SILVICAL CHARACTERISTICS *of* AMERICAN SYCAMORE

Robert W. Merz

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This is the twelfth of a series of 17 papers dealing with the silvical characteristics of forest trees important in the Central States region. The following species are included in this series. (Those marked with an asterisk have already been published.)

*Ohio buckeye
Yellow buckeye
*Northern red oak
*Black oak
*Chinkapin oak
*Pin oak
*White oak
*Swamp white oak
Bur oak
Butternut
*Black walnut
*Shellbark hickory
*Sycamore
*Honeylocust
Hackberry
Black locust
*Eastern redcedar

Papers covering additional important American species will be issued by other Forest Experiment Stations of the U. S. Forest Service.

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Silvical Characteristics of American Sycamore

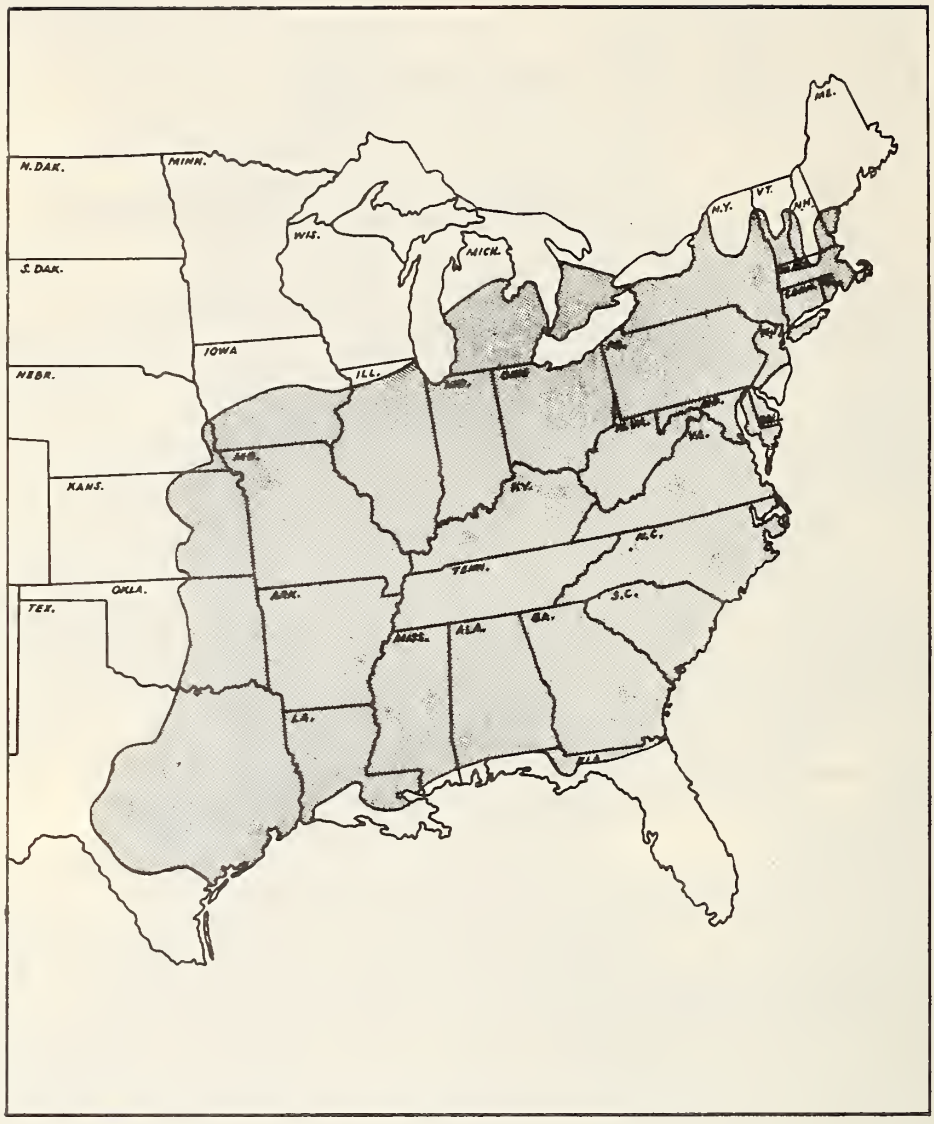
ROBERT W. MERZ, forester
Carbondale Forest Research Center

American sycamore (Platanus occidentalis L.) (30)[1/], is also commonly called sycamore, planetree, buttonwood, and buttonball-tree, is a member of the planetree family. The family, Platanaceae, contains six or seven species, three of which are native to the United States; the large American sycamore of the eastern states, and the smaller Arizona and California sycamores that occur in a few of the southwestern states (23, 30).

The American sycamore grows to a larger diameter than any other American hardwood. Trees are on record that exceed 10 feet in diameter and 140 feet in height (7), and Sargent (47) states that this species may attain a diameter of 11 feet and height of 170 feet. An individual tree in Indiana is recorded as being 33 feet in circumference 4 feet above the ground and 168 feet tall (1).

Sycamore is characterized by the different colors of its bark; a light gray outer bark and an inner bark that varies from pale tan to green or chalky white give the tree a mottled or dappled appearance (41). Large trees often have a buttressed trunk and smooth, variegated bark that is distinctive. Extremely large sycamores are commonly hollow and sometimes the cavities in these trees were used by early settlers as places of abode and storage (39). Open-grown specimens form a large, irregular crown that may become 100 feet in diameter. Under forest conditions the tree has a relatively small crown and a long, slightly tapered bole that may be clear of branches for 70 or 80 feet.

1/ Numbers in parentheses refer to Literature Cited, p. 15.



Sycamore occurs most frequently in the central and southeastern portions of its range in the states of Alabama, Arkansas, Indiana, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee (7). It is also found in northeastern Mexico (30). In the Central States region, sycamore makes up a little over 2 percent of the total sawtimber volume, according to Forest Survey Reports (13, 14, 25, 26, 27, 28).

SITE

Climate

A wide variety of climatic conditions occur within the range of sycamore. Average annual temperatures vary from 40° to 70° F., with average annual maximums and minimums ranging from 105° to -30° F.; the lowest temperature recorded is -40° F. Average annual precipitation ranges from 30 to 80 inches and the frost-free period is from 100 to 300 days (56). The natural occurrence of this species in eastern North America probably is limited in the north by frosts (6) and low winter temperatures, and in the west by the dry climate of the Great Plains.

Soils

Sycamore occurs most frequently and reaches its largest size in alluvial soils found along streams and in bottomlands (46, 57). Baxter (6) lists this species among those that are tolerant of wet soil conditions. In the northern part of its range the species is found along edges of streams, lakes, small depressions having slow drainage, wet muck land and shallow peat soils, as well as on the soils associated with river bottoms and flood plains. Farther south it grows most commonly on the alluvial soils of flood plains adjacent to larger rivers, on former stream banks except in sloughs and swamps (44), and in the more moist coves, lower slopes, and ravines. In general sycamore makes its best growth on soils where there is a good supply of ground water, typically on the edges of lakes and streams (7).

Although sycamore grows best on bottomlands, it sometimes occurs as a pioneer species on upland old field sites. This is particularly true in the central part of its range. In the south it rarely occurs on abandoned fields, or even on well-drained ridges in the first bottoms, but it usually succeeds cottonwood or willow on the borders of all major streams (44).

On eroded old fields sycamore stands may become established but seldom make good growth. In 60 old fields in Ohio sycamore was found to be a minor constituent of the reproduction (34). The species sometimes occurs in excellently stocked natural stands on coal-stripped land of the Central States. In Missouri it is often found in pure stands or in mixtures with other hardwoods as volunteers on spoil banks (45), and is one of the pioneer species on the ridges of strip-mined land in Vermillion County, Illinois (38). Sycamore is

recommended for planting on all types of coal-stripped land in many of the northeast and central states (18, 29, 42).

Sycamore is fairly tolerant of fluctuations in ground water levels. In one instance a 3-foot rise in the water table appeared to have no effect upon its growth during the period of 6 years. In the same area silver maple, pin oak, and American elm, growing with the sycamore, suffered some mortality (59). Hall and Smith (22) in Tennessee, however, found that sycamore was only able to survive when flooded less than 25 percent of the growing season. They found American elm, sweetgum, cottonwood, and pin oak to be more tolerant of flooding than sycamore. In wet situations sycamore seems to develop best when the summer water table drops enough to permit good soil aeration during the growing season (10).

Silker (49) found that sycamore made good growth in moist, well-drained, gravelly and cherty terrace soils in Tennessee. These observations were made on planted trees set out in a heavy cover of broomsedge or Johnson grass mixed with goldenrod. No tests were made on land subject to moderate or intermittent flooding.

Physiography

Throughout its range sycamore most commonly grows on flat land having a good supply of ground water, such as is found on the edges of streams, lakes, and swamps (fig. 1). It occurs at elevations ranging from just above sea level in some sections to 1,000 feet in the northern part of the Appalachian Mountains and 2,500 feet in the southern part (50). Sycamore also is found in coves and on lower east and north slopes and on the moist soils of steep slopes and ravines facing major stream bottoms.

Associated Species

Sycamore occurs as single trees or in small groups in mixtures with other species, but seldom in extensive pure stands in the northern part of its range. In the Mississippi bottomlands of the south, however, it does occur in pure stands of 40 to 100 acres (31). Sycamore is a predominant component of two of the forest types recognized by the Society of American Foresters (50). In the Riverbirch-Sycamore type, the named species predominate. Associate species include red maple, black willow, and other moist-site hardwoods. The type is widespread, occurring in southern New England, southern New York, New Jersey, Pennsylvania, southern portions of

Figure 1.--Sycamores need plenty of water.

the Lake States, and south into Oklahoma, Missouri, and Tennessee; it is also found in the Allegheny and Piedmont Plateaus of the Appalachian Mountains.

In the Sycamore-Pecan-American elm type, the named species predominate and the chief associates include boxelder, green ash, and sugarberry. Other species also found are silver maple, cottonwood, black willow, water oak, Nuttall oak, sweetgum, and river birch. This type occurs throughout the southern part of the range of sycamore and is usually found on the alluvial flood plains of major rivers.

Other forest types in which sycamore occurs as an associated species are Black ash-American elm-Red maple, Northern red oak-Mockernut hickory-Sweetgum, Silver maple-American elm, and Black willow. Of these the first two occur in the northern parts of the range of sycamore, the second two occur in the central and south-central portion of the range, and the last type occurs throughout the range (50).

Putnam (44) states that sycamore is an important constituent of the Cottonwood type and what is locally known as the Riverfront hardwood type of the Delta region of the South. These are valuable pioneer types characteristic of the fronts on all major streams except in areas of sloughs and swamps. Sycamore also is listed as one of the species found on the well-developed flood plains of the Missouri River in southeastern Nebraska (2).

Birds and Animals

Sycamore makes excellent den trees for squirrels, raccoons, and birds, including chimney swifts, that nest in hollow trees (3, 41). The seeds of sycamore are eaten by purple finch and gold finch, game ducks (32), and the wild turkey (20); the seed also was a favorite food of the now extinct Carolina paroquet (41). The bark is sometimes eaten by beavers in Missouri (4) and the seeds are eaten by the eastern fox squirrel to a limited extent in Ohio (33).

LIFE HISTORY

Seeding Habits

Flowering and Fruiting

Sycamore is a monoecious species, having dark red, staminate flowers borne along the branchlets and pistillate flowers borne at the ends of the branchlets. One to two pistillate heads arise from one stalk differentiating this species from California sycamore which bears two to seven heads on a stalk (21).

The flowers appear in May in the North and as early as late March in the South, and the seed-ball, which is a multiple fruit, ripens by September or October. It often remains on the tree over winter, breaking up or falling off the tree the following spring. The seed is an achene with a light brown, hairy, thin-but-hard, seed coat.

The minimum commercial seed-bearing age for sycamore is reported to be 25 years and optimum seed production occurs between 50 to 200 years; generally it is not dependable for seed after the age of 250 years (21). The species usually bears good seed crops every 1 or 2 years with some seed being produced every year. Late spring frosts commonly kill the flowers, leaves, and even the twigs, reducing the amount of seed produced.

Seed Production and Dissemination

Sycamore seeds are very light and small, averaging about 200,000 per pound. Seeds are dispersed from September through May of the following spring. As the seed-ball breaks up, the seeds are released and float down slowly. The hairs act as a parachute and the seeds are widely scattered by the wind (21). Several birds are known to feed on the seed and may serve as agents of dissemination to a minor extent. The seeds are also carried by water where seed trees grow on stream banks. This waterborne seed is often deposited on mud flats or sand-bars where conditions are favorable for germination.

The best seedbed conditions for the germination of sycamore are moist to wet soils. At the time the fruit matures the seed is dormant. A short period of stratification above freezing will break the dormancy but often the germination capacity is low. Stratified or spring-collected seed can be expected to show a germinative capacity ranging from 5 to 69 percent with an average of about 35 percent in 15 to 20 days in moist sand flats under temperatures of 70° to 85° F. (21). Maisenhelder (31) reports that sycamore seed stratified 30 days at 46° F. at the Delta Research Center had 54 percent germination 12 days after sowing; unstratified seed had a 41 percent germination 48 days after sowing. It is preferable to sow late winter or spring collections of seed for best results.

McDermott (35) found that the germination rate of sycamore seed was affected by light. In tests made at temperatures ranging between 23° to 27° C. the mean germination under artificial light was 17.5 percent and only 3.1 percent in the dark.

Toumey (54) indicates that the average germinative capacity of sycamore seed is 30 percent.

Vegetative Reproduction

Sycamore sprouts readily from the stump at an early age (sapling or pole-size stage) and reproduces itself by this means as well as from seed. Toumey (54) reports that slips or cuttings

made from sycamore, presumably young, fast-growing stems, will readily root and may be used to propagate this species. Maisenhelder (31) reports that 66 to 80 percent of cuttings, made from 1-year-old seedlings and sprouts, rooted and grew satisfactorily. The cuttings were 20 inches in length, 0.5 inch or more in diameter at the small end, and were set 15 inches into the ground.

The Athens-Macon Forest Research Center (U. S. Forest Service) made some cutting tests of sycamore in the fall of 1955 and the spring of 1956. They obtained healthier top growth from cuttings that were made close to the root collars. Fall-planted cuttings seemed to grow better than those planted in the spring. Survival of the cuttings, however, was not affected by season of planting or by the position of the cutting on the parent stem (51).

Seedling Development

Establishment

Sycamore is established in open situations from seed, usually on bare mineral soil. Although it probably becomes established most often on moist bottomland sites, it does appear on upland sites when competition is lacking. Some excellently stocked stands of sycamore have become established on coal strip-mined land throughout the Central States and these are often relatively dry sites late in the growing season.

In a study made by Biswell (8) where soil and amount of light were variables, it was found that sycamore seedlings grew better in full light than in half shade. The root system also penetrated deeper into the soil and was more branched under conditions of full light. It was found also that this species had better root penetration in loess soil than in alluvial or clay soils. Later measurements showed that sycamore, after 6 years, had an average root penetration of 7 feet with well-developed branching laterals.

In a study of the effects of saturated soil on the growth of potted sycamore and other seedlings, McDermott (36) found that sycamore made a rapid recovery after stunting resulting from flooding.

Early Growth

Sycamore must have ample light to germinate and survive. As a seedling, sycamore grows rapidly and develops a strong, spreading root system. It may grow as much as 3 or 4 feet in height the first year. In the South where sycamore occurs with silver maple, it is necessary to remove established boxelder and inferior individuals of hackberry, elm, and pecan or they will suppress the sycamore and silver maple (44).

Sapling Stage to Maturity

Growth

Sycamore is a fast-growing tree throughout its life. Within its range only cottonwood and, in some cases, a few of the pines, soft maple, and black willow grow faster. The average 10-year diameter growth rates for three size classes of sycamore as determined in five states by the Forest Survey (13, 14, 25, 26, 27, 28) are given below:

State	Seedlings and saplings (Inches)	Pole-size (Inches)	Sawtimber (Inches)
Illinois	3.24	--	3.38
Indiana	3.50	2.58	2.54
Kentucky	2.36	2.72	3.20
Missouri	2.36	3.08	3.60
Ohio	2.90	1.40	2.38

These are average growth rates for all sites where the species was found and should not be considered as indicative of growth that might be expected on either very poor or very good sites.

One stand of sycamore in North Carolina, 17 years of age, has attained an average d.b.h. of more than 9 inches and an average height of 70 feet. It has a volume of 20 cords per acre or 2,310 board-feet of sawtimber plus 12 cords of pulpwood. This stand is expected to have a volume of 10,000 board-feet per acre in 5 more years (19).

Reaction to Competition

Although there is some difference of opinion among foresters about tolerance, as indicated by Baker (5), sycamore should be classed as intermediate in tolerance and competitive ability. However, it has also been classed as an intolerant tree (43, 58). It can compete successfully with cottonwood for Westveld (57) points out that sycamore tends to replace or succeed cottonwood on certain sites unless special steps are taken to favor the latter. Toumey and Korstian (55) list sycamore as intermediate in tolerance in southern Connecticut and they cite Zon and Graves who also give it a similar ranking.

Oosting (40) found in the Piedmont of North Carolina that sycamore and birch tend to replace pioneer species like alder and willow on small islands or spits in streams after this land becomes stable and drained to some extent. Sycamore and birch, in turn, are succeeded in these situations by species of elm, ash, and red maple. However, McDermott (37) found that sycamore seedlings were at least as tolerant as American and winged elm on the basis of height growth and top-root ratios under controlled light conditions.

Steyermark indicates that on sand and gravel bars and on flood plains in Missouri, sycamore is one of the pioneer species that persists throughout later successional stages in the Sugar maple-Bitternut hickory association (52). This association begins on wet sites where the soils are usually neutral to calcareous.

Sycamore is a constituent of forest types that are pioneer, transitional, sub-climax, and climax in the successional stage. Clements (15) lists sycamore as one of the constituents of the sub-climax, moist or wet site, deciduous forest in association with oaks, black walnut, hackberry, sweetgum, cottonwood, and willow. It probably is able to maintain itself in some of the sub-climax and climax types because of its rapid growth and longevity. Usually it only maintains a position in sub-climax types when they occur in bottomland or other moist situations. On dryer sites sycamore usually has only pioneer or transitional status and eventually is replaced by species of greater tolerance or of less exacting moisture requirements.

Epicormic branching is not known to be serious on sycamore. One pruning test made on widely spaced, open-grown natural trees 9 years old did not result in serious branching of this type (19).

ENEMIES AND HAZARDS

Insects

A variety of insects feed on sycamore but none of them is of economic importance in forest stands. Some of them may, however, seriously damage individual trees planted for landscaping purposes. Probably none of the insects that attack sycamore kills healthy trees, but when they attack a tree of reduced vigor, they may cause severe injury or death. The more important insects attacking sycamore are the sycamore lacebug (Corythuca ciliata), the flatheaded sycamore hardwood borer (Chalcophora campestris), and the sycamore tussock moth (Halisidota harrisii). Other insects of less importance that feed on sycamore include the leaf feeders and hoppers, cicadas (Magicicada septendecim), aphids, scales, crosswood borers, flatheaded borers, roundheaded borers, bark borers, darkling beetles (Tenebrionidae), ambrosia beetles, moths and caterpillars, leaf rollers, and horntails (Siricoidea) (16). Sycamore is also subject to ant attacks which often cause ingrown bark pockets to form, reducing the quality of the wood (44).

Diseases

There are relatively few serious diseases that cause loss among sycamores in forest stands. Diseases may on occasion, however, reduce the value of this species for landscape and shade use. Sycamore is susceptible to anthracnose (6, 9, 11, 24, 48, 53), the same disease that attacks oaks. This fungus disease attacks in the spring and sometimes completely defoliates the trees. Severe attacks will also kill twigs and frequently cankers will be formed up to 1 inch in diameter. Usually a second set of leaves is produced following defoliation and few trees die from an attack (11). However, anthracnose may weaken a tree making it susceptible to attack by other diseases. Heavy attacks by this disease also reduce radial and terminal growth.

In a stand of sycamore near Athens, Georgia, about 40 percent of the trees growing along a small stream were affected by die-back identified as Diplodia natalensis (Evans) that began in the small branches and spread to the larger branches and, in some cases, to the trunk of the tree. Some of the trees were killed. This die-back occurred following infections of anthracnose. A similar die-back disease was reported in Louisiana but was not identified (53).

In 1954 anthracnose infection in sycamore was very severe throughout Illinois. The earliest case was reported on April 29 in Pulaski County and by May the disease was epidemic throughout the

State. It is generally believed that abundant rain and cool weather favors the development of this disease (9).

Canker stain, a fatal stem disease of the London planetree, also attacks sycamore. The disease is known principally in eastern and southeastern United States and has been reported in Missouri. Apparently, sycamore is less susceptible than the London planetree (12).

Sycamore is host to the eastern mistletoe (Phoradendron sp.) but damage usually is not serious. Nectria canker (Nectria sp.) is a very serious canker disease of hardwood stands in the East and Boyce (11) states, "In the East it can be assumed that nectria canker will work on all hardwoods." There are no reports, however, that sycamore is particularly susceptible. Generally, this tree is susceptible to very few diseases.

Weather

Weather damage to sycamore is commonly confused with that caused by insects and diseases. For example, anthracnose attacks are often mistaken for frost damage. Low winter temperature may also injure the cork cambium and cause the outer bark to be sloughed off, but this does not affect the health of the tree (11). Late spring frosts may kill sycamore buds over a wide area and, where this occurs, the damaged trees will characteristically have long dead twigs with bushy masses of leaves developed around their bases by mid-summer.

A very limited study of sycamore following a sleet storm in west-central Illinois in 1939 (17) indicates this tree may be susceptible to ice breakage. Of 979 trees among 52 species, sycamore was one that suffered heavy damage. Six sycamores were examined and all were damaged: One had minor damage, two were moderately damaged, and three suffered heavy damage. These individuals were shade trees, probably with large spreading crowns. Baxter (6), however, lists sycamore as a tree that is seldom damaged by glaze storms.

Sycamore, because it develops a widespreading, strongly branched root system, is considered a very windfirm tree (57). However, large sycamores are likely to develop wind-shake. This is a separation of the annual rings which reduces the value of the tree for lumber and other products.

RACES AND HYBRIDS

Two varieties of sycamore are reported: Var. glabrata and var. attenuata (30, 46). The former is common in western Texas and the latter is apparently intermixed with P. occidentalis throughout its range. Sargent (46) states that P. acerifolia, the London plane-tree of the Old World, is often considered a hybrid of P. orientalis and American sycamore. It is similar in appearance to American sycamore but the bark has a more olive-green color and the fruit heads occur in two's rather than singly (23).

SPECIAL FEATURES

It is the most massive if not the tallest tree in eastern North America (46) (fig. 2). Sycamore wood is close textured with an interlocked grain and is moderately heavy, very hard, stiff, and strong. It is not durable in contact with the soil and warps very easily. However, it does not impart an odor or taste and for this reason is a good wood for packaging food products. When quarter-sawed, the rays are darker than the rest of the wood, which is opposite to the situation in oak. It is a species that is favored for veneer purposes. It once was widely used in cooperage for staves and barrel heads (7).

According to Preston (43) sycamore is able to withstand smoke and thus may be useful as an ornamental in certain situations where other trees might not live.

Figure 2.--Sycamore is perhaps the most massive tree in North America.

TREE SPECIES MENTIONED

Alder	-	*Alnus* B. Ehrh.
Black ash	-	*Fraxinus nigra* Marsh.
Green ash	-	*F. pennsylvanica* Marsh.
River birch	-	*Betula nigra* L.
Boxelder	-	*Acer negundo* L.
Cottonwood	-	*Populus* L.
American elm	-	*Ulmus americana* L.
Winged elm	-	*U. alata* Michx.
Hackberry	-	*Celtis occidentalis* L.
Bitternut hickory	-	*Carya cordiformis* (Wangenh.) K. Koch
Mockernut hickory	-	*C. tomentosa* Nutt.
Red maple	-	*Acer rubrum* L.
Silver maple	-	*A. saccharinum* L.
Sugar maple	-	*A. saccharum* Marsh.
Northern red oak	-	*Quercus rubra* L.
Nuttall oak	-	*Q. nuttallii* Palmer
Pin oak	-	*Q. palustris* Muenchh.
Water oak	-	*Q. nigra* L.
Pecan	-	*Carya illinoensis* (Wangenh.) K. Koch
Sugarberry	-	*Celtis laevigata* Willd.
Sweetgum	-	*Liquidambar styraciflua* L.
American sycamore	-	*Platanus occidentalis* L.
Arizona sycamore	-	*P. wrightii* S. Wats.
California sycamore	-	*P. racemosa* Nutt.
Black walnut	-	*Juglans nigra* L.
Black willow	-	*Salix nigra* Marsh.

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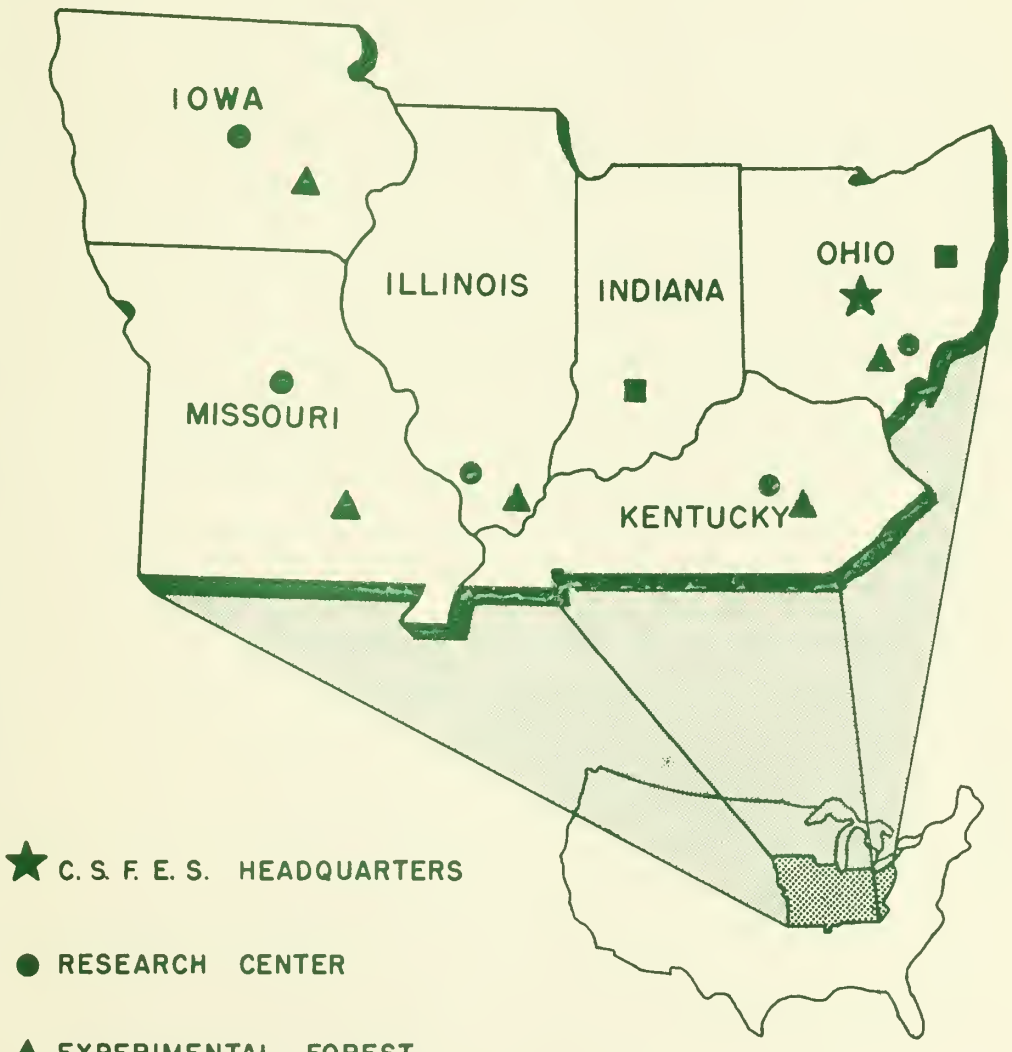


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