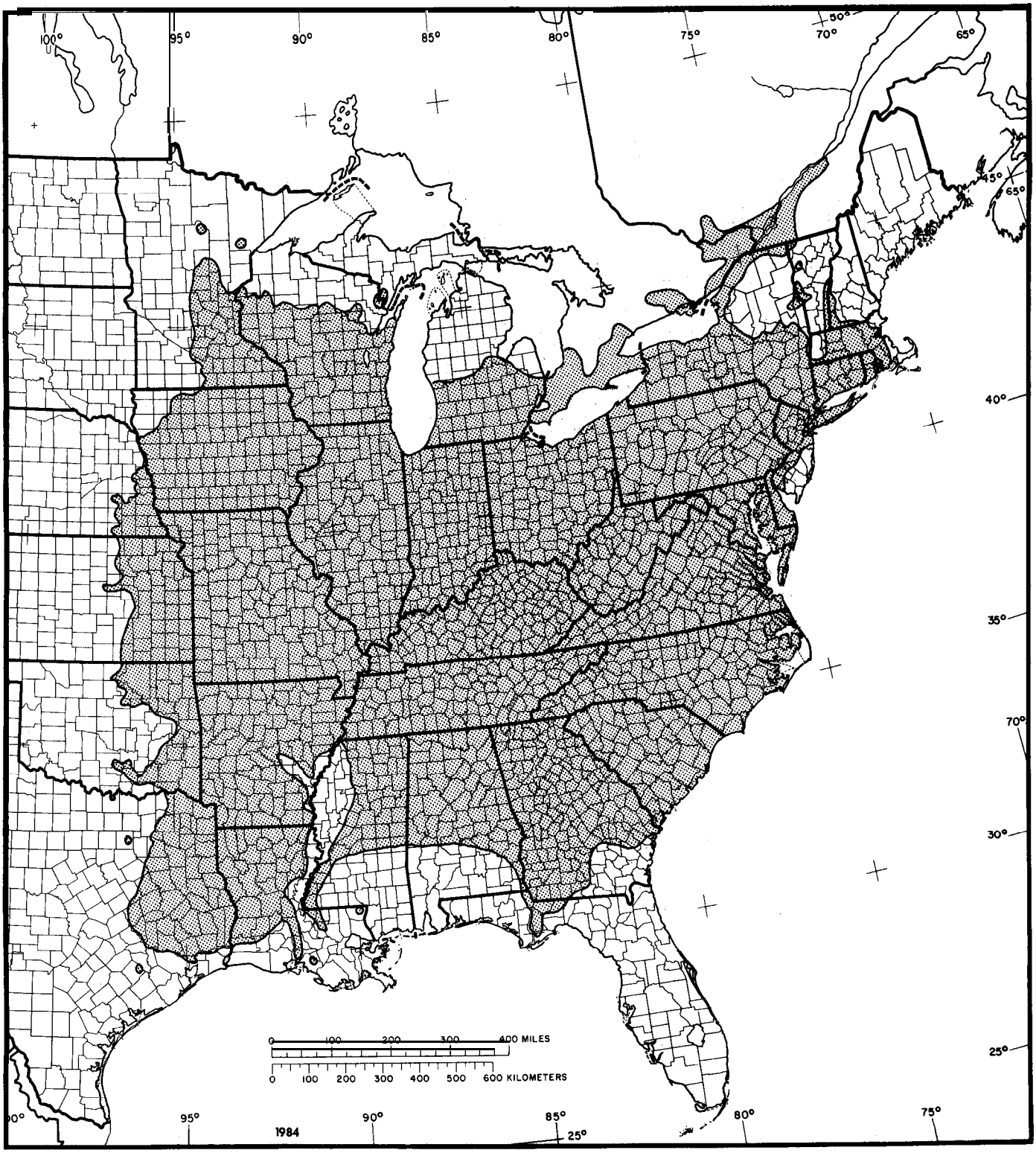


**Figure** *l-The native range of bitternut hickory.*

**Figure 2**—*Typical form of open-grown bitternut hickory.*

Alfisols comprise about 15 percent of the bitternut range, mainly in northern and northwestern portions. These soils contain a medium to high supply of nutrients. In Minnesota and Wisconsin, bitternut hickory is found on moist, well-drained, sandy soils with slopes up to 25 percent. Near Lake Erie and in southern Illinois and northeastern Missouri, it occasionally occurs on wet to moist, poorly drained soils on slopes of less than 10 percent.

## Associated Forest Cover

Bitternut hickory, though present throughout the eastern forest, does not grow in sufficient numbers to be included as a titled species in the Society of American Foresters forest cover types *(8)*, but it is mentioned as an associated species in six types. With one exception, most of these types are subclimax to climax.

In the northern forest region, the types are Sugar Maple-Basswood (Society of American Foresters Type 26) and Sugar Maple (Type 27); in the central forest region, White Oak-Black Oak-Northern Red Oak (Type 52) and White Oak (Type 53); in the southern forest region, Loblolly Pine-Shortleaf Pine (Type 80) and Swamp Chestnut Oak-Cherrybark Oak (Type 91). Hickories are mentioned, but not individually identified, in 16 other cover types; however, 5 of these mentioned types are subclimax to climax.

Because bitternut hickory occupies many sites throughout its geographic range, its associations vary, In addition to the species named in the cover types, bitternut hickory grows with various oaks **(*Quercus*** spp.) in the northern region. In the southern part of Quebec, there is a sugar maple-bitternut hickory subtype that is restricted to deep soils. Trees associated with it include basswood *(Tilia* spp.), eastern hophornbeam ***(Ostrya virginiana),*** northern red oak ***(Quercus*** *rubra)*, butternut *(Juglans* ***cinerea),*** and black maple *(Acer* ***nigrum).*** In the central hardwood region, extending in to northwestern Minnesota, bitternut hickory is found with hackberry *(Celtis* ***occidentalis),*** green ash ***(Fraxinus*** *pennsylvanica)*, and butternut. Common understory herbaceous stems include largeflower bellwort *(Uvularia grandiflora)*, Virginia creeper *(Parthenocissus* ***quinquefolia),*** hepatica ***(Hepatica*** *acutiloba)*, wood-nettle ***(Laportea canadensis),*** wild ginger *(Asarum* ***canadense),*** large flowering trillium *(Trillium grandiflorum)*, springbeauty *(Claytonia* ***caroliniana),*** violets ***(Viola*** spp.), anemone ***(Anemone*** spp.), Solomons-seal ***(Polygonatum*** *pubescens)*, and false Solomons-seal ***(Smilacina*** *stellata).*

In upland oak types of the central forest region, bitternut hickory is commonly associated with mockernut hickory *(C.* ***tomentosa),*** pignut hickory *(C. glabra)*, and shagbark hickory *(C. ovata).* Other common associates are yellow-poplar ***(Liriodendron*** *tulipifera)*, blackgum *(Nyssa sylvatica)*, white ash ***(Fraxinus americana),*** green ash, maples, elms *(Ulmus* spp.), pines *(Pinus* spp.), and eastern hemlock *(Tsuga* ***canadensis).*** Important understory trees and shrubs associated with bitternut include dogwood *(Cornus* spp.), sassafras ***(Sassafras*** *albidum)*, sourwood *(Oxydendrum* ***arboreum),*** downy serviceberry ***(Amelanchier arboreal,*** redbud ***(Cercis canadensis),*** American hornbeam ***(Carpinus caroliniana),*** eastern hophornbeam ***(Ostrya*** *virginiana)*, witch-hazel ***(Hamamelis uirginiana),*** sumac *(Rhus* spp.), viburnums ***(Viburnum*** spp.), rhododendron ***(Rhododendron maximum),*** wild grape *(Vitis* spp.), greenbriers *(Smilax* spp.), Virginia creeper, and poison-ivy ***(Toxicodendron*** *radicans).* Bitternut hickory is also prominent in the southern bottom-land hardwood swamps, in the cover type Chestnut Oak-Cherrybark Oak. There it is found with shellbark hickory *(C. laciniosa)*, shagbark and mockernut hickories, green and white ash, white oak *(Quercus alba)*, Shumard oak *(Q. shumardii)*, Delta

post oak *(Q. stellata* var. *paludosa)*, and blackgum. Understory vegetation in this area includes pawpaw *(Asimina triloba)*, American hornbeam, flowering dogwood, painted buckeye *(Aesculus sylvatica)*, devils-walkingstick *(Aralia spinosa)*, redbud, American holly *(Ilex opaca)*, dwarf palmetto *(Sabal minor)*, southern arrowwood *(Viburnum dentatum)*, and possumhaw *(Ilex decidua)*.

In the southern pine forest region, bitternut hickory is found primarily as an understory species on dry open sites where shortleaf pine *(Pinus echinata)* predominates along with blackjack oak *(Quercus marilandica)*, post oak, mockernut hickory, pignut hickory, and flowering dogwood. Vines, herbaceous vegetation, and shrubs are sparse. The most common understory vegetation includes hawthorns *(Cra taegus* spp.), beautyberry *(Callicarpa americana)*, blueberry *(Vaccinum* spp.), sumacs, longleaf uniola *(Uniola sessiflora)*, panicums *(Panicum* spp.), sedges *(Carex* spp.), and bluestems *(Andropogon* spp.).

## Life History

### Reproduction and Early Growth

**Flowering and** Fruiting-Bitternut hickory is monoecious; male and female flowers are produced on the same tree. The male flowers are in catkins about 8 to 10 cm (3 to 4 in) long and are produced on branches from axils of leaves of the previous season or from the inner scales of the terminal bud at the base of the current growth. Female flowers are about 13 mm (0.5 in) long and appear in short spikes on peduncles terminating in shoots of the current year (3). Depending on latitude and weather, greenish flowers bloom in the spring from April to May. Usually the male flowers emerge before the female flowers. Hickories produce very large amounts of pollen that are carried by the wind.

Ripe fruits are about 25 to 40 mm (1.0 to 1.5 in) long, and solitary or in clusters of two or three; they are subglobose with a yellowish-green, often minutely scurfy, thin husk that is four-winged above the middle. Fruits are slightly flattened. The fruit ripens from September to October and contains bitter-tasting kernels. The drupelike nuts are subglobose, light reddish brown to gray-brown, thin-shelled, two-lobed, and abruptly pointed into a conical head *(10,11,17,21)*.

**Seed Production and Dissemination—**Bitternut hickory seeds are dispersed from September through December. This species does not produce seeds abundantly until the tree is approximately 30 years old. Optimum production extends from 50 to 125 years; trees that are more than 175 years old seldom produce good seed crops (3).

Good seed crops occur at 3- to 5-year intervals, with light crops in the intervening years. Bitternut hickory seed is estimated to be from 70 to 85 percent viable (28). Germination requires 90 to 120 days. Seeds for all species seldom remain viable when they are in the ground for more than 1 year. Clean bitternut seeds may range from 275 to 410/kg (125 to 185/lb) (3).

Seed dissemination is almost entirely by gravity; the fruit is thought to be generally distasteful to wildlife (35). Since bitternut grows in wet bottom land, floodwater probably influences its seeding range.

**Seedling Development-Embryo** dormancy in hickory seed can be overcome by stratification in a moist medium at 0.6" to 4.4" C (33" to 40" F) for 30 to 150 days; when stored for a year or more, seed may require only 30 to 60 days' stratification. Bitternut seeds can probably tolerate a more moist seedbed than most of the other hickories, and it is the least susceptible to frost. Germination is hypogeal. On red clay soil in the Ohio Valley under open or lightly shaded conditions, bitternut hickory seedlings measured 34 cm (13.3 in) in height at 4 years. Sprouts of l-year-old bitternut seedlings grown on red clay averaged 28 cm (11 in) (23).

**Vegetative Reproduction-Stump** and root sprouting are common among pecan hickories. Bitternut hickory is the most prolific root and stump sprouter of the northern species of hickory, with sprouts arising from stumps, root collar, and roots. Most sprouts from saplings and pole-size trees are at the root collar, and sprouts from sawtimber-size trees are root suckers. Stump sprouts are usually less numerous than root collar sprouts or root suckers *(9,23)*. Bitternut hickory develops a dense root system and can be transplanted more successfully than other hickories. For this reason, it may have promise as root stock for grafting and budding; however, propagation is usually by seed, with best results in early spring *(10,13,20)*. Techniques for selecting, packing, and storing hickory propagation wood have been described *(19)*.

### Sapling and Pole Stages to Maturity

**Growth and Yield-Bitternut** hickory typically attains a height of about 30 m (100 ft) and 61 to 91 cm (24 to 36 in) in d.b.h. The tree attains its best

height growth in the rich bottom lands of the lower Ohio River Basin *(7)*. Its life span is about 200 years.

Second-growth bitternut hickory on a good site in the Ohio Valley reached the following average heights and diameters (23):

| | Height | | Age d.b.h. | |
|---|---|---|---|---|
| *yr* | *m* | *ft* | *cm* | *in* |
| 10 | 3.0 | 10 | 5 | 2.0 |
| 20 | 7.3 | 24 | 10 | 4.0 |
| 30 | 12.2 | 40 | 15 | 6.0 |
| 40 | 15.8 | 52 | 19 | 7.6 |
| 50 | 18.9 | 62 | 23 | 9.2 |
| 60 | 21.0 | 69 | 29 | 11.4 |
| 70 | — | — | 33 | 13.0 |

Growth rates (d.b.h.) of hickory species have been compared to other species in Appalachian hardwood stands as follows (29): dominant-codominant hickories 38 to 51 cm (15 to 20 in) in d.b.h. in well-stocked stands on good oak sites grew slower than northern red oak, yellow-poplar, black cherry *(Prunus serotina)*, and sugar maple *(Acer saccharum)*. Hickories grew about the same as chestnut oak *(Quercus prinus)*, white oak, sweet birch *(Betula lenta)*, and American beech *(Fagus grandifolia)*. Diameter growth for hickory was about 0.3 cm (0.12 in) per year; it was about 0.5 cm (0.20 in) for black cherry and about 0.6 cm (0.23 in) for yellow-poplar and red oak. Equations are available for predicting merchantable gross volumes from hickory stump diameters in Ohio *(12)*. 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 (22,371.

Bitternut hickory generally prunes itself more readily than other hickories. Epicormic branching is not a problem with hickory species, but occasionally a few branches do occur *(27,29)*. In bitternut hickory, the ratio of sapwood to heartwood is low; sapwood seldom is more than 38 mm (1.5 in) wide or more than 25 years old (23). Bitternut hickory is the hardiest of the hickories *(26)*, as indicated by its wide geographic range.

**Rooting** Habit-Bitternut hickory develops a dense root system with a pronounced taproot. It is windfirm and can be transplanted more successfully than any other hickory species *(20)*.

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 (32). Small laterals originate throughout the length of the taproot but may die back during the fall. During the second year, the taproot may reach a depth of 122 cm (48 in) and the laterals grow rapidly. After about 5 years or so, the root system attains its maximum depth, and the horizontal spread of the roots is about double that of the branches. By age 10, the height of the top is about four times the depth of the taproot while the spread of the crown branches is only about half that of the root system.

Mature pecan hickory root systems have a deep taproot, with lateral roots emerging at nearly right angles to the taproot, but no major lateral roots. Pecan hickory roots begin to develop just before spring shoot growth. Roots are more responsive to favorable conditions of soil or climate, and conversely more sensitive to adverse conditions. Depending on environmental conditions, there are usually four to eight cycles of root growth during the year (32).

**Reaction to Competition-Bitternut hickory is** considered intolerant of shade but seems to have a higher seedling tolerance on bottom lands than most of its associates (24). Hickories also can be intermediate in tolerance (23,291. Bitternut is less susceptible to frost damage than other hickories (24).

Silvicultural practices for managing the oak-hickory type are summarized by Watt et al. *(36)*. Establishing hickory trees from seedlings is difficult because of seed predators. Infrequent bumper seed crops usually provide some seedlings, but seedling survival is poor under a dense canopy. Because of its prolific sprouting ability, hickory reproduction can survive browsing, breakage, drought, and fire. Top dieback and resprouting may occur frequently, with each successive shoot attaining a larger size and developing a stronger root system than its predecessors *(16)*. By this process, hickory reproduction gradually accumulates and develops under moderately dense canopies, especially on sites dry enough to restrict reproduction of more tolerant, but more fire- or drought-sensitive species.

Wherever hickory advance reproduction is adequate, clearcutting results in fast-growing sapling stands of hickories. If there is no advance hickory reproduction, clearcutting eliminates hickories except for stump sprouts. Theory suggests that light thinnings or shelterwood cuts can be used to create advance hickory regeneration, but this has not been demonstrated.

**Damaging** Agents-Bitternut hickory saplings are easily damaged by fire, and older trees also are susceptible to fire damage because of the low insulating capacity of the hard bark *(13,24)*. It is not affected by severe diseases but has many of the problems common to most hickories; these include mineral streaks and sapsucker-induced streaks that

degrade lumber. White heart rot *(Poria spiculosa)* is the most widespread and damaging disease of hickory. This trunk rot can produce extensive decay from wounds. A common white wood rot ***(Phellinus igniarius)*** also attacks bitternut hickory through fire wounds. Occasionally Nectria ***(Nectria galligena)*** and Strumella *(Strumella coryneoidea)* produce cankers on the stems of bitter-nut hickory, but most fungi cause little, if any, decay in small young trees. In general, the hard, strong, durable wood of hickories makes them relatively resistant to decay fungi *(2,10,13)*.

Foliage diseases such as leaf mildew, witches' broom ***(Microstroma juglandis),*** and leaf blotch ***(Mycosphaerella dendroides)*** occur on all hickory species. Pecan scab ***(Cladosporium effusum)*** also occurs on foliage, and bitternut hickory is a host to anthracnose ***(Gnomonia caryae).***

Nuts of all hickory species are susceptible to attack by the hickory nut weevil *(Curculio caryae)*. Another weevil ***(Conotrachelus aratus)*** attacks young shoots and leaf petioles. ***The Curculio*** species are the most damaging, often destroying 65 percent of the hickory nut crop (1).

The most important bark beetle attacking bitternut hickory is the hickory bark beetle ***(Scolytus quadrispinosus).*** Attacks by this insect are more serious during drought years and where hickory species are growing rapidly. The twig girdler ***(Oncideres cingulata)*** often seriously deforms trees by severing branches, and sometimes these girdlers even cut hickory seedlings near ground level (1). Two casebearers ***(Acrobasis caryivorella*** and ***A. juglandis)*** feed on buds and leaves and later 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 that commonly feed on dying or dead hickories and logs include the banded hickory borer ***(Knulliana cincta)***, a long-horned beetle ***(Saperda discoidea),*** apple twig borer ***(Amphicerus bicaudatus)***, the flatheaded ambrosia beetle ***(Platypus compositus)***, redheaded ash borer ***(Neoclytus acuminatus)***, and a false powderpost beetle ***(Scobicia bidentata).***

Insects that severely damage lumber and manufactured hickory products include the powderpost beetles ***(Lyctus*** spp.) and ***Polycanon stoutii.*** Gall insects *(Caryomyia* spp.) commonly infest leaves. The fruittree leafroller *(Archips argyrospila)* and the hickory leafroller ***(Argyrotaenia juglandana)*** are the most common leaf feeders. Gypsy moth ***(Lymantria dispar)*** larvae feed on hickory leaves, but hickories are not the gypsy moth's favorite food. The giant bark aphid ***(Longistigma caryae)*** is common on the bark of hickories. This aphid feeds on twigs and can cause branch mortality. European fruit lecanium ***(Parthenolecanium corni)*** is common in hickories ***(1).***

Some birds and mammals eat the nuts when there are less favored hickory nuts available. Together with losses from insects and disease, these virtually eliminate the annual nut production except during bumper seed crop years.

## Special Uses

Bitter-nut is used for lumber and pulpwood. Pecan hickories, such as bitter-nut, are not equal to true hickories in strength, hardness, and toughness. Based on ovendry weight and green volume, the specific gravity of green bitternut wood is 0.60; at 12 percent moisture content, the specific gravity is 0.66 *(31)*.

Hickory species are most desirable for charcoal and fuelwood; pecan hickories are less desirable than the true hickories. Bitternut hickory ranks third in heating value among hickories (25); it burns with an intense flame and leaves little ash.

Because bitternut hickory wood is hard and durable, it is used for furniture, paneling, dowels, tool handles, and ladders. It is a choice fuel for smoking meats ***(15).*** Other uses include bars, crates, pallets, and flooring *(10)*.

Bitternut hickory seeds are eaten by wildlife but are of little value for human consumption because of their high tannin content, and extreme bitterness and astringency *(7,18,26,35)*. Seeds do not usually constitute a large portion of the diet of squirrels. Rabbits, beavers, and small rodents and mammals occasionally feed on the bark of hickory species *(5,35)*. The foliage of bitternut hickory has a high calcium content and is near the top of the list of soil-improving species (4).

Early settlers used oil extracted from the nuts for oil lamps. They also believed the oil was valuable as a cure for rheumatism (19). Bitternut hickory is desirable as an ornamental or shade tree, and the dense root system provides good soil stability.

## Genetics

To date, no information has been published concerning population or other genetic studies of this species.

Hickories are well-known for their variability and many natural hybrids among North American species are known, Usually the species within each genus can be successfully intercrossed ***(14).*** Bitternut hickory naturally hybridizes with the following

species: *C. illinoensis* (*C. x brownii* Sarg.), *C. glabra* (*C. x demareei* Palmer), and *C. ovata* (*C. x laneyi* Sarg.).

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