1984

Juglans Cinerea: The American White Walnut

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JUGLANS CINEREA

THE AMERICAN WHITE WALNUT
(TITLE)

BY

Dennis Robert Hattermann

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Science

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1984
YEAR

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JUGLANS CINEREA

THE AMERICAN WHITE WALNUT

BY

DENNIS R. HATTERMANN

B.S. in Botany, Eastern Illinois University

ABSTRACT OF THESIS

Submitted in partial fulfillment of the requirements of the degree of Master of Science in Botany at the Graduate School of Eastern Illinois University.

Charleston, Illinois

1984

The American white walnut, Juglans cinerea L. is a native North American tree in the Juglandaceae, or walnut family. It prefers rich, moist, rather neutral to slightly basic lowland soils. This is an in depth study of its taxonomy, morphology, anatomy, age, size, growth habit, distribution, ecology, propagation, economic importance, medicinal uses, toxicity, folklore, diseases and pests, and chemical constituents.

J. cinerea L. is monoecious and confined in its distribution to the eastern and central parts of North America. It can be easily identified by its large, pinnately compound leaves and ashy-gray bark with broad, flat plates and deep furrows. It is a rather small to medium sized tree rarely attaining a height of more than 21.3 m or a trunk diameter of more than 91 cm. It is considered to be rather short-lived, rarely surviving more than 80 years.

The fruits, referred to commonly as nuts, but more technically dry drupes, can be used for a variety of purposes. The most important of these are as food for man and other animals, as well as a source of a yellowish-brown dye. They are very rich in oil, which probably accounts for the common name butternut. Their caloric value is 3370 calories per pound, the highest for any nut species.

The wood of this tree is very attractive and has a soft texture, light weight, and is easily workable. Because of these qualities it has been employed rather extensively in the past for interior finish and cabinet work, even though it is less durable and lower in strength than its close relative the black walnut. Despite these desirable qualities, the tree at present has little economic importance

outside of local uses, such as in the New England states where maple butternut candy is made. The reason for this lack of interest is not actually known but it could be due to a variety of factors such as those mentioned above, as well as difficulty in cracking the nuts of wild trees and more importantly its susceptability to disease. The ravages of disease, combined with the great demand of this tree for cabinet work has resulted in this tree becoming very rare and scattered in native stands. A fact not known by many people is that many easily cracking, disease resistant varieties are now available through nurserymen.

Probably the most important disease of this tree, which has resulted in its widespread decline over most of its range, is a canker disease caused by the fungus Sirococcus clavigignenti-juglandacearum Nair, Kostichka and Kuntz. Another important disease is a branch canker or dieback caused by the fungus Melanconis junglandis (Ell. and Ev.) Graves.

Butternut twigs are most successfully grafted on 2-3 year old black walnut seedlings via a girdle graft or splice graft several feet from the ground just as growth begins in the spring. Grafts sometimes bear nuts after only two years from time of grafting. Trees are easily transplanted, and should be supplied with nitrogen and phosphorus fertilizer to stimulate growth and help fill out the nuts.

ACKNOWLEDGEMENTS

I would like to express my sincere personal gratitude to Dr. Charles B. Arzeni for his friendship, support, and guidance during this study and throughout our association. I would also like to give a special thanks to Dr. Wesley C. Whiteside and Dr. John E. Ebinger for their criticisms of this manuscript.

I am also deeply grateful to and would like to especially thank my fiancee, Jan, for supporting my educational endeavors and for proofreading and typing this manuscript.

Finally, I would like to thank my parents, my fiancees parents and the rest of my family, for supporting my educational endeavors and for motivating me to strive for excellence.

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INTRODUCTION :

The American white walnut or butternut (Juglans cinerea L.) is a tree whose natural distribution is confined to the eastern half of North America, mostly within the United States but also reaching into southern Canada. This tree appears to have received very little attention even though it possesses two potentially profitable economic products, which are high quality wood and nuts. The tree is presently declining rapidly throughout its range from disease and, therefore, most of the research conducted in recent years has been concerned primarily with discovering and classifying the organism responsible for this disease. Although rare, when this tree is encountered it is easily distinguished by its large, pinnately compound leaves and ashy-grey bark with broad, flat plates separated by deep fissures.

The purpose of this paper is to uncover and assemble all of the information concerning this tree into a single comprehensive manuscript. Although every attempt was made to find all of the information available concerning the butternut, the author realizes that some things may have been overlooked. However, it is hoped that this paper will be complete enough to give a comprehensive picture of this tree and provide an informative basis for future research.

NOMENCLATURE AND DESCRIPTION :

Juglans cinerea L. is a mamber of the walnut family, Juglandaceae, which is comprised of six or seven genera and approximately sixty different species of both trees and large shrubs. These are widely distributed in the temperate areas of the North Temperate Zone and, to a lesser extent, in the tropical forests of the Northern and Southern Hemispheres. There are two generea and approximately twenty-five species of the Juglandaceae found in the United States.

The genus Juglans, the walnuts, presently is comprised of about twenty species which are distributed in the forests of North, Central, and South America, the West Indies, Southern Europe, and Southern and Eastern Asia. Although six species of Juglans are native to the United States, only J. nigra and J. cinerea are important sources of lumber (Harlow et al., 1979).

Juglans, the genus name of the walnuts, comes from the Latin Jovis glans which means "acorn (or any nut of similar shape) of Jove" (Vines, 1960). Vines also states that the species name, cinerea, refers to the ashy gray hairs of the young tree parts. According to Constantine (1975), Juglans means the nut of Jupiter and cinerea means ash colored, pertaining to the bark. This tree is referred to by many different common names, the most widely used of which is Butternut (Me., N.H., Vt., Mass., R.I., Conn., N.Y., Pa., Del., W.Va., N.C., S.C., Ala., Ky., Mo., Ill., Ind., Wis., Iowa, Nebra., Minn., S. Dak.). Other names include Oil Nut (Me., Minn., N.H., S.C.), American White Walnut (trade name), Buttnut (N.J.), Walnut (Minn.), Lemon Walnut (lit.), Filnut, Lemonnut, and White Mahogany (Schoonover and Shelley, 1951; Krochmal. 1974; and Snow, 1903).

LEAVES :

The leaves of Juglans cinerea are alternate, deciduous, and pinnately compound with leaflets in odd numbers between eleven and nineteen (Figures 1 and 2). The leaves are also generally 24.5-63.5 cm long and the leaflets are 5.1-12.7 cm long and 3.8-5.1 cm wide (Vines, 1960). Grimm (1962), on the other hand, reports that the leaves are 38.1-76.1 cm long and the leaflets are 5.1-10.1 cm long and approximately half as wide. Obviously there is some variability. The leaflets are oblong-lanceolate with finely serrated margins and acute to

acuminate apices and unequally rounded bases. Serrations are prominent at the leaf apex but disappear toward the base (Sargent, 1933). The rachis is pubescent and glandular (Vines, 1960). The leaflets near the middle of the rachis tend to be somewhat longer than those at either end and are nearly sessile, except for the terminal leaflet which is often long-stalked (Britton, 1908). The leaves emerge from the bud glandular and sticky (Sargent, 1933) and eventually become finely pubescent and yellow green on the dorsal surface and lighter on the ventral surface with glandular pubescence (Vines, 1960). According to Sargent (1933), the upper surface is also rugose at maturity. They turn brown or yellow and drop in early autumn (Sargent, 1933).

Figure 1. Dorsal surface of a leaf.

Figure 2. Ventral surface of a leaf.

FLOWERS :

The white walnut is monoecious with the flowers first appearing between April and June when the leaves are partially developed. The staminate flowers (Figure 3) are about 6.4 mm long and are arranged in cylindrical catkins which are 3.8-12.7 cm long and which emerge from axillary buds of the preceeding season (Vines, 1960). According to Sargent (1933), the catkins are 7.6-12.7 cm long. The pistillate flowers (Figure 3) are approximately 8.5-12.8 mm long and are arranged in 5-8 flowered terminal spikes which are formed from the present season's growth (Vines, 1960). According to Rogers (1935), the immature catkin emerges in the fall but then stops growing and overwinters as a little cone-shaped structure but resumes growth in the spring. Numerous overlapping flower bracts serve as a protective covering for the young catkin through the winter. The central axis of the catkin is rigid at first but becomes flexible at maturity (Rogers, 1935). According to Brown (1975), the calyx of the staminate flowers is usually six-lobed and arises from the adaxial surface of an acute, rusty-pubescent bract. It is light yellowish green and subtends approximately 8-12 stamens with dark brown anthers and very short but free filaments (Brown, 1975). Sargent (1933) reports that the calyx is 6.4 mm long and has a puberlous outer surface. Vines (1960) reports that there are 7-15 stamens and the calyx is four-lobed. He also includes that pistillate flowers are arranged in spikes which occur solitarily or in groups and are constricted above the middle. The ovary is one-celled and inferior beneath a short style from which emerges two bright red, spreading, clavate stigmas which are approximately 12.8 mm long (Brown, 1975). The ovary is surrounded by a very small, linear-lanceolate, four-lobed calyx (Vines, 1960). Bracts and bractlets,

Figure 3. Flowers and twigs of Juglans cinerea: A, portion of twig showing staminate catkins below and pistillate flowers clumped higher on the twig; B, terminal portion of twig; C, single staminate flower; D, single pistillate flower; E, longitudinal section of a single pistillate flower (Figure 3 A-C cited in Brown, 1975; 3 D cited in Otis, 1931; and 3 E cited in Lawrence, 1951).

A

C

D

B

E

which are shorter than the calyx lobes, are covered with a sticky, white or pink, glandular pubescence (Sargent, 1933). Corollas are absent on both the staminate and pistillate flowers (Mohlenbrock, 1973).

FRUITS :

The fruit is a nut, or more technically a dry drupe since the nut is surrounded by an indehiscent involucre (Keeler, 1900) (Figure 4). These occur solitarily or in clusters or drooping racemes of 1-5 which ripen between September and November. They are oblong-ovate, faintly 2-4 ridged, 3.8-7.6 cm long, and have a pungent odor. The thick, green husk is indehiscent, semi-fleshy, and is covered with a sticky, reddish, matted pubescence (Vines, 1960). The fruits are $\frac{1}{2}$ as wide as they are long (Hosie, 1973). According to Britton (1908), the nut is oblong-ovoid and has an abruptly tapered (acute to acuminate) apex and a rounded base. The nut wall is hard, light brown, and approximately 6 mm thick (Britton 1908), and is adorned with 4 prominant, sharp, thin ridges or ribs. In some instances there are 4 less prominant, more obscure ribs (Vines, 1960). The spaces between the ribs are deeply and irregularly sculptured into thin, broad longitudinal plates (Sargent, 1933). The base of the nut is two-celled while the upper half is one-celled (Vines, 1960). The upper cell extends into the acuminate tip (Britton, 1908). According to Sargent (1933), the seed is sweet and edible but very oily, and Woodroof (1979) states that the kernal is thin and not easily separated from the shell in all but a few selected cultivars. The cotyledons are oblong, slightly grooved inside and sharply ridged outside (Britton, 1908). Some authors such as Keeler (1900) and Sargent (1933) state that the seed will become rancid very quickly. However, accord-

Figure 4. Dried fruits of J. cinerea with and without their husks.

ing to Medsger (1966), the seeds should not spoil for almost one year if stored in a cool place. Woodroof (1979) states that the kernal has a very high nutritive value, being 27.9% protein and containing 3370 calories per pound, both of which are the highest values of any nut. The closest competitor is the pecan with 3300 calories per pound. The quality of the nut is rated very highly by many nut enthusiasts and it has a very distinctive flavor which is much like, although somewhat better than, the Japanese butternut, Juglans sieboldiana (Woodroof, 1979).

TWIGS AND BUDS :

The twigs are stout and lustrous bright green, or dark orangish brown, with yellowish or reddish brown, sticky pubescence and numerous pale or white lenticels in their first year (Figure 3). Usually in the second year the twigs become puberlous and assume a more brown color tinged with orange or red, eventually becoming ashy gray (Sargent, 1933; Vines, 1960; and Brown, 1975). The leaf scars are alternate and are rather large and gray with pubescence bordering the upper edge (Mohlenbrock, 1973). According to Vines (1960), they are also elevated and three-lobed with three U-shaped groups of bundle scars. The terminal buds are 12.8-17.1 mm long, 6.4 mm wide, and flattened, with a blunt tip and short pale pubescence on the outer scales (Sargent, 1933). According to Vines (1960), the terminal buds are 12.8-19.2 mm long and depressed, with entire or lobed scales and oblique bases. The axillary buds are smaller, being about 3.2 mm long, and are depressed and ovate with rounded tips and rusty pubescence. Keeler (1900) states that the axillary buds are practically naked and are found in groups of three to four and that when spring arrives the inner scales enlarge. According to Sargent (1933), the axillary buds are flattened and possess pubes-

cence which is rusty brown or pale. The pith is chambered, being thin plated with thickened diaphragms (Vines, 1960).

BARK :

The mature trunk bark (Figure 5) is generally 18-25 mm thick (Britton, 1908) and is ashy gray to light brown in color and externally consists of flat-topped, rather broad, short ridges which join in places to give patterns which are somewhat diamond-shaped (Vines, 1960). The surface of the ridges separates into small, plate-like, appressed scales (Sargent, 1933) and separating these ridges are dark, narrow, shallow crevices (Hosie, 1973). According to some authors (Otis and Burns, 1931), the ridges are narrow and the furrows are wide and Vines (1960) and Mohlenbrock (1973) both report that the crevices are fairly deep. The trunk bark is generally smoothish and gray on young trees but becomes rougher and more brown as the tree ages (Britton, 1908; Otis and Burns, 1931; and Sargent, 1933). According to Keeler (1900), the bark, probably the inner bark, contains tannic acid.

WOOD : GENERAL DESCRIPTION AND PROPERTIES :

The wood is light brown in color, coarse grained, lightweight and soft (Mohlenbrock, 1973). Not only is butternut wood lighter than its close relative the black walnut, it is also much less durable and lower in strength (Constantine, 1975). However, although lighter than the black walnut, this wood is very attractive and because of its soft texture and light weight it is easily worked. It has been employed rather extensively for interior finish and cabinet work (Peattie, 1950). Figures 6,7, and 8 show the radial, transverse, and tangential cuts of wood respectively. According to Keeler (1900), this wood takes a beautiful polish and it can be made to resemble black walnut through stain-

Figure 5. Bark exhibiting the characteristic ashy gray color and deep furrows separated by rather broad, flat ridges.

Figure 6. Radial wood section (Harrar, 1967).

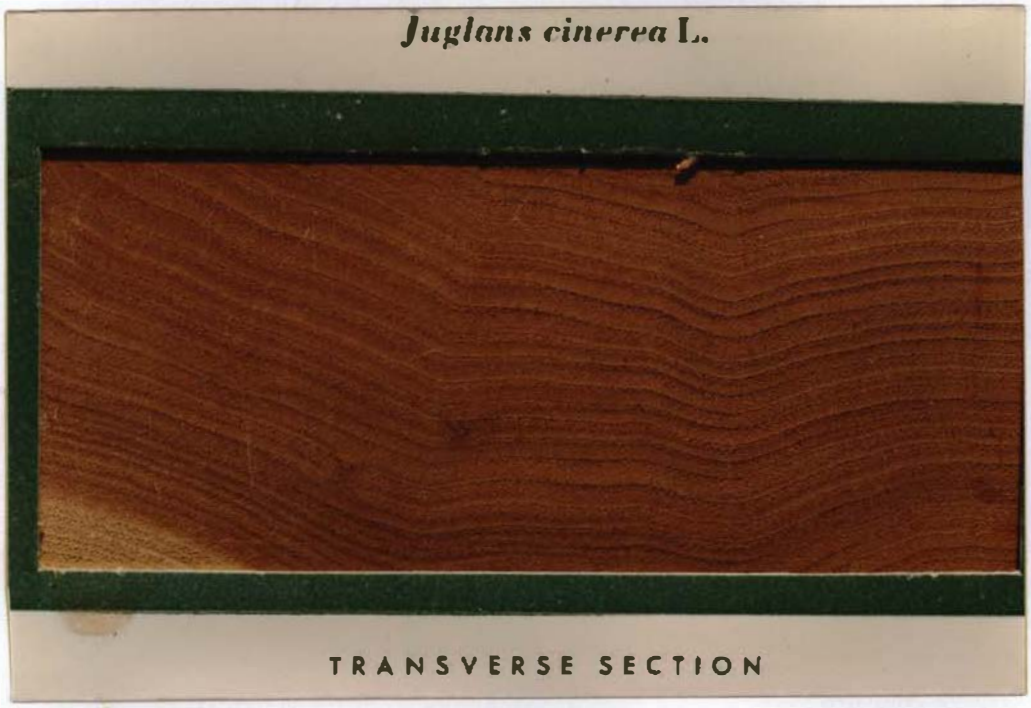


Figure 7. Transverse wood section (Harrar, 1967).

Figure 8. Tangential wood section (Harrar, 1967).

ing (Brown et al., 1949). The sapwood is seldom more than 2.54 cm wide and is white to light grayish brown in color while the heartwood is light chestnut brown in color, lustrous, and often variegated with pigment figure (Brown et al., 1949). The heartwood is so light that it is very hard to distinguish from the sapwood and it is not fluorescent (Miller, 1976). According to Snow (1903), the sapwood has a coarse-grained compact structure and the heartwood darkens upon exposure to the atmosphere.

This wood has an approximate specific gravity of .36 green and .46 overdried and has a moderately high shock resistance. However, it is moderately weak when bent or compressed endwise. The grain is straight and the wood is not very durable, shrinks moderately, and has no characteristic odor or taste. The growth rings are very distinct and can be seen quite easily due to the difference in size between late summerwood pores and those of early springwood. Butternut wood is classified as semi-ring porous with scattered pores, the largest of which are easily visable without magnification. These pores gradually get smaller between the inner and outer portion of the ring. Tyloses are fairly abundant and the pores are in groups of two to several or solitary. The parenchyma, including the ray parenchyma, is seen easily with a hand lens, but is often indistinct without magnification, and is arranged in fine, continuous, tangential bands which are fairly numerous. The parenchyma is especially conspicuous at the outer portion of the growth ring (Brown et al., 1949). The wood has a modulus of rupture of 8,400 and a modulus of elasticity of 1,150,000. A cubic foot (2.83×10^4 cm^3) of seasoned wood weighs approximately 11.34 kg (Snow, 1903). According to Record (1919), this wood shrinks .36% in length, 2.9% in radius, 3.1% in diameter, 6.9% in circumference, 7.3%

in area of cross section, and 7.6% in volume.

WOOD : MINUTE ANATOMY :

There are generally 6-12 vessels/mm^2, the largest of which are 160-260 microns in diameter (Brown et al., 1949). According to Miller (1976), the pore diameter is from 184-213 microns and the vessel members are 483-645 microns long. He also includes that 65-93% of the pores are solitary with the other 35-37% in radial multiples of two, three, and four. Microscopic photographs of transverse and tangential wood sections can be seen in Figures 9 and 10 respectively. The vessels possess simple perforation plates and have intervessel pits with a diameter of 10-16 microns and a shape which is orbicular to oval, or angular if crowded. Fibers are 20-45 microns in diameter and are thin-walled. The parenchyma is non-crystalliferous and is metatracheal and metatracheal-diffuse. Lines of zonate parenchyma are mostly uniseriate. Rays are homogeneous to heterogeneous, unstoried, and 1-4 seriate (Brown et al., 1949). According to Miller (1976), the rays are also homocellular with a height of 340 to 434 microns and a usual width of 2-4 cells. The individual ray cell height is between 13 and 20 microns as seen from the tangential surface and the shape of each cell from the same viewpoint is oval to oblong. The fiber tracheids are from 1,137 to 1,549 microns in length. In his study, Miller observed very little paratracheal parenchyma and the axial parenchyma which was present could not be seen without magnification, and was present in apotracheal bands. He also found heartwood crystals of ellagic acid in the fibers, rays, and axial parenchyma cells in two of six specimens he observed. However, neither prismatic crystals nor silica were seen in any of the specimens. Reticulate thickenings are also absent

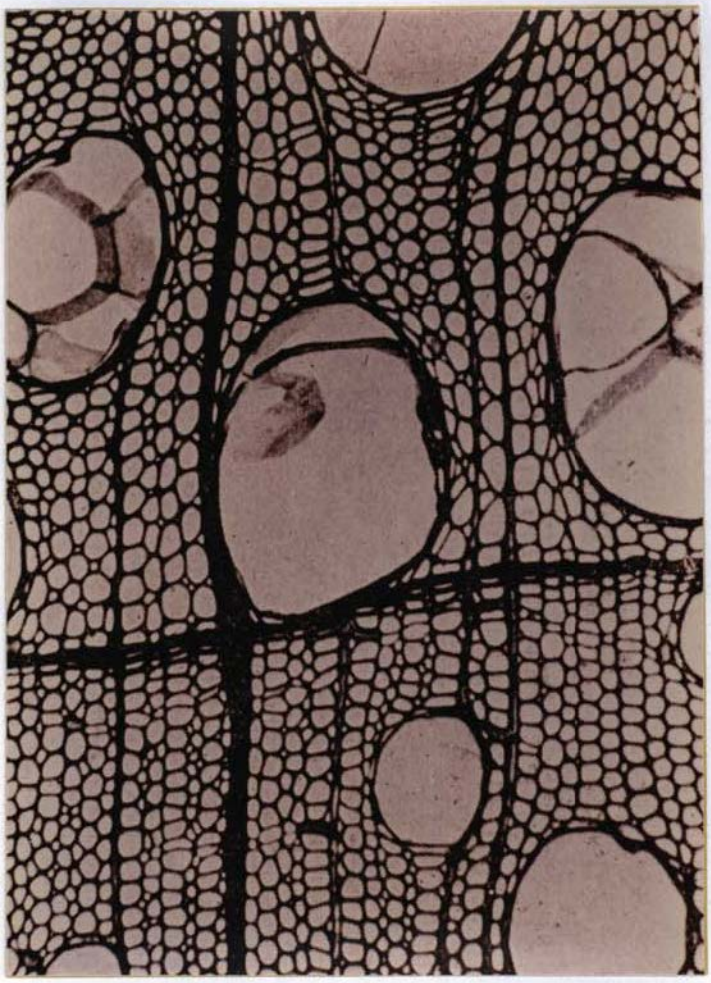


Figure 9. Transverse wood section of Juglans cinerea (Harlow et al., 1979).

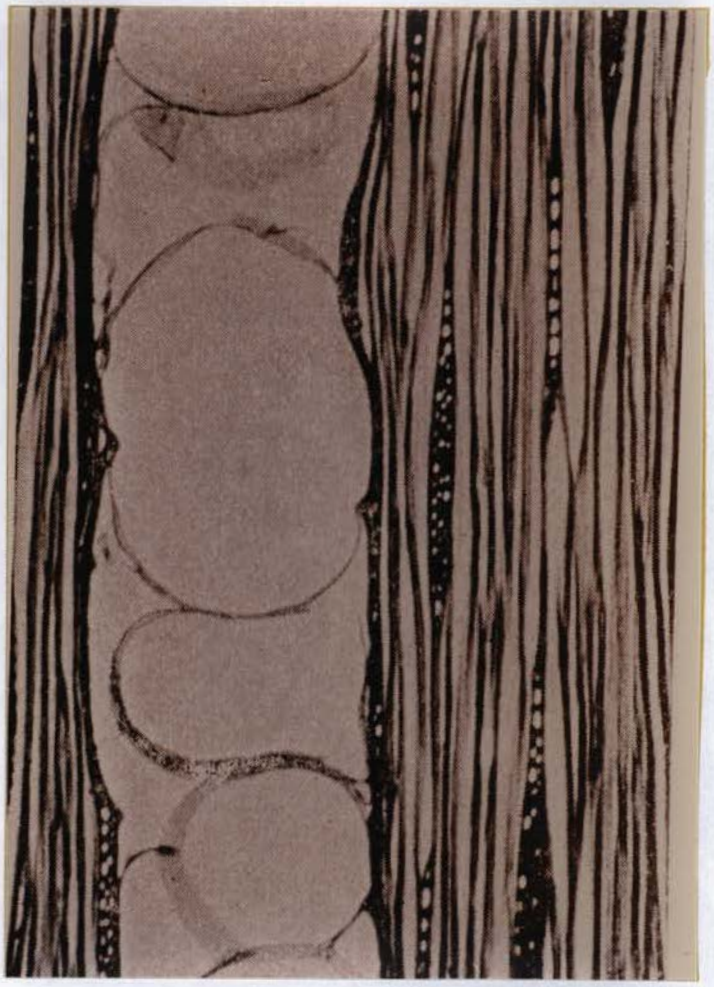


Figure 10. Tangential wood section of *Juglans cinerea* (Harlow *et al.*, 1979).

(Miller, 1976).

AGE :

According to Hosie (1973), this tree rarely lives longer than eighty years and is therefore considered rather short lived. Vines (1960) agrees with Hosie to a certain extent in reporting a maximum age of seventy-five years.

SIZE :

The butternut is generally considered a small to medium sized tree (Hosie, 1973; Grimm, 1962; Otis and Burns, 1931; and Mohlenbrock, 1973) which seldom attains a height of more than 21.3 m or a trunk diameter of 60.9 to 91.4 cm. Grimm (1962) agrees with Otis reporting that a height of 9-15 m and a 30.4-91.4 cm trunk diameter are commonly attained, but also includes that it can get much larger. Other authors such as Vines (1960) and Hough (1947) indicate that the butternut may reach as high as 30 m and possess a trunk diameter of 122 cm. However, Hough (1947) also includes that this is a rare occurrence and that it seldom ever exceeds 19-21 m in height. According to Grimm (1967), a butternut from St. Joseph County, Michigan is reported the champion with a 26 m height, a 3.6 m girth (1.4 m from the ground) and a spread of 3.7 m. Mohlenbrock (1973) states that butternuts can get as tall as 27.4 m with a 91 cm trunk diameter. According to Britton (1908), the maximum size of this tree is 30 m tall with a 1 meter trunk diameter. Because white walnut trees have been plagued by disease in the past several years, larger trees (as well as trees of all sizes) are probably not found occurring naturally as often today as they once were. This author could not find any trees even approaching the maximum heights cited above in the woodlands surrounding Charleston, Illinois. The few trees that were

found were much smaller and often possessed several dead or dying branches, or at times death of the entire tree was evident.

HABIT OF GROWTH :

A tree from 9-15 m tall with a trunk diameter of 90.9-91.4 cm will normally have stout, lateral horizontal branches emerging from the trunk at approximately 4.6 to 6.1 m above the ground (Otis and Burns, 1931). The growth habit of a smaller tree can be seen in fall and late winter in Figures 11 and 12 respectively. These limbs are ascending and split into branchlets which are large and sparsely forked. In following the smaller branchlets from their points of attachment, they tend to droop at first but eventually turn upward at the tips (Hosie, 1973). The branches and branchlets form a broad, open crown which is rounded at the top and unsymmetrical (Brown, 1975). The crown is low and symmetrical according to Keeler (1900). According to Mohlenbrock (1973), the crown may be broad and rounded or flat-topped and he also includes that the trunk is without a buttress, columnar, and straight. There is a tap root present as well as lateral roots which spread widely and may reach quite deeply into the soil (Hosie, 1973).

DISTRIBUTION :

The white walnut is found primarily in the eastern half of the United States (Map 1) with the northernmost line running from Maine, New Brunswick and Southern Ontario, westward through the middle of Michigan and Wisconsin and into Minnesota. The westernmost line turns southward through the middle of Iowa and Missouri. The southernmost line runs through Northern Arkansas, Mississippi, Alabama, and Georgia, and then swings northward into the western tip of North Carolina and up into Virginia and to the coast. From

Figure 11. Tree growth habit in autumn.

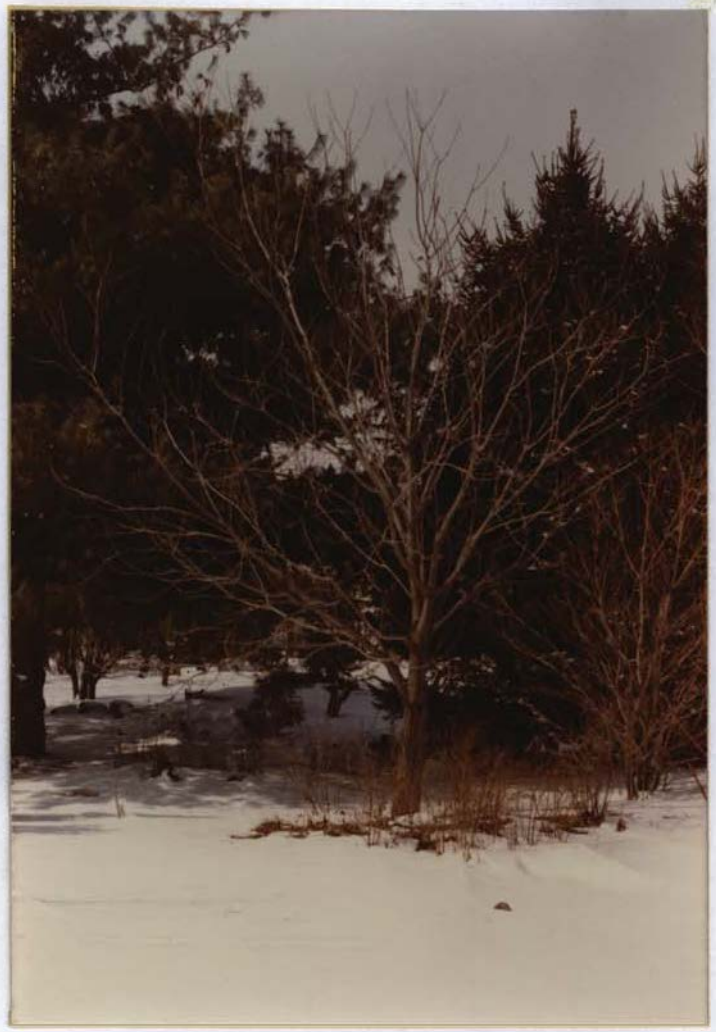
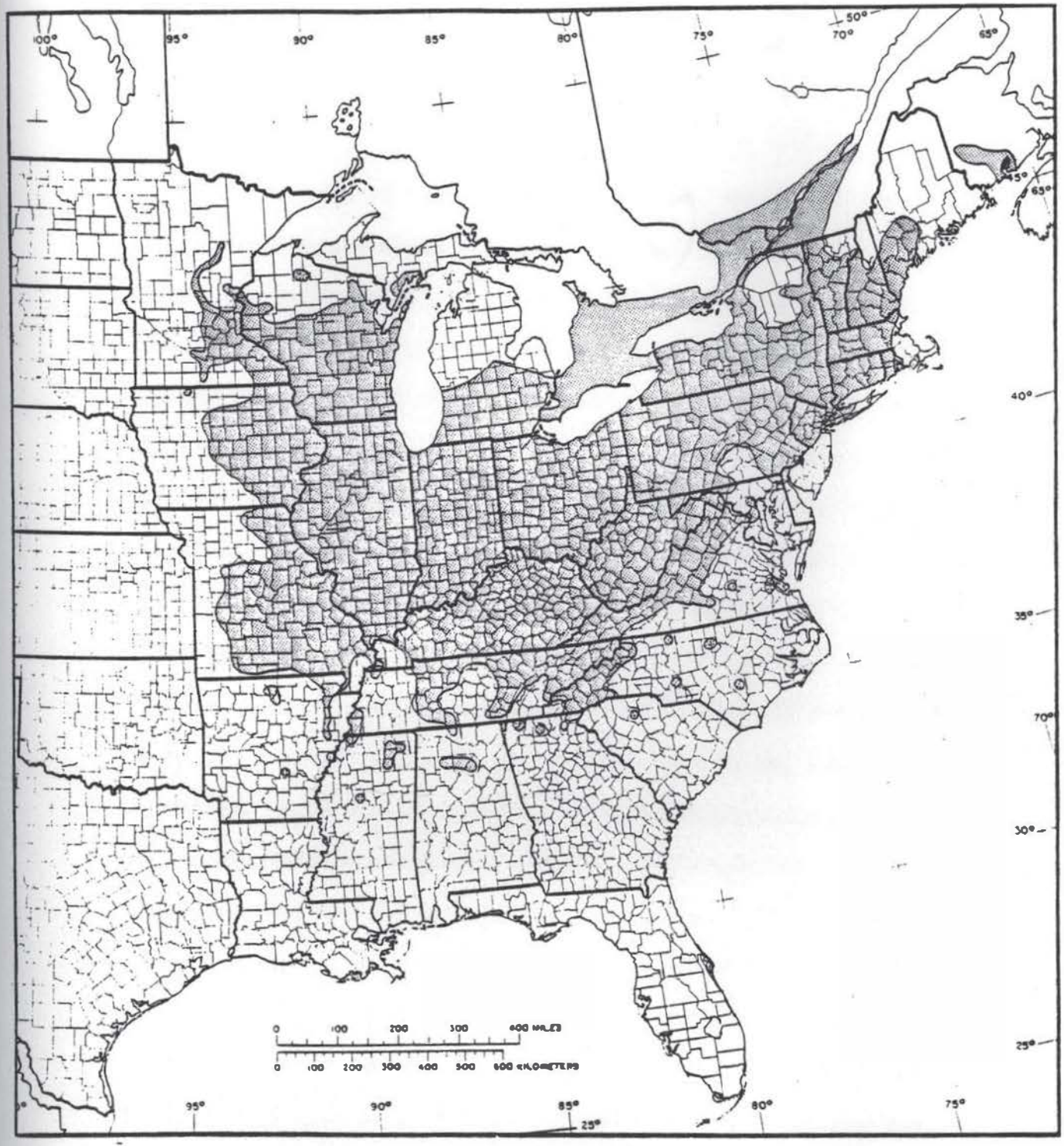


Figure 12. Tree growth habit in late winter.



Map 1. Natural distribution of the American white walnut (Little, 1971).

here it continues into the Southern portion of Maine and Canada (Grimm, 1967).

ECOLOGY :

The American white walnut prefers rich, moist lowland soils and is often found along waterways, fences, or roads, or in pastures, low moist woods, lower fertile hillsides, or on rocky hills (Brown, 1975; Brussel, 1976). It grows best in soils that are well drained but moist and consist of deep loam or alluvium with a pH between 5.5-7.0, although it can grow well on drier, rocky soils, especially those derived from limestone. Soils east of the Mississippi River usually benefit from liming. The butternut is also known as one of the most hardy of the walnut trees but it needs full sunlight (Harlow et al., 1979; Harlow, 1963). J. cinerea is never found in pure stands but instead is commonly found scattered or in small groups in association with beech, sugar maple, white ash, white elm, slippery elm, black cherry, black oak, red oak, white oak, basswood, shagbark hickory, bitternut hickory, yellow birch, eastern hemlock and eastern white pine. It is normally found in association with sugar maple at the northern limits of its range but more rarely with eastern white pine (Hosie, 1973; Harlow et al., 1979). The white walnut can exhibit very tenacious growth as Harlow (1963) found when he cut a 20 cm tree in spring which was shading his garden. In the autumn of the same year he found that it had sprouted vigorously from a 3 m log which was only connected to the stump by a 2.5 cm wide strip of bark and wood. In June of the next year it was still growing even though it was dying from fungus attack.

PROPAGATION : SEEDS :

According to a report by the U.S.D.A. Forest Service (1948),

the earliest recorded date of cultivation of Juglans cinerea was 1633. This source also reports that the optimum seed bearing age of this tree is 30-60 years, with a minimum age of 20 years and a maximum age of 80 years. Generally, good crops are produced every 2-3 years with light crops in intervening years. When the nuts are ripe, sometime between September and November, their husks turn brown and they fall from the tree. They should be collected shortly after they fall before they are carried away by squirrels and other animals. The nuts are easier to extract from the husk if this is done, either by hand or with a corn sheller, before they dry. Trees which are vigorous and healthy usually produce from $\frac{1}{4}$ to 1 bushel of clean nuts. It the nuts are to be stored with the husks left on they should be spread out to dry first. Nuts which are stored just above freezing in sealed containers should remain viable for 4-5 years (U.S.D.A. Forest Service, 1948).

Seed stratification to break dormancy can be accomplished by keeping the nuts at 35-45°F for 90-120 days in sand and peat or sandy loam (Vines, 1960) (Table 1). According to the U.S.D.A. Forest Service (1948), if the low temperature stratification is preceeded by stratification at room temperature for 60 days, germination will occur more quickly. The fruits or nuts should be covered with 2 feet of soil or straw if they are to be stored outside during the winter. Germination is hypogenous and occurs best when the nuts are on rich, loamy soil and covered with forest litter or debris. Shade from the side, but not overhead, is also desirable. The nuts are often destroyed in nature by various rodents such as squirrels, as well as larger mammals, and even some birds. Germination tests can be accomplished by sowing 50 to

Table 1. Conditions of germination for J. cinerea (U.S.D.A. Forest Service, 1948).

Seed Stratification	
Medium	Sand, sand and peat, sandy loam.
Temperature	35-45°F
Duration	90-120 days
Remarks	Germination may be hastened by preceeding the low temperature stratification with a 60 day period of room temperature stratification.
Recommended germination test conditions	
Temperature	
Night	68°F
Day	86°F
Duration	
Stratified seed	45-60 days
Untreated seed	110+ days

100 stratified nuts in peat mats or sand flats and waiting 45 to 60 days for results. If the seeds have not been stratified, 100+ days are required. The average germinative capacity is 65%. In nursery or field practice, the nuts are usually sown in sandy soil to produce a more fiberous root system. They are set in drills 20-30 cm apart (sometimes 41-107 cm is used) and are buried with firmed soil to a depth of 2.5-5 cm. Screens or some other protective device should be used to prevent destruction by rodents or other animals (U.S.D.A. Forest Service, 1948). According to Vines (1960) germination averages about 80%.

PROPAGATION : VEGETATIVE :

According to Ashworth (1969), some experts consider the butternut the most difficult nut tree to graft, and it can be very difficult due primarily to high spring sap flow and pressure. However, if certain precautions are taken, it can be grafted quite successfully using any tree grafting method. Most people who have tried grafting the butternut on its own seedlings have obtained more favorable results grafting it on black walnut stock (Ashworth, 1969). The resulting trees are usually more vigorous and longer lived (MacDaniels, 1950). Ashworth (1969) has obtained good results with both the girdle graft and the splice graft. MacDaniels (1950), on the other hand, has had as many grafting failures as successes and doesn't really know why. He has had most success with inlay or bark slot grafts on stubs with a 5 cm diameter. Weshcke of Minnesota and Burgart of Michigan both agree with MacDaniels and also add that the grafts should not be made at the crown but should be several feet from the ground. Burgart has obtained good results using bark slot grafts on 2-3 year old black walnut seedlings (MacDaniels, 1950). Grafting

should be done early just as growth starts, rather than after the leaves appear, according to MacDaniels (1950), and he includes that other experts recommend the same. The butternut may be grafted on J. sieboldiana, as well as on itself or on black walnut, however, generally J. sieboldiana stocks have a different growth rate and are not very hardy (MacDaniels, 1950). According to Ashworth (1969), the butternut has been bud-grafted successfully in the spring by Gilbert Becker of Climax, Michigan. He has had best results, with scions or buds, by taking scions from the dormant wood of the terminal portion of two year old growth. The buds are small but they can be readily forced into growth (Ashworth, 1969). Both Ashworth (1969) and MacDaniels (1950) agree that the graft should be carefully wrapped and braced to prevent breakage, since butternut wood is normally brittle. Ashworth (1969) also recommends that a small hole be made in the tape on the lower portion of the graft to allow sap to drain. After the graft is completed it should be kept at the optimum temperature for callus formation which appears to be approximately 84°F (30°C) (Figure 13) (Hartmann and Kester, 1975).

According to Moyer (1973), newly transplanted trees should be mulched heavily as far out as the drip line, but a mulch-free area should be left with a 6 dm diameter around the trunk to discourage rodents. According to Creasy (1982), nothing should be planted within 1.2 m from the trunk. This is especially critical in the Western U.S. to prevent crown rot. Moyer (1973) also includes that before trees are placed in the ground, that the soil should have rock phosphate mixed into it as deeply as possible and nitrogenous fertilizer should be added in early spring to stimulate growth. Additional rock phosphate should be worked into the soil surface be-

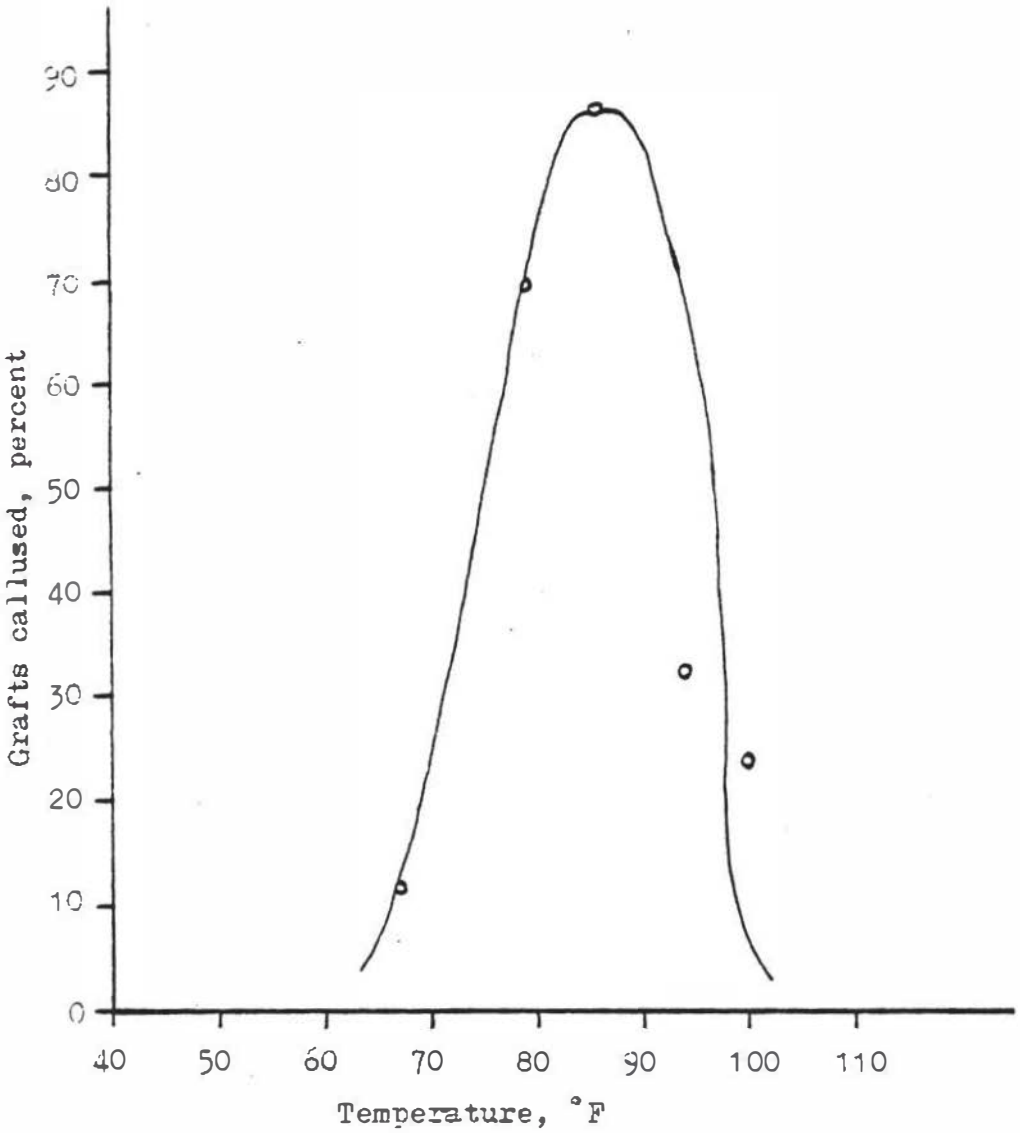


Figure 13. Influence of temperature on the callusing of walnut (Juglans) grafts (Hartmann and Kester, 1975).

neath the tree every three to four years. Burgart (1957) agrees that nitrogen and phosphorus are essential for trees to remain healthy and productive. He suggests that sewage sludge fertilizer and rock phosphate should be added in a ratio of 2:1 as a source of nitrogen to promote growth, and phosphorus to help fill out the nuts. The addition of greensand and phosphate also adds more oiliness to the nut kernels (Burgart, 1957). Von Althen (1977) reports that in hardwood plantations of J. cinerea 6 pounds (2.7 kg) of active princep should be added per acre (.41 hectare) to eliminate herbaceous competition. MacDaniels (1950) believes that a more careful investigation of butternut propagation should be conducted.

BREEDING OBJECTIVES :

According to MacDaniels (1950), the butternut has not received much attention in the past. He attributes this lack of interest primarily to unsatisfactory experience on the part of people who have tried to grow and use it. Probably the two most important obstacles restricting its use are difficulty of propagation and cracking, even though several varieties are available through nurserymen which are easier than the wild type to propagate and crack (MacDaniels, 1950). According to Ashworth (1969), "Aiken" was the first grafted butternut, which was from S.E. Aiken of Grasmere, New Hampshire, and was introduced by J.F. Jones in 1917. This variety cracked well even though the nut was small. Although several butternut varieties have been named since then, only a few have been widely distributed and extensively propagated including Craxeasy, Johnson, Kinneyglen, Love, and Van Syckle. New Discovery, by Weschcke of Minnesota, and Ayers, by Davis of Michigan, are two more recently named varieties.

One of the most hardy and easily cracking varieties was discovered by Ashworth at Chamberlins Corners, near Madrid, New York, and was appropriately named Chamberlin. This clone cracks extremely easily and has been known to withstand temperatures as low as -46°C without injury (Ashworth, 1969). Other varieties with superior shelling qualities include Kenworthy, Buckley, Helmick, Herrick, Sherwood, Thill, and Van der Poppen (MacDaniels, 1950). MacDaniels also mentions that twenty-six different varieties were listed by Watts in the thirty-fifth Annual Report of the Northern Nut Growers Association.

Despite the fact that many of these good varieties are available through nurserymen, the butternut has little commercial importance today outside of local uses. The only commercial value of any importance is in Vermont, and other New England states, where maple-butternut candy is made. Another possible reason why the butternut is not grown commercially to any extent besides difficulty of propagation and nut cracking, could be that this tree is regarded as being rather short lived, due to attack by a variety of pathogens (see diseases and pests). Another difficulty could be that the seedlings sold by nurserymen are usually slow in bearing nuts. However, despite the drawbacks, this species should be commercially desirable due to the fact that the nuts are very delicious and have the highest caloric value of any nut. This tree species is also easily transplanted and grafts sometimes bear nuts after only two years from the time of grafting. It is also a very hardy species and grows better on poor soils than several other important nut tree species (MacDaniels, 1950). The author believes that if more disease resistant, easily cracking varieties can be bred, such as those listed above, and if

the misconceptions about this being a "problem tree" can be erased, that this tree could become economically feasible to grow commercially. The bottom line is that more extensive research should be conducted on breeding this uniquely American tree, which has been largely neglected in the past.

ECONOMIC IMPORTANCE : DYES AND FOOD :

The butternut presently has less commercial value than it had in years past outside of local uses. It is used in the New England states, however, especially Vermont where it is combined with maple sugar in making butternut candy (MacDaniels, 1950). Commercial characteristics can be seen in Table 2. The husks of the fruits, the inner bark, and the leaves all contain a rich chocolate brown, orangish brown, or tan dye which can be used to dye clothing (Medsger, 1966; Grimm, 1967; Weiner, 1972). The dye was widely used by the early settlers, and some backwoods regiments in the Civil War went to battle wearing homespun uniforms dyed with butternut dye (Grimm, 1967). According to Angier (1969), this is why confederate soldiers and partisans were referred to as butternuts. (Instructions for preparing and using the dye can be found in the Appendix).

Butternut sap is very sweet and makes a good syrup but one tree will only furnish $\frac{1}{4}$ as much sap as one maple tree (Werthner, 1935). Sometimes maple sap is added to butternut sap in making sugar or syrup. According to Menninger (1977), in 1813 a sample of butternut sugar was sent to the Massachusetts Society for the Promotion of Agriculture. Roger Williams once stated that the English in the country made an excellent "Beere both for taste, strength, and color" from chips of wood underlying the bark of

Table 2. Commercial characteristics of butternuts (U.S.D.A. Forest Service, 1948).

Commercial seed bearing age	
Minimum	20 years
Optimum	30-60 years
Maximum	80 years
Seed year frequency	
Good crops	2-3 years
Light crops	intervening years
Commercial seed	
Purity	100%
Soundness	96%
Cost per pound	10-30 cents[1]
Cleaned seed	
Yield per 100lbs. of fruit	20-30 pounds
Seeds per pound	
Low	15
High	40
Average	30

[1]Seeds may be much more inexpensively purchased by the pound.

butternut trees. The nuts are eaten fresh or can be gathered in an immature stage of development and pickeled husk and all with vinegar, sugar, and spices. This was widely practiced by early pioneers (Vines, 1960). If the nuts can be pierced with a nut-pick they are not too old for pickling (McPherson and McPherson, 1977). The nuts can also be used in brownies, ice cream, cookies, cakes, pies, and countless other desserts (Angier, 1969) (see Appendix). According to Creasy (1982), walnuts (he did not specify which species) can be used in place of pine nuts in pesto sauce, and a subtly flavored oil can be made from them which can be used for salads and cooking instead of regular oil. This oil can be purchased from various foreign and health food stores. The limits to the number of different ways this nutritious product of nature can be utilized rests with the imagination of the individual.

ECONOMIC IMPORTANCE : WOOD :

Although the wood is weaker, softer, and less durable than black walnut it takes a beautiful polish, exhibiting a satiny lustre and beautiful grain (Grimm, 1967). It is used primarily for cabinet work, interior finish, and furniture making (Grimm, 1967; Schoonover, 1951; Hosie, 1973). According to Woodroof (1979), one of the reasons that this tree is disappearing so rapidly from native stands is due to the fact that the wood is in such great demand for cabinet work. Another reason it is in decline is due to a canker disease caused by Sirococcus clavigignenti-juglandacearum Nair, Kostichka, and Kuntz (Nair, 1979). According to Titmuss (1955), this wood is often marketed under the name white walnut and is generally considered as being inferior to, and less durable than, the American black walnut. He adds, however,

that it does have an economic importance for its fruits as well as its wood but that the wood will deteriorate rapidly if it is not seasoned properly. Because of its softness, which makes this wood easy to handle with all types of tools, it is a favorite of wood carvers (Constantine, 1975). Butternut wood is also used for instrument cases, novelties, boxes, crates, woodenware, and toys (Vines, 1960) and many older churches have alters and pews made from it (Grimm, 1967; Werthner, 1935; Hottes, 1942). According to Hill (1952), this wood is also used for millwork and excelsior and Grantham (1940) states that butternut wood has been used for boat finish. This wood has also been used for panelling "shays" in old carriages and was used as a veneer to panel the Chicago Board of Trade Grill. Finely carved butternut was also used for the Dayton Women's Clubhouse on North Ludlow Street. It was originally built by Robert W. Steele and refinished and remodelled by Napoleon B. Darst before the Civil War (Werthner, 1935). Dr. John Speer, a botany professor at Eastern Illinois University, has used butternut wood for the sides and back of a dulcimer that he constructed. The surface of this wood never warps or cracks and only mellows with age, much like its close relative the black walnut. This beautiful and uniquely American wood is rapidly becoming a very scarce comodity, and unless research and proper planning are undertaken soon, it may disappear entirely from native stands (Peattie, 1950). According to Grantham (1940), the state of Virginia used 18,000 board feet of butternut wood in 1911 at an average cost of $51.07 per M. bd. ft. f.o.b. mill. Approximately 1,500 board feet was used for boat and ship building with the remainder used for fixtures and miscellaneous purposes. Creasy (1982) believes that the walnuts

make handsome yard trees even in winter with bare branches but that they will drop catkins, leaves, and husks which can become a nuisance. However, if good use is made from the delicious nuts it may well be worth the bother.

MEDICINAL USES, TOXICITY AND FOLKLORE :

According to the ancient "Doctrine of Signatures", any head ailment could be cured with walnuts since they resembled the human brain or head. William Cole once stated, "Wall-nuts have the perfect signature of the head: the outer husk or green covering represent the Pericranium, or outward skin of the skull, whereon the hair groweth, and therefore salt made of those husks or barks, are exceeding good for wounds of the head. The inner wooddy shell hath the signature of the skull, and the little yellow skin, or peel, that covereth the kernell of the hard Meninga and Piamater, which are the thin scarfes that envelope the brain. The kernel hath the very figure of the brain, and therefore it is very profitable for the brain, and resists poysons . . . . . ". A tisane of walnut leaves taken internally has been said to destroy worms and help bad skin conditions (Lehane, 1977). According to McPherson and McPherson (1977), the inner bark of the butternut was used by the Potawatomie Indians to make a tea which soothed upset stomachs. The inner root bark was once used to make a decoction which was used as a cathartic. It was a drug with a bitter, slightly acid taste and a faintly aromatic odor and was officially known as "Underground Juglans" (McPherson and McPherson, 1977). The root bark is collected primarily from North Carolina, Michigan, and Virginia in autumn to make this drug (Vines, 1960). This drug has been widely used in the past century (Brussel, 1976; Weiner,

1972). Some physicians thought that it acted effectively without colicky after effects. From 1820 to 1905 the inner root bark was listed officially in the U.S. Pharmacopoeia as a laxative and tonic. Several different Indian tribes, besides the Potawatomies, made use of the butternuts' medicinal effects including the Menominees, who ate the syrup for digestive disorders, and the Meskwakis, who made a laxative tea from the bark (Weiner, 1972; Brussel, 1976). The Seneca tribes used butternut fruits to make baby food by mixing dried, pulverized kernels of butternuts and hickory nuts with dried, pulverized bear and deer meat (Brussel, 1976). Brussel also includes that the butternut has anthelmintic, astringent, tonic, cholagogue, and alternative properties. It has also been indicated to provide a slow remedy for colds, fevers, sluggish liver, and la grippe and it will expel intestinal worms. Oil pressed from the nuts has also been used to treat tapeworms and fungus infections (Brussel, 1976). Peattie (1950) states that Roger Williams once mentioned that the Indians made an excellent "Oyle good especially for annoynting their heads" from butternuts. According to Menninger (1977), the Narragansett Indians called the butternut "Wussoquat" and oil from this nut was used by them for "seasoning their ailments".

DISEASES AND PESTS :

The diseases and pests of this tree are shown in Table 3. Probably the most important of these is a canker disease caused by a fungus known only recently as Sirococcus clavigignenti-juglandacearum Nair, Kostichka, and Kuntz based on the imperfect stage. As far as this author knows the perfect stage has not been discovered (Nair et al., 1979). The fungus, isolated from several midwestern states, has been demonstrated to

Table 3. Diseases and pests of the American white walnut (U.S.D.A. Forest Service, 1948).

Disease or pest	Common name	Part affected
Actinothecium juglandis[1]	leaf spot	leaves
Botryosphaeria ribis[1]	branch canker, dieback	branches
Cercospora juglandis[1]	leaf spot	leaves
Conotrachelus juglandis[4]	cucurlios	
Cylindrosporium sp.[1]	leaf spot	leaves
Datana integerrima[5]	walnut caterpillar	leaves
Fomes igniarius[2]	trunk rot	trunk
Gnomonia leptostyla[1]	anthracnose, leaf spot, leaf blotch	leaves and fruits, general
Melanconis juglandis[1]	canker, dieback	branches
Meloidogyne spp.[1]	root knot nematodes	roots
Microstroma juglandis[1] (*M. brachysporum*)	downy spot, white mold, witches' brooms	leaves and twigs
N. cinnabarina[2]		
N. coccinea[2]		
N. ditissima[2]		
Nectria galligena[1]	perennial target canker	trunk and branches
Polyporus sulphureus[2]	trunk rot	trunk
Sirococcus clavigignenti-juglandacearum[4]	butternut canker	all above ground bark covered areas

Table 3- continued

Disaese or pest	Common name	Part affected
	fall webworm[3]	
	mites[3]	
	witches' brooms[1]	
	aphids[3]	

[1]As cited in Agricultural Handbook No. 165, 1960.

[2]As cited in Hepting, 1971.

[3]As cited in Woodroof, 1979.

[4]As cited in Wilson and Corneil, 1978.

[5]As cited in English, 1965.

be pathogenic on butternut trees of all sizes according to Koch's postulates. The fungus commonly forms black cankers in scars, buds, lenticels, and bark wounds (including insect wounds and natural cracks) as well as occaisionally in injury free areas. In spring an inky-black, watery exudate arises from the fissures, while dry, sooty patches remain in summer (Nair et al., 1979). The fungus can be isolated from bark or wood and grown easily in the light or dark at an optimum temperature of 16-20°C. It forms hyphal pegs and pycnidia and sporulates profusely. When mycelium or spores are inoculated into fresh wounds, cankers develop on both butternut and black walnut (Juglans nigra) seedlings and saplings. When butternut seedlings are inoculated with conidial suspensions of this fungus the leaves develop necrotic lesions, droop, wither, and abscise, either before or after the fungus invades stem tissue. At 16, 20, 24, and 28°C stem cankers develop rapidly and seedlings are killed within two weeks, especially if water stressed (Kuntz et al., 1977). Orchard and colleagues (1981) conducted research which revealed an apparent resistance of various butternut seedlings to this disease. These researchers observed that only 38% of the seedlings (taken from both healthy and diseased parents) tested contracted the disease within three weeks, while the remaining 62% remained asymptomatic until harvest ten to thirteen weeks later. If this resistance is genetically based, it should be possible to breed resistant varieties. This study was prompted because the authors observed that in the natural environment, healthy trees were observed among those ridden with disease (Orchard et al., 1981). Since this fungus was formally named by Nair and his colleagues (1979), a type culture has been deposited at the American Type Culture Collection, Rockville,

Maryland, U.S.A. (ATTCC 36624). According to Nair and colleagues (1981), this is the first species of Sirococcus found to infect any deciduous tree family. These researchers also include that little or no regeneration occurs in diseased areas. Nicholls (1978) tested the effects of various chemicals against Sirococcus fungus in lab culture. Although maneb was ineffective at all concentrations tested, he found that chlorothalonil was effective at higher concentrations (1 ppm) while benomyl exhibited the best activity against the fungus, and was effective at concentrations as low as 0.1 ppm. This type of treatment is only economically feasible in nurseries and plantations, being too costly for use in large scale operations such as forest spraying.

Although Sirococcus is by far the most important and most destructive pathogen of the American white walnut, there are several other organisms which parasitize this tree species (Table 3). Seliskar (1976) conducted a study in which a mycoplasmalike organism (MLO) was found in leaf and stem phloem cells of butternut trees exhibiting walnut bunch disease (a yellows-type of witche's broom disease). Since this organism was not found in non-diseased butternuts, it was assumed that this was the cause of the bunch disease. This disease is systemic but its movement is sometimes very slow. Another important disease is a twig and branch dieback caused by Melanconis juglandis (Hepting, 1971). According to Hepting, the progress of this disease is slow and it occurs without wilting and without the formation of well defined lesions or cankers. Hepting states that this was responsible for the widespread dying of butternut trees over N.E. North America, but this phenomenon could have been at least partly due to the Sirococcus fungal species

described earlier. The branch dieback is accompanied by a change in bark color from the normal dark greenish-brown, to red brown, and then to gray. As the branches die, black, pustular acervuli dot the surface. This stage is known as Melanconium oblongum. New shoots appear but soon die. Apparently this disease only attacks trees which have already been weakened. Graves (1923) also conducted research on this disease after observing widespread death or weakening of butternut trees in Connecticut in the early 1920's. Although the disease caused by Sirococcus was not observed until 1967, it could be possible that this fungus was resulting in some of the observed tree death at this time. Gnomonia leptostyla is the perfect stage of walnut anthracnose (imperfect stage=Marssonina juglandis) which has been known to attack both the foliage as well as the nuts of several walnut species including butternut (Black and Neely, 1978). In their study, Black and Neely found that artificially inoculated trees of Juglans cinerea, along with several other species, was less susceptible to this pathogen than J. nigra, while J. hindsii and J. major were the most susceptible. According to Graves (1923), this disease can cause considerable damage to butternut trees. The walnut caterpillar, Datana integerrima, is large and black with gray hairs and is attracted primarily to isolated trees. This pest defoliates other walnut trees besides the butternut as well as hickory, oak, honey locust, and willow and occasionally apple and other fruit trees (English, 1965). Aphids attack butternut trees but do not inflict much damage. The only problem is the nuisance they cause because of the sticky substance which drips from them onto things below such as cars, driveways, etc. (Creasy, 1982). Injury to tree foliage can

occur as a result of environmental contaminants, as well as disease, as Temple (1976) discovered in his study of the effects of boron, which was being released from a major appliance manufacturing plant in Ontario, Canada, on various plant species growing nearby. He observed that J. cinerea exhibited numerous, dark, irregularly-shaped interveinal necrotic lesions as well as marginal necrosis. Injury was consistently more serious on older leaves than on those more recently formed (Temple, 1976).

CHEMICAL CONSTITUENTS :

Some research has been conducted on the chemical constituents of various parts of butternut trees such as the leaves and nut kernels. Rascusen and Foote (1974) conducted a study on the hexosamine content of leaves of twenty plant species besides the butternut. For Juglans cinerea they found a total hexosamine content of 2.3 ug hexosamine per mg leaf protein, while polymer-bound hexosamine was present at a concentration of 2.1 ug/mg protein. The total hexosamine content included 80% acetone-soluble, as well as polymer-bound hexosamine. Furr and colleagues (1979) assayed the elemental composition of butternut kernels and found several elements in various concentrations as listed in Table 4.

CONCLUSION :

The American white walnut, Juglans cinerea L., is a beautiful, uniquely American tree which could be utilized in a number of important ways commercially. However, this tree has been largely neglected, expecially in recent years, and presently has little or no economic importance, except for local uses. Probably the two main reasons for this neglect are that the wild variety has the reputation of having nuts which are difficult to crack and being

Table 4. Elemental composition of butternuts (*J. cinerea* fruits) (Furr *et al.*, 1979).

Element	ppm (dry weight)	Element	ppm (dry weight)
Al	2.6	Mg	2676
As	0.02	Mn	31
Au	0.001	Mo	0.4
B	7	Na	2.7
Ba	1.6	Ni	4.3
Br	1.5	Pb	0.3
Ca	724	Rb	2.5
Cd	---	S	2870
Ce	---	Sb	0.05
Cl	78	Sc	0.003
Co	0.2	Se	0.1
Cr	1.4	Si	1450
Cs	0.02	Sm	0.03
Cu	8.4	Sn	0.7
Eu	0.02	Sr	0.3
F	1.1	Ta	0.03
Fe	76	Th	0.1
Hf	---	Ti	2.7
Hg	0.01	U	---
I	0.1	V	0.02
K	7493	W	0.08
La	0.03	Yb	0.04
Lu	0.004	Zn	26

rather short-lived, with wild trees often succumbing to disease before reaching maximum size or age. What most people don't realize, however, is that several varieties now exist which have easily cracked nuts, many of which are presently available through nurseries.

It seems unusual to pay such little attention to a tree with such great potential for economic success, due to its beautiful, easily workable wood and its delicious, highly nutritious fruits. But, the wild variety of this tree is now very rare and is still declining throughout most, if not all, of its range due primarily to a canker disease caused by the fungus Sirococcus clavigignenti-juglandacearum Nair, Kostichka and Kuntz. If this tree is to be kept from disappearing from our environment entirely, much more extensive research, especially in the area of disease control, must be conducted to fill the gaps in our knowledge concerning this tree. Granted, much work has been done already, with the main focus in recent years being concerned with the canker disease responsible for the widespread decline. However, this author found detailed information about this tree rather difficult to obtain and that which was found was often similar to other information described previously. Also, at times various authors seemed to present contradictory information concerning such things as physical characteristics and maximum size or age of the tree. At any rate, hopefully this paper will serve as a valuable source of information for those wishing to pursue further study of a potentially valuable, uniquely beautiful tree, the American white walnut.

APPENDIX

Some selected butternut recipes

An After Dinner Snack

For a really rich, nutty tidbit to serve with coffee and brandy after a roasted fowl dinner, combine 2 cups of sugar, 1 cup of cereal cream, and 1 heaping tablespoon of butter in a saucepan and cook to the soft ball candy stage. Then add ½ pound of pitted dates, very finely chopped, and a touch of salt. Cook over very low heat for another 15 minutes, stirring constantly, then stir in 2½ cups chopped butternuts, cool and shape the confection into a long, thin roll, wrapped in wax paper. Chill in the refrigerator, and then slice thinly before serving (Knap, 1975).

Pickled Butternuts

Green immature butternuts may be gathered in early summer and pickled, husk and all. Use nuts that are soft enough to be pierced with a nut pick. First add the nuts to boiling water and boil until the water becomes dark. Pour off the dark water, add freshly boiling water, and continue cooking until the nuts are barely tender. Now pack the nuts into hot, sterilized quart canning jar. To each jar add 1 teaspoon pickling spices, then cover the nuts with a mixture of hot vinegar and honey. The proportion of vinegar and honey can vary according to individual taste; we use a one-to-one ratio. Seal and process 15 minutes in a boiling water bath. The pickles are ready to eat in 6-8 weeks (McPherson and McPherson, 1977).

A Noteworthy Dessert

Mix ½ cup of broken butternut meats with 1 cup diced dates, 1 cup sugar, 1 teaspoon baking powder, and $\frac{1}{8}$ teaspoon salt. Beat 4 egg whites until they are stiff and fold them into the above mixture. Bake in a greased pan in a slow oven for 20 minutes. Serve either hot or cold with whipped cream. This is also good, particularly when hot, with liberal scoops of vanilla ice cream (Angier, 1969).

Butternut Date Pie

Chop a cup apiece of dates and nuts. Roll a dozen ordinary white crackers into small bits, too. Mix with 1 cup sugar and ½ teaspoon baking powder. Then beat 3 egg whites until they are stiff. Sometimes, if the nuts are not as tasty as usual, we also add a teaspoon of almond extract. In either event, fold into the nut mixture and pour into a buttered 9-inch pie pan. Bake ½ hour, or until light brown, in a moderate oven. Cool before cutting. Ice or whipped cream is good with this, too, but it is also delicately tasty alone (Angier, 1969).

Butternut Brownies

Blend together 1 cup sugar, 1 teaspoon salt, ½ cup melted butter or margarine, 2 squares bitter chocolate, 1 teaspoon vanilla, and 3 eggs. When this is thoroughly mixed, stir into it 1 cup finely broken butternuts and ½ cup flour. Pour into a shallow greased pan and bake in a moderate oven 20 minutes (Angier, 1969).

Butternut Dye

Part used: Green hulls, fresh or dried.
Other color: Brown.

Mordant
(For cotton only)

Alum . . . . . 1 cup
Washing soda . . . . . ¼ cup
Water. . . . . 2 gallons

Dissolve the alum and washing soda in the water, and bring to a boil. Add the wet cotton, and boil gently for 1 hour. Hang up to dry.

Dye Bath

Butternut hulls, green . . . 3 gallons
Water

Chop the hulls, cover with water and soak for 30 minutes. Boil for 30 minutes and strain. Discard the hulls and add cold water to the liquid to make 2 gallons. Bring to a boil, and add the dampened, mordanted cotton. Boil gently for 30 minutes. Then

transfer to a bath containing:

Copperas. . . . . .1½ teaspoons

Water, boiling. . . . .2 gallons

Boil gently for 10 minutes. Rinse and dry (Krochmal and Krochmal, 1974).

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