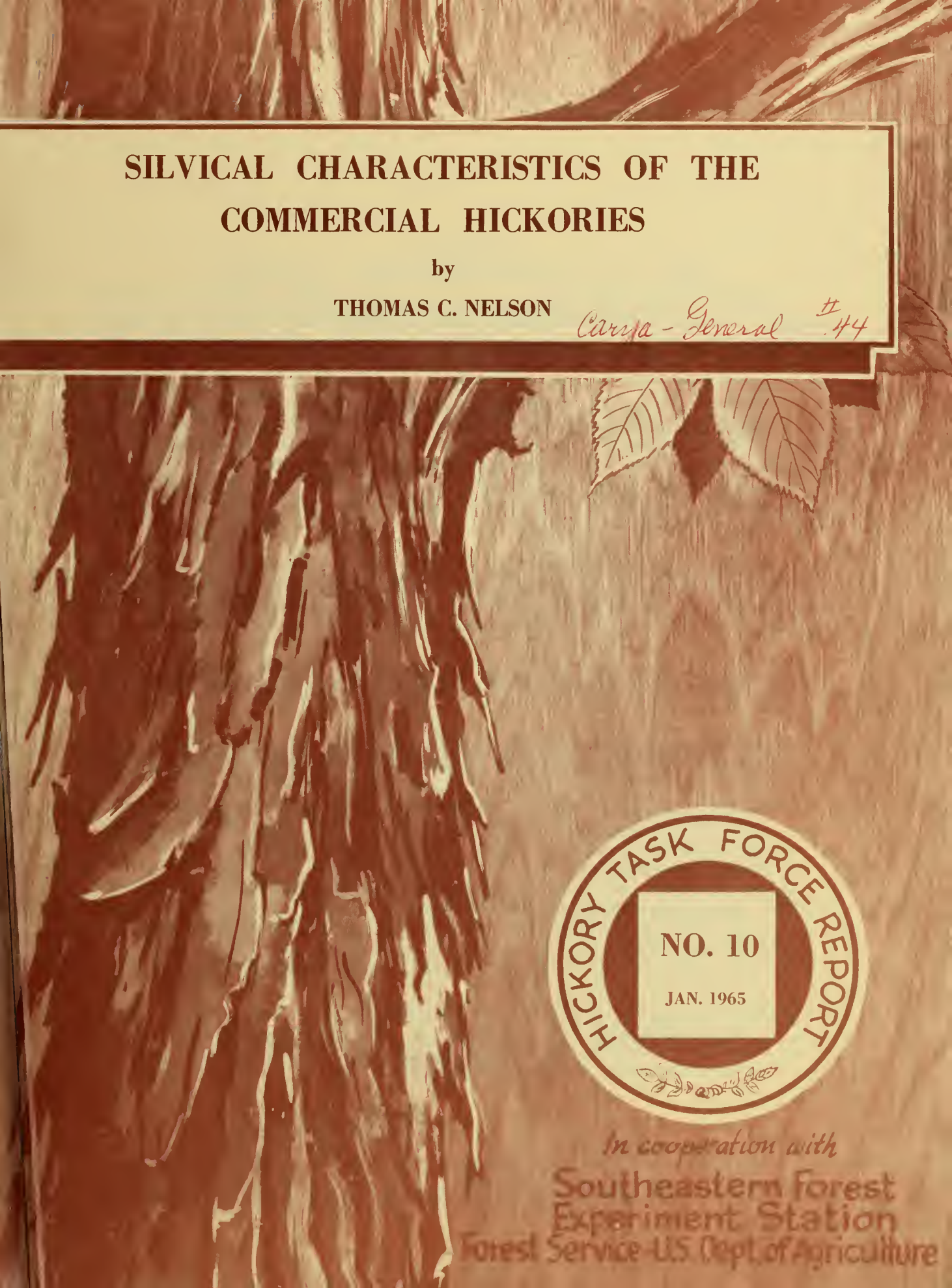

SILVICAL CHARACTERISTICS OF THE COMMERCIAL HICKORIES

by

THOMAS C. NELSON

HICKORY TASK FORCE REPORT

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Foreword

Hickory (Carya spp.) has earned the reputation of being one of the world's toughest woods. In shock resistance it has no equal. The reputation earned by hickory is based on the performance of high-quality material in products requiring a high degree of strength and toughness.

Today, a limited quantity of high-grade hickory is available and its value and scarcity are well recognized by the wood-using industries. There is, however, a large volume of low-grade hickory that was bypassed when loggers cut our hardwood forests, and many land managers are troubled by the increasing amount of growing space occupied by it. Although this low-grade hickory does not possess the quality or properties required in many products, it is a potentially valuable wood for many uses.

A conference of federal, state, university, and industrial representatives was held in Clemson, S. C., in April 1953, and the Hickory Task Force was organized to promote the utilization of hickory. Accomplishment of this objective will be reached through research and publication of known information.

The Southeastern Forest Experiment Station has assumed the responsibility to edit, publish, and distribute reports containing information which will be developed under this program.

Full acknowledgment is due the many cooperating agencies and individuals who are making the project possible. Subject Matter Committee Chairmen are:

Robert L. Youngs, Forest Products Laboratory, Madison, Wisconsin
Growth and Properties of Hickory.
Roger Anderson, Duke University, Durham, North Carolina
Enemies of Hickory.
Roy M. Carter, N. C. State College, Raleigh, North Carolina
Manufacturing and Seasoning of Hickory.
Woodrow W. King, Tennessee Valley Authority, Norris, Tennessee
Products from Hickory.
Eric L. Ellwood, N. C. State College, Raleigh, North Carolina
Hickory for Fiber and Fuel.
Monie S. Hudson, Spartanburg, South Carolina
Treating Hickory.
Kenneth C. Compton, Central States Forest Experiment Station,
Columbus, Ohio. Marketing of Hickory.

Walton R. Smith, Chairman
Hickory Task Force

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Contents

Not too long ago, hickory species commanded a choice role among the trees of the eastern United States. Their superior burning qualities and heat value, their enduring qualities in implements and farm machinery, and their strength for wheel and spoke construction made them highly desirable.

Although many uses for hickory still exist, and new ones are developing, some of their characteristics have caused lumbermen and pulpwood producers to exclude hickory from current logging operations. This exclusion, together with the natural role of hickory species as components of climax types, has led to a rapid increase in the proportion of hickory in our eastern hardwood stands.

The increase of hickory leads to the question of how shall we manage it. The answer depends, in a large measure, upon understanding the silvical characteristics of the hickories.

Silvical requirement writeups by Robert W. Merz, Central States Forest Experiment Station, and by Louis C. Maisenhelder, E. Richard Toole, R. L. Johnson, and W. R. Beaufait, Southern Forest Experiment Station, were drawn upon freely. Grateful acknowledgment is given these workers.

The Commercial Species and Their Associates

Although more than thirty species of hickory grow in the eastern United States, only eight are of commercial importance (15):

True hickories

Shagbark hickory, Carya ovata (Mill.) K. Koch
Shellbark hickory, Carya laciniosa (Michx. f.) Loud.
Pignut hickory, Carya glabra (Mill.) Sweet
Mockernut hickory, Carya tomentosa Nutt.

Pecan hickories

Pecan, Carya illinoensis (Wangenh.) K. Koch
Water hickory, Carya aquatica (Michx. f.) Nutt.
Nutmeg hickory, Carya myristicaeformis (Michx. f.) Nutt.
Bitternut hickory, Carya cordiformis (Wangenh.) K. Koch

The true hickories are principally components of the oak-hickory forests, although some species occur in the beech-maple and bottomland hardwood forests (table 1). The pecan hickories, with the exception of some bitternut hickory, are usually found in bottomlands or areas adjacent to them (table 2).

Table 1.--Forest types and associations of the true hickories

Species	Component of S.A.F. types (32)	
	S.A.F. type number	S.A.F. type name
Shagbark hickory	52	White oak-red oak-hickory
	53	White oak
	91	Swamp chestnut oak-cherrybark oak
Shellbark hickory	42	Bur oak
	91	Swamp chestnut oak-cherrybark oak
Pignut hickory	40	Post oak-black oak
	52	White oak-red oak-hickory
Mockernut hickory	56	Northern red oak-mockernut hickory-sweetgum
	40	Post oak-black oak
	52	White oak-red oak-hickory
	60	Beech-sugar maple
	91	Swamp chestnut oak-cherrybark oak

Table 2.--Forest types and associations of the pecan hickories

Species	Component of S. A. F. types (32)	
	S. A. F. type number	S. A. F. type name
Pecan	94	Sycamore-pecan-American elm
	63	Cottonwood
	92	Sweetgum-Nuttal oak-willow oak
	93	Sugarberry-American elm-green oak
	95	Black willow
Water hickory	96	Overcup oak-water hickory
	92	Sweetgum-Nuttal oak-willow oak
	93	Sugarberry-American elm-green ash
	101	Baldcypress
	102	Baldcypress-water tupelo
Nutmeg hickory	91	Swamp chestnut oak-cherrybark oak
Bitternut hickory	52	White oak-red oak-hickory
	91	Swamp chestnut oak-cherrybark oak
	53	White oak

True Hickories

Climate

The true hickories grow in a climate classified as humid (35), and are also found in the super-humid climate of the Southern Appalachians. Minimum average annual rainfall within their ranges approximates 30 inches per year and the maximum reaches as high as 80 inches per year (37). At least 20 inches of the annual rainfall occurs during the growing season.

Mean summer temperatures range as high as 80° F.; mean winter temperatures of all the species' ranges are below freezing. All the true hickories are subjected to temperature extremes, from well above 100° F. to well below 0° F. (37).

Soils and Physiography

The preferred sites for the true hickories vary within their ranges. In general, the species occupy drier sites in the North than in the South.

In the North, shagbark hickory is found on upland slopes, whereas further south, it is more prevalent on deep, moist soils of alluvial origin (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 to north and east slopes; and in Arkansas, Mississippi, and Louisiana, it grows principally in river bottoms.

Shellbark hickory is primarily a bottomlands species, requires a moister site than other true hickories, and develops best in deep, fertile, moist soils. In the northern part of its range, it is found on south and

west exposures of loamy soil and on dry, exposed, sandy plains (4). In the South, it is found on river terraces and loamy flats in second bottoms. It does not thrive in heavy clay soils (42).

Pignut hickory inhabits dry ridges and hillsides (30). It responds readily to increases in soil fertility (6), however, and is also common on moist sites in the Southern Appalachian region (42).

In the North, mockernut hickory grows on the better ridge and hillside soils, and less frequently on the alluvial bottoms (43). In the Cumberland Mountains and the hills of southern Indiana, it grows in dry situations, such as south and west slopes on dry ridges. Stunted mockernut grows in Alabama and Mississippi upon the sandy shortleaf and loblolly pine land (12). Most of the merchantable mockernut, however, grows on moderately fertile uplands, and attains its best development only on fresh, deep, fertile soil (6).

Reproduction

All hickories are monoecious. Flowering occurs in April and May, but carries over into June for shellbark and pignut. Fruit begins to ripen in September, and seed dispersal is completed in December (30).

Table 3.--Seed-bearing age of true hickories

Species	Seed-bearing age (39)		
	Commercial	Optimum	Maximum
	- - - - Years - - - -		
Shagbark hickory	40	60-200	300
Shellbark hickory	40	75-200	
Pignut hickory	30	75-200	300
Mockernut hickory	25	40-120	300

The optimum seed-bearing age of the true hickories varies from 40 to 200 years (table 3). Good seed crops are borne at not less than 3-year intervals, with a light crop in intervening years (39). In fact, pignut may have a good seed crop every year or two (36). Fifty to seventy-five percent of the seed are capable of germinating (34).

Pignut hickory is the lightest seeded of the commercial true hickories, having approximately 200 seed per pound. Shellbark hickory is the heaviest (25-35 seed per pound); mockernut averages 90, and shagbark 100 seed per pound (39).

Hickory seed are dispersed by gravity, birds, and animals (24). On sloping land the nuts travel some distance downhill by gravity alone, and animals, such as the red squirrel, eastern gray squirrel, eastern fox squirrel, chipmunk, and raccoon carry the seed away and bury them.

Stratification of hickory nuts at winter temperatures slightly above freezing aids germination (1), but nuts seldom remain viable when they are in the ground for more than one year.

A

B

C

D

Typical leaves and nuts of the true hickories.
A, shagbark hickory. B, shellbark hickory.
C, pignut hickory. D, mockernut hickory.

The true hickories sprout prolifically from the stump following fire; cutting and coppice management has been recommended. As the stumps increase in size, however, the number of stumps that produce sprouts decreases (6). These species are generally conceded to be difficult to reproduce from cuttings.

Seedling Development

True hickories require a moist seedbed for satisfactory seed germination and early establishment (42). In this respect shellbark is more exacting than the other true hickories (24). Establishment seems to be best in a microclimate created by hardwood duff and litter. Young mockernut hickory seedlings are very susceptible to frost (6).

The true hickories are shade tolerant in early life, but are not fast-growing trees in the seedling stage. Boisen and Newlin (6) report the following height growth of pignut hickory seedlings in the Ohio Valley in the open or under light shade, on red clay soil:

Age (Years)	Height (Inches)
1	3.0
2	5.8
3	8.0
4	12.0
5	17.0

Height growth of seedlings of shagbark and mockernut hickories are equal to that of pignut, but shellbark hickory has a slightly faster seedling growth rate (6):

	Height at 4 years (Inches)
Shagbark	12.0
Shellbark	16.0
Pignut	12.0
Mockernut	12.5

True hickories develop a long taproot with few laterals; at one year, shagbark seedlings have a taproot approximately one foot long.

Sapling Stage to Maturity

As a group, hickories are slow growers. Ten-year diameter growth rates for three size classes in several of the Central States are (19, 20, 21, 22):

State	Seedlings & saplings (Inches)	Poles (Inches)	Sawtimber (Inches)
Illinois	1.22	1.24	1.52
Indiana	1.12	1.38	1.46
Kentucky	.70	1.22	1.44
Ohio	1.20	1.30	1.28

Shagbark hickory is one of the fastest-growing hickories, but will produce only about one-fourth to one-half as much merchantable material as a white oak growing under the same conditions of soil and light. It reaches heights of 130 to 140 feet and diameters of 20 to 30 inches in the Cumberland Mountains. In the bottomlands along the Mississippi River shagbark trees grow to larger diameters, but the maximum height growth is usually less than in the mountains. A characteristic of the species is the tendency for the main stem to fork into two or three prongs at one-half to two-thirds the height of the tree (6).

Shellbark hickory occasionally reaches a height of 120 feet and diameters that rarely exceed 3 feet (13, 31). Cheyney (11) reports, however, that it grows to heights of 140 feet and to diameters of 40 inches. Shellbark often develops a relatively clean bole that may be free of branches for half its length (13).

Measurements in virgin stands growing in the Appalachians showed that it took 31 years for shellbark to grow 1 inch in radius. Measurements of old-growth trees in partially cut stands showed a growth rate of 1 inch in radius in 16 years, and second-growth hickories averaged an inch of radial growth in 11 years (27).

Pignut hickory often reaches 80 or 90 feet in height and occasionally 120 feet. The trunk is often forked, and maximum d.b.h. is 3 to 4 feet (30). On both dry and moist sites of the Southern Appalachian region, pignut hickory will produce sawtimber, but in the longleaf pine-turkey oak type of the southern pine region it never reaches saw-log size (42).

Mockernut hickory seldom reaches 100 feet in height or 3 feet in diameter; it is usually much smaller (18). Annual growth of mockernut hickory in dry situations is estimated at 15 cubic feet per acre per year. In fully stocked stands on soils of moderate fertility, 30 cubic feet per acre per year is a safe estimate, although growth rates of 44 cubic feet per acre per year are reported in Ohio (6).

The true hickories are rather tolerant and are usually climax species in the timber types in which they occur. Suppressed stems recover rapidly when released (6).

Shellbark hickory is reportedly the most tolerant of the hickories (39), although Boisen and Newlin (6) state that shagbark is more tolerant than shellbark. Pignut hickory has been classified as intolerant in the Northeast and tolerant in the Southeast (33), and mockernut is probably as intolerant as any of the true hickories.

Pecan Hickories

Climate

The pecan hickories occupy much the same climate as the true hickories, except that bitternut is the only pecan hickory found in the superhumid climate of the Southern Appalachians.

Soils and Physiography

Pecan is most common on well-drained loams which are not subject to prolonged overflow, although it does occur on heavy-textured soils. It is limited largely to first-bottom alluvial soils of relatively recent origin and finds its best development on river-front ridges and well-drained flats. It rarely occurs on low clay flats (28, 29).

Water hickory also prefers well-drained, moist, light-textured alluvium, but because of its ability to grow on poor sites where most desirable hardwoods cannot survive, it is most often found in poorly drained, heavy clay flats and is common in sloughs.

Nutmeg hickory occurs on the loessal soil of the brown loam bluffs adjacent to the Mississippi River flood plain (31). It is found in the Mississippi River delta within its range, principally on high second-bottom flats (29).

In the northern part of its range, bitternut hickory occurs on a variety of sites: rich, loamy, or gravelly soil, low wet woods, along the borders of streams, but also on high, dry uplands (25). In the southern portion of its range, bitternut is more restricted to moist sites than in the northern portion. It reaches its largest size on the rich bottomlands of the lower Ohio basin (30). In the southeastern portion of its range, it occurs only on overflow bottoms (5). In the southwestern part of its range, however, bitternut is common on the poor, dry, gravelly soil of the uplands (30).

Bitternut is absent from the mountain forests of northern New England and New York (30), and it is not found at the higher elevations in the Appalachians.

Reproduction

Flowering of the pecan hickories occurs in April and May. Fruit begins to ripen in September and is completely dispersed by the last of December (39).

Seed-bearing ages (39) of the pecan hickories are:

Species	Minimum (Years)	Optimum (Years)
Pecan	20	75-225
Water hickory	20	40-75
Nutmeg hickory	30	50-125
Bitternut hickory	30	50-125

A

B

C

D

Typical leaves and nuts of the pecan hickories.
A, pecan. B, water hickory.
C, nutmeg hickory. D, bitternut hickory.

Good seed crops of pecan and water hickories are usually borne every year. Excessive rainfall during the flowering period may prevent pollination and result in a nut-crop failure. Nutmeg hickory has good seed crops every 2 to 3 years, and bitternut has good seed crops every 3 to 5 years, with light seed crops in intervening years (39).

Seed dissemination of pecan, water hickory, and nutmeg hickory is principally by water and animals. The nuts may be carried considerable distances by floodwaters and float about in local accumulations of rainwater during the winter. Aerial dissemination is principally by squirrels; blackbirds possibly carry some of the seeds.

Seed dissemination of bitternut hickory is almost entirely by gravity, because the fruit is generally distasteful to wildlife (40).

Stump and root sprouting are common among all the pecan hickories. Bitternut hickory is the best sprouter of the northern species of hickory, and sprouts arise from stumps, root collars, and roots. Most of the sprouts from sapling and pole-size trees are root collar sprouts and those from sawtimber-size trees are mostly root suckers. Sprouts from the stumps are usually less numerous than either root collar sprouts or root suckers.

Seedling Development

Seed of the pecan hickories remain dormant until spring, and germination occurs from late April to early June. Exceptionally dry weather or heavy competition will greatly reduce survival. On loamy soils, height growth of pecan seedlings will average about 3 feet per year for several years under favorable conditions.

Water hickory seedling development is similar to that of pecan. On many sites, nearly 80 percent of the heavy seed crop will germinate, and it is not unusual to have thickets and clumps of water hickory seedlings. They can withstand considerable shade and competition once they are well established. Because water hickory has a longer dormant season than most tree species, it is able to withstand late spring flooding--a considerable advantage on many sites.

Little is known concerning the seedling establishment and development of nutmeg hickory, except that moist, fertile soils are the best natural seedbeds.

Bitternut hickory probably can tolerate a more moist seedbed than most of the other hickories and is the least susceptible to frost. On red clay soil in the Ohio Valley under open or lightly shaded conditions, bitternut seedlings measured 13.3 inches in height at 4 years (6).

Sapling Stage to Maturity

The pecan hickories grow more rapidly than the true hickories.

Pecan is a medium to very large straight-stemmed tree attaining heights as high as 180 feet and, occasionally, diameters of 6 to 7 feet (31). It prunes itself well in well-stocked stands.

Diameter growth of pecan is close to the average for bottomland hardwoods. The average 10-year diameter growth in natural, unmanaged stands in the northeast Louisiana Delta is 1.9 inches in the 6- to 12-inch diameter class, 2.7 inches in the 14- to 18-inch diameter class, 2.1 inches in the 20- to 28-inch diameter class, and 2.3 inches in the 30-inch diameter class (7).

Thrifty water hickory on a good site will attain a total height of 110 feet and a diameter of 3 feet. Dominant stems on good sites might average 14 inches d.b.h. at 50 years of age; on poor sites 50-year-old dominants would probably reach 10 inches d.b.h.

Nutmeg hickory attains heights of 80 to 100 feet and often a diameter of 2 feet (31). It is characterized by a tall, straight trunk.

Second-growth bitternut hickory on a good site in the Ohio Valley reaches the following average heights and diameters (6):

Age (Years)	Height (Feet)	D.b.h. (Inches)
10	10	2.0
20	24	4.0
30	40	6.0
40	52	7.6
50	62	9.2
60	69	11.4
70	--	13.0

Bitternut has a tendency to prune itself more readily than the other hickories. The proportion of sapwood to heartwood is characteristically low; sapwood is seldom over $1\frac{1}{2}$ inches wide or more than 25 years old (6).

Pecan is intolerant, but less so than cottonwood and willow, and is a subclimax species. It responds well to release in all age groups when the trees are of good vigor; trees which have declined to poor vigor do not.

Water hickory is also intolerant, and seedlings will not become established under shade (28). With a growth rate slower than its associates, water hickory is soon overtopped on a good site. It can remain suppressed for several years and will respond well to release even in medium sawtimber sizes. On poorer sites it has very little competition from other trees.

Little is known about the tolerance of nutmeg hickory. Bitternut hickory, usually considered intolerant, seems to have a higher seedling tolerance on overflow bottoms than most of its associates.

Enemies and Hazards

Insects

Most of the literature references to insect attack mention the genus Carya rather than the species themselves, and the insect enemies are not important enough to limit perpetuation of the hickories in any locality.

The hickory twig girdler (Oncideres cingulatus) attacks most species of hickory (14, 17) and is especially severe on shagbark and shellbark reproduction. Two other species of twig girdlers, Oncideres texanus and Oncideres pustulatus, are reported on shagbark and bitternut (17). The hickory spiral borer also attacks young hickory and is among the worst enemies of mockernut (3). The pecan weevil (Curculio caryae) attacks the nuts of all the hickories and is found from Connecticut west to Iowa and south to Florida (14).

The hickory bark beetle (Scolytus quadrispinosus) feeds in the cambium and attacks most of the hickory species. The trees are seriously weakened or killed by these attacks, and products cut from affected trees are often degraded by bark pockets. Bitternut is attacked especially hard in drought years (3). The flat headed borer (Smodicum cucujiforme) riddles the heartwood of hickories after gaining access through fire and logging scars. The pecan carpenterworm (Cossula magnifica) downgrades both trees and logs (3), and has been reported specifically upon mockernut and nutmeg hickory. The living hickory borer (Goes pulcher) feeds in the trunks and branches of the hickories (14). Among the defoliators, the sycamore lacebug (Corythucha ciliata) is an example of sucking insects that work on this genus. It feeds on the underside of the leaves, causing them to drop; in times of drought the damage can be serious (14). The leaf-feeding forest tent caterpillar (Malacosoma disstria) has been reported on water hickory. Although Datana angusii, a defoliating caterpillar, attacks mockernut, and the walnut caterpillar (Datana integersima) has been reported on pecan (14), they are probably of little economic importance in timber growth and mortality.

Dying hickories and hickory logs are attacked by Ambrosia beetles (Platypus compositus) and powder post beetles (Xylobiops basilaris) (3).

Diseases

More than 100 fungi attack the hickories and pecans (10), including those that cause leaf diseases, bark cankers, wood rots, and root rots.

Leaf and twig diseases of hickory are numerous, but they cause little damage other than varying degrees of defoliation. Leaf blotch (Mycosphaerella dendroides), anthracnose (Gnomonia caryae), witches'-broom (Microstroma juglandis), and scab (Cladosporium effusum) are probably the most common. Phomopsis tumor is widespread on hickories (9), and a leaf spot (Marrsonia juglandis) has been reported (41).

Nectria galligena, a bark canker, has been reported on pignut and mockernut (38), and probably occurs on most species of hickory.

One of the most common diseases of hickory from Pennsylvania southward is a trunk rot caused by Poria spiculosa. A single trunk canker near the base is a sign that the butt log is badly affected, and multiple cankers are evidence that the entire trunk has an extensive rot cylinder (10).

Clitocybe parasitica is probably the most common root rot of hickories, although it has been reported specifically for only mockernut (38).

Animals and Birds

In addition to the mammals listed earlier as seed dispersing agents, the black bear, gray fox, red fox, cottontail rabbit, and white-footed mouse feed on the nuts, as well as the bark in some cases. The white-tailed deer feeds on the foliage, twigs, and nuts (8, 23), and hickory suffers moderately from browsing by cattle (24). Hogs eat many of the water hickory seeds and seedlings.

Much of the degrade in Appalachian hickory is the result of bird-peck caused by sapsuckers (Spleycapicus varius) (26). Martin et al. (23) report that hickory nuts are a minor source of food for the mallard duck, wood duck, quail, and the wild turkey.

Fire

Hickory of all species is susceptible to damage by fire at all ages, and even a light fire will kill all reproduction and small saplings. Heavier burns may kill trees 10 to 12 inches in d.b.h. and wound others, making them subject to serious butt rot and resulting in degrade of the tree, loss of sound volume, or both.

Weather

Hickories as a group are resistant to damage from glaze storms (2), but shellbark, pignut, and mockernut are reportedly very susceptible to frost damage (6, 40). Baxter (2) reports that hickory and other trees died in large numbers in Iowa from the effects of the drought of 1934.

Literature Cited

(1) Barton, Lela V.
1936. Seedling production in carya ovata (Mill.) K. Koch, juglans cinerea l. and juglans nigra l. Boyce Thompson Inst. Contrib. 8: 1-5.

(2) Baxter, Dow Vawte
1943. Pathology in forest practice. 618 pp., illus. New York.

(3) Beal, James A.
1952. Forest insects of the Southeast: with special reference to species occurring in the piedmont plateau of North Carolina. Duke Univ. School Forestry Bul. 14, 168 pp., illus.

(4) Betts, H. S.
1945. Hickory. In American Woods. U. S. Forest Serv., 10 pp., illus.

(5) Bishop, G. Norman
1948. Native trees of Georgia. Ed. 2, 96 pp., illus. Athens, Ga.

(6) Boisen, Anton T., and Newlin, J. A.
1910. The commercial hickories. U. S. Dept. Agr. Forest Serv. Bul. 80, 64 pp., illus.

(7) Bond, W. E., and Bull, H.
1946. Rapid growth indicates forestry opportunities in bottomland hardwoods. South. Lumberman 172(2154): 54-56, 58, 60, 62, illus.

(8) Brown, Louis G., and Yeager, Lee E.
1945. Fox squirrels and gray squirrels in Illinois. Ill. Nat. Hist. Survey 23, pp. 449-536, illus.

(9) Brown, N. A.
1938. The tumor disease of oak and hickory trees. Phytopathology 28: 401-411, illus.

(10) Campbell, W. A., and Verrall, A. F.
1956. Fungus enemics of hickory. U. S. Forest Serv. Southeast. Forest Expt. Sta. Hickory Task Force Rpt. 3, 8 pp., illus.

(11) Cheyney, E. G.
1929. Sylvics. 149 pp. Minneapolis.

(12) Coker, W. C., and Totten, H. R.
1945. Trees of the southeastern states. Ed. 3, 419 pp., illus. Chapel Hill, N. C.

(13) Collingwood, G. H., and Brush, Warren D.
1947. Knowing your trees. 312 pp., illus. Washington.

(14) Craighead, F. C.
1950. Insect enemies of eastern forests. U. S. Dept. Agr. Misc. Pub. 657, 679 pp., illus.

(15) Cruikshank, James W., and McCormack, J. F.
1956. The distribution and volume of hickory timber. U. S. Forest Serv. Southeast. Forest Expt. Sta. Hickory Task Force Rpt. 5, 12 pp., illus.

(16) Harlow, William M., and Harrar, Ellwood S.
1941. Textbook of dendrology. Ed. 2, 542 pp., illus. New York and London.

(17) Herrick, Glenn W.
1935. Insect enemies of shade trees. 417 pp., illus. New York.

(18) Hough, R. B.
1936. Handbook of the trees of the northern states and Canada. Ed. 3, 470 pp., illus. New York.

(19) Hutchison, O. Keith
1956. Indiana's forest resources and industries. U. S. Forest Serv. Forest Resources Rpt. 10, 44 pp., illus.

(20) _____ and Morgan, James T.
1956. Ohio's forests and wood-using industries. U. S. Forest Serv. Central States Forest Expt. Sta. Forest Survey Release 19, 40 pp., illus.

(21) _____ and Winters, Robert K.
1953. Kentucky's forest resources and industries. U. S. Forest Serv. Forest Resources Rpt. 7, 56 pp., illus.

(22) King, David B., and Winters, Robert K.
1952. Forest resources and industries of Illinois. Ill. Agr. Expt. Sta. Bul. 562, 95 pp., illus.

(23) Martin, Alexander C., Zim, Herbert S., and Nelson, Arnold L.
1951. American wildlife and plants. 500 pp., illus. New York and Toronto.

(24) Merz, Robert W.
1959. Silvical characteristics of shellbark hickory. U. S. Forest Serv. Central States Forest Expt. Sta. Misc. Release 18, 14 pp., illus.

(25) Otis, Charles H.
1931. Michigan trees. 362 pp., illus. Ann Arbor, Mich.

(26) Paul, Benson H.
1929. The quality of Appalachian hickory. South. Lumberman 135(1749): 29-32.

(27) _____
1929. The relation of rate of growth to the production of white wood in hickory trees. U. S. Forest Serv. Forest Prod. Lab. Rpt. R1605, 4 pp.

(28) Putnam, J. A.
1951. Management of bottomland hardwoods. U. S. Forest Serv. South. Forest Expt. Sta. Occas. Paper 116, 60 pp.

(29) _____ and Bull, Henry
1952. The trees of the bottomlands of the Mississippi River delta region. U. S. Forest Serv. South. Forest Expt. Sta. Occas. Paper 27, 207 pp.

(30) Sargent, Charles S.
1890. The silva of North America. Vol. VII, 173 pp., illus. Boston and New York.

(31) _____
1933. Manual of the trees of North America. 910 pp., illus. Boston.

(32) Society of American Foresters
1954. Forest cover types of North America (exclusive of Mexico). 67 pp., illus. Washington, D. C.

(33) _____
1955. Forestry handbook. Illus. New York.

(34) Sudworth, George B.
1900. The forest nursery: collection of tree seeds and propagation of seedlings. U. S. Dept. Agr. Div. Forestry Bul. 29, 63 pp., illus.

(35) Thornthwaite, C. W.
1941. Atlas of climatic types in the United States, 1900-1939. U. S. Dept. Agr. Misc. Pub. 421, 58 pp., illus.

(36) Toumey, J. W.
1929. Initial root habit in American trees and its bearing on regeneration. Internatl. Plant Sci. Cong. Proc. 1926: 713-728.

(37) U. S. Department of Agriculture
1941. Climate and man. U. S. Dept. Agr. Yearbook 1941, 1248 pp., illus.

(38) _____
1952. Index of plant diseases in the United States, part IV. Spec. Pub. 1, Plant Disease Survey, Agr. Res. Adm., pp. 531-806.

(39) U. S. Forest Service
1948. Woody-plant seed manual. U. S. Dept. Agr. Misc. Pub. 654, 416 pp., illus.

(40) VanDersal, William R.
1938. Native woody plants of the United States: their erosion-control and wildlife values. U. S. Dept. Agr. Misc. Pub. 303, 362 pp., illus.

(41) Westcott, Cynthia
1950. Plant disease handbook. 746 pp., illus. New York, Toronto, and London.

(42) Westveld, R. H.
1949. Applied silviculture in the United States. Ed. 2, 590 pp., illus. New York and London.

(43) Zon, Raphael, and Graves, Henry S.
1911. Light in relation to tree growth. U. S. Dept. Agr. Forest Serv. Bul. 92, 59 pp., illus.

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