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THE HARDY CATALPA.

HORTICULTURAL AND BOTANICAL DEPARTMENTS.

THE BOTANICAL DEPARTMENT.

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The Hardy Catalpa (Catalpa speciosa) as an Economic Tree.

INTRODUCTION.

ALTHOUGH the merits of catalpa timber have been sufficiently recognized in the past by individual botanists, foresters, and business men, the majority of the publications calling the attention of the public to its value appeared before practical experience in growing the tree in forest plantations had made it possible for a comparative study of methods of management of such plantations to be made, or any conclusions to be drawn as to cost of raising the trees or the possible profits. Since the information now become available, through experience gained at several large commercial plantations in this state, appears likely to be of value to the economic interests of the West generally, it seems desirable to publish all the accumulated data available.

HISTORICAL OUTLINE.

The fact that there were two American forms of catalpa appears to have been noticed by the earlier botanical explorers. Thomas Nuttall, "Genera of North American Plants," vol. I, p. 10 (1818), was apparently the first to report the presence of *Catalpa speciosa* in the region where it now seems to have been indigenous, viz., along the rivers and in the bottom lands of that belt of country in the Mississippi basin trending southwest from southern Illinois and Indiana, through western

Kentucky and Tennessee, to southeastern Missouri and northeastern Arkansas. Nuttall, however, reported the tree only upon hearsay, and not from observation. He was (*loc. cit.*) "informed by Governor Harrison (of the Northwest territory) of its indubitable existence in very considerable quantities on the banks of the Wabash, . . . but extremely local." Further, he says: "I have never once met it on either bank of the Ohio, Mississippi or Missouri rivers, which I have ascended and descended thousands of miles." Later ("Travels in Arkansas," 1819), he writes : "At Point Pleasant, six miles below New Madrid (MO.), I saw the catalpa in the forests, apparently indigenous, . . . though still contiguous to habitations."

From a statement of Nuttall's, that "in the Southern states it does not appear to grow with any degree of vigor," it would plainly appear that he supposed the differences in habit and stature between the trees described to him by General Harrison, and which he saw for himself in Missouri, in 1819, and those growing in the Southeastern states, to be due solely to the effects of climate and soil, and not to hereditary differences of specific value. Nuttall did not seem to suspect that the tree seen by him in the West was other than the *Catalpa bignonioides* of Walter, described in his "Flora Caroliniana," page 64 (1788). An interesting note is given by him as to the origin of the name, from "Catawba," " derived from a tribe of Indians residing on the Catawba river." The tree that Nuttall had in his mind was the species now known as *Catalpa catalpa* (L.) Karsten (*C. bignonioides* Walter), found apparently native along rivers in southeastern Georgia, western Florida, and central Alabama and Mississippi, and of which he relates as follows ("Sylva Americana," Michaux and Nuttall, vol. 3, p. 77): "In a journey made into Georgia, Alabama and western Florida in 1830, at Columbus, Ga., on the banks of the Chattahootshee, I, for the first time in my life, beheld this tree, decidedly native, forming small haggard, crooked trees, leaning fantastically over the rocky banks of the river."

This species of catalpa had found its way up and down the Atlantic coast, as an ornamental tree, early in the last century, and was known from Massachusetts to Indiana. According to D. J. Browne, "Trees of America," it was "introduced into Britain in 1726, . . . frequently to be met with in gardens of collectors both in that country and on the continent of Europe."

Through the first half of the nineteenth century, concurrently with the settlement of the middle West, this tree was introduced by seedsmen and nurserymen through Ohio and Illinois, Kentucky, Missouri, and Iowa, where it was long confused with the native *Catalpa speciosa*, and generally supposed to be the same species; although the

eminent botanist, Doctor Engelmann, of St. Louis, had noted as early as 1842 that there was a difference of about two weeks in the dates of flowering of the catalpa trees in that city, as well as a difference in the size and showiness of the flowers; but it did not become apparent that the larger flowered, earlier variety was the indigenous Western or hardy catalpa, and that the other was the Southeastern species, by that time quite generally introduced through the West, and most commonly known and planted.

The credit for this discovery attaches to Dr. John A. Warder, of Ohio, editor of the *Western Horticultural Review*, whose attention was called in 1853 to the observable differences in locally cultivated catalpa trees by one of the members of the firm of J. C. & E. Y. Teas, nurserymen of Raysville, Ind., who had obtained from Dr. Job Haines, an amateur nurseryman, of Dayton, Ohio, seed of the earlier blooming and larger flowered catalpa. Warder became convinced that the tree in question was a constant variant from the commonly accepted and generally grown "type" of catalpa, and described it as such informally in the columns of the *Western Horticultural Review*, volume 3, page 533. Later, it seems to have been called by Warder and others *C. bignonioides*, var. *speciosa*, so named an account of the showy flowers, but it was regarded as being simply a more ornamental form of the ordinary catalpa.

In Teas Bros.' catalogue for 1856, Doctor Engelmann found the tree for sale as *Catalpa speciosa*, and in the *Botanical Gazette*, volume 5, page 1 (January, 1880), on the basis of his diagnosis of its characters, he made it known to science as a distinct species, under the name of *Catalpa speciosa*, Warder. Ever since then the distinctions between the two forms have been clear to botanists.

In the meantime, from various foci, seeds and seedlings of C. *speciosa* had been moving over the West. Gen. William Henry Harrison, on leaving Vincennes, Ind., his seat of residence as governor of the Northwest territory, for his home in Ohio, carried seed of the Western catalpa with him, and distributed it among his neighbors. He seems to have been greatly impressed with the enduring character of its timber when in contact with the soil.

A chance visitor from Kentucky to Washtenaw county, Michigan, carried a pod of *C. speciosa* to a Mr. Bennet of that locality, from whom, in 1844, two plants reached Mr. Joel T. Griffin, a nurseryman of Omaha, Neb., who became the medium for its distribution through that region.

Mr. Suel Foster, a resident of Muscatine, Iowa, who, in 1853, obtained catalpa trees derived from the stock in the Teas Bros.' nursery,

was also active and prominent in calling attention to the economic value of the Western catalpa in the states bordering on the plains.

We therefore find, in the early '70's, a generally well-diffused knowledge among Western tree-planters of the distinction between the two catalpas, and of the very important fact that *C. speciosa*, the Western form, was hardy about as far north as 44° and from the Missouri river to New England, and that its wood, like that of the Eastern species, possessed the very desirable quality of resisting the agencies of decay to a remarkable degree, and beyond that shown by any other native species of timber.

SYSTEMATIC.

The genus *Catalpa* belongs to the family of the *Bignoniaceæ*. Of the six species, two, *C. catalpa* Karst. and C. *speciosa* Ward., are native to North America. Following are the botanical descriptions of the American species :

Catalpa catalpa (Linn.) Karsten.

Bignonia catalpa Linnæus, Spec. Pl., ed. l, II, 622 1753).
Catalpa bignonioides Walter, Flora Caroliniana, 64 (1788).
Catalpa cordifolia Moench, Meth. 464 (1794).
Catalpa ternifolia Cavanilles, Desc. Pl. 26 (1802).
Catalpa syringæfolia Sims, in Bot Mag. XXVII, t. 1094 (1808).
Catalpa communis Du Mont de Courset, Bot. Cult., ed. 2, III, 242 (1811).
Catalpa catalpa Karsten, Deutsch Fl. 927 (1882).

" Flowers in many-flowered, crowded panicles ; corolla thickly spotted on the inner surface. Fruit slender. Leaves slightly acuminate.

" A tree, rarely sixty feet in height, with a short trunk, sometimes three or four feet in diameter, and stout, elongated brittle branches, which form a broad head and dichotomous branchlets. The bark of the trunk varies from a quarter to a third of an inch in thickness, and is light brown tinged with red on the surface, which separates in large, thin, irregular scales. The branchlets, when they first appear, are green shaded with purple, and slightly puberulous. During their first winter they are thickened at the nodes, lustrous light orange color or gray-brown, covered with a slight glaucous bloom, and marked with large, pale, scattered lenticels, the outer layer of the thin bark separating easily from the bright green inner layer. The leaf-scars, in which appear a circle of conspicuous fibro-vascular bundle scars, are large, oval, and elevated, and do not entirely disappear until the third or fourth year, when the branches are reddish brown, and marked with a network of thin, flat, brown ridges. The branch continues to grow throughout the summer, the end dying in the autumn, without forming a terminal bud, and appearing during the winter as a black scar by the side of the upper axillary bud. The axillary buds are minute, globose, and deeply immersed in the bark, with several pairs of chestnut-brown, broadly ovate, rounded, slightly puberulous and loosely imbricated scales; those of the inner ranks are accrescent, and when fully grown are bright green, pubescent, and sometimes two inches in length. The leaves are opposite and in threes, broadly ovate, rather abruptly contracted into slender points, or sometimes rounded at the apex, cordate at the base, and entire or often laterally lobed. When they

unfold they are coated on the lower surface with a pale tomentum, and are pilose on the upper surface; and at maturity they are thin and firm, light green and glabrous above, pale and pubescent below, five or six inches long and four or five inches broad, with stout, terete petioles five or six inches in length, prominent midribs and primary veins arcuate near the margins, connected by reticulate veinlets, and furnished in their axils with clusters of dark glands. They smell disagreeably when bruised, and turn black and fall to the ground after the first frost of the autumn. The flowers, which appear from May in the South to July in New England, are produced in compact, many-flowered panicles eight or ten inches long or broad, with light green branches tinged with purple, and are borne in slender pubescent pedicels half an inch in length. The calyx is half an inch in length, and green or light purple. The corolla is white, with a broad, companulate, flat tube, and spreading limb, which, when it is expanded, is an inch and a half wide and nearly two inches long; it is marked on the inner surface on the lower side with two rows of yellow blotches following the parallel lateral ridges or folds, and in the throat and on the lower lobes of the limb with crowded conspicuous purple spots. The stamens and the style are slightly exserted. The fruit, which ripens in the autumn, hangs in thick-branched, orange-colored panicles, and remains on the trees without opening during the winter; it is six to twenty inches long, a quarter to a third of an inch thick in the middle, with a thin wall, which is bright chestnut-brown on the outside and light olive-brown and lustrous on the inside, and in the spring splits into two flat valves before finally falling; the partition is thin and light brown. The seed is about an inch long, a quarter of an inch wide, silvery gray, with pointed wings, terminating in long, pencil-shaped tufts of white hairs.

"*Catalpa catalpa* is usually supposed to be indigenous on the banks of the rivers of southwestern Georgia, western Florida, and central Alabama and Mississippi. The hardiness of this tree, however, in severe climates like that of New England, would indicate an origin in some colder and more elevated region, and it is possible that the catalpa trees which now appear to be growing naturally in the Southern states are the offspring of trees carried there by man.

"The wood of *Catalpa catalpa* is soft, not strong, coarse-grained, and very durable in contact with the soil, with numerous obscure medullary rays and rows of large open ducts clearly marking the layers of annual growth; it is light brown, with lighter colored, often nearly white sap-wood, composed of one or two layers of annual growth. The specific gravity of the absolutely dry wood is 0.4474, a cubic foot weighing 27.88 pounds. It is used, and highly valued, for fence-posts, rails and other purposes where durable wood is needed.

"The bark, which contains tannin and an amorphous bitter principle, has been occasionally used, as well as the seeds, in decoctions for the treatment of bronchitis, and in homeopathic practice." ("The Silva of North America," Charles Sprague Sargent, vol. VI, p. 86.)

Catalpa speciosa Warder.

Catalpa cordifolia Jaume, in Nouveau Duhamel, II, t. 5 (1802), not Moench (1794).

Catalpa bignonioides Lesquereux, in Owen's 2d Rep. Arkan. 375 (1860), not Walter (1788).

Catalpa speciosa (Warder, in Hort.) Engelmann, in Bot. Gaz., vol. V, l (1880).

"Flowers in few-flowered, open panicles; corolla inconspicuously spotted. Fruit stout. Leaves caudate acuminate.

"A tree in the forest occasionally 120 feet in height, with a tall, straight trunk, rarely four and a half feet in diameter, and a narrow, round-tipped crown of slender branches; usually smaller, although often a hundred feet high, and when grown in open situations rarely more than fifty feet in height, with a short trunk and a broad head of spreading branches. The bark of the trunk is three-quarters of an inch or sometimes nearly an inch thick, brown tinged with red, and broken on the surface with thick scales. The branchlets are stout, and when they first appear are light green, often tinged with purple, and covered with scattered pale hairs; during the first winter they are light orange color or reddish brown, covered with a slight bloom, and marked with many pale, conspicuous lenticels, and with the elevated oval leaf-scars, which are a quarter of an inch long and display a circular row of large fibro-vascular bundle scars; in their second and third years the branches grow darker and the leaf-scars and lenticels nearly disappear. The end of the branch dies in the autumn without forming a terminal bud, and during the winter appears as an elevated circular scar close to the upper axillary bud. The buds are minute, globose, partly immersed in the bark, and covered with loosely imbricated chestnut-brown ovate scales, keeled on the back and slightly apiculate at the apex; those of the inner ranks are accrescent and at maturity are foliaceous, obovate, acute, gradually narrowed below a sessile base, many nerved, with dark veins pubescent on the lower surface, and sometimes nearly two and a half inches long and three-quarters of an inch broad. The leaves are opposite or in threes, oval, long-pointed, cordate at the base, and usually entire or furnished with one or two lateral teeth; when they unfold they are pilose on the upper surface and covered on the lower and on the petioles with pale or rufous tomentum, which soon disappears, and at maturity they are thick and firm, dark green above and pale and covered with soft pubescence below, especially along the stout midribs and the principal veins marked in their axils with large clusters of dark glands. They are ten or twelve inches long, seven or eight inches broad, and are borne on stout terete petioles four to six inches in length. They turn black and fall after the first severe frost of the autumn. The flowers, which appear late in May or early in June, are borne on slender purple pedicels, furnished near the middle with one or three bractlets, and are produced in open few-flowered panicles five or six inches long and broad, with green or purple branches marked with orange-colored lenticels, the lowest being often developed from the axils of small leaves. The calyx is purple and divided at the base into two ovate pointed apiculate divisions. The corolla is white, with a broad conical oblique tube nearly an inch long, often marked externally with purple spots near the base, and internally on the lower side with two bands of yellow blotches which follow two parallel lateral ridges, and with occasional purple spots spreading over the lobes of the lower lips of the limb, which, when the flower is fully opened, has a vertical diameter of nearly two inches and a horizontal diameter of two inches and a half. The filaments, which are marked near the base with a few oblong purple spots, are slightly exserted, and rather longer than the slender glabrous style. The fruit is eight to twenty inches long and one-half to three-quarters of an inch in the middle, with a thick wall, which towards spring splits into two concave valves; the partition is thickened in the middle and nearly triangular in section. The seed is an inch long and a third of an inch broad, with a light brown coat, and wings which are rounded at the ends and terminate in a fringe of rather short hairs.

"*Catalpa speciosa* inhabits the borders of streams and ponds and fertile, often undulating bottom lands, and is distributed from the valley of the Vermillion river, in Illinois, through southern Illinois and Indiana, western Kentucky and Tennessee, southeastern Missouri and northeast Arkansas; through cultivation it has become naturalized in southern Arkansas, western Louisiana, and eastern Texas. In southern Illinois and Indiana, where it probably grew to its largest size, the western catalpa was formerly extremely abundant." ("The Silva of North America," Charles Sprague Sargent, vol. VI, p. 89.)

In addition to the native species, there is quite frequently to be found in cultivation the Japanese species, *Catalpa kæmpferi* Sieb. & Zucc., in ornamental grounds, between which and the American species there appear to be numerous hybrids. The long, very narrow pods, borne in very thick clusters, and the low habit of growth, render this tree easily distinguishable. The latest botanical discription of *C. kæmpferi,* published by Sir Joseph Hooker in the *Botanical Magazine,* is as follows:

"A middle-sized tree, twenty-five to thirty feet high, with spreading, rather brittle branches and copious foliage; main branches stout; shoots green, smelling disagreeably when bruised; leaves about six inches long and broad, of a bright pale green color, with brown glandular spots at the junction of the nerves, broadly ovate, base rounded or cordate, margin sinuate or three-lobed, the lateral lobes short, terminal, tapering to a fine point, surfaces pubescent at first, then glabrous above, smooth or roughish beneath; petiole two to five inches long, round; nerve axils pubescent. Panicle terminal, erect, as long as the leaves, narrow or broad; rachis with small brown petioled leaves at the base; flowers two or three together at the ends of the branchlets of the panicle, horizontal or drooping, pale yellow, sprinkled with minute red spots within; calyx very small, lips rounded. Corolla campanulate, three-quarters of an inch long, mouth oblique, upper lip short recurved, lower spreading; lobes all rounded with crisped margins; in many of the flowers a small recurved, tongue-shaped appendage to the corolla occurs on the corolla tube near its base above. Capsule a foot long and one-third of an inch in diameter, cylindric, straight, smooth, brown; seeds compressed, velvety, produced at each end into fine, silky hairs."

There seem to be intergrading forms between the two American species of catalpa. Whether these variants are ecological in character, assuming *C. catalpa* to be indigenous, or whether, by means of occasional early-blooming individuals of the Southeastern or occasional later-blooming individuals of the Western or hardy catalpa, hybrids have arisen between the two forms, it is on present evidence impossible to say. It is certainly true that intermediate forms exist. To the practical planter the essential thing is to avoid *Catalpa kæmpferi, C. catalpa,* or their hybrids, or the so-called hybrids of *C. catalpa* and *C. speciosa,* and so far as possible to confine his forest to trees most near to the best type of *Catalpa speciosa.* Great carelessness is said to exist in the trade in the matter of distributing pure seed of *C. speciosa.* For the benefit of prospective catalpa growers

without special botanical knowledge, a few salient characters may be seized upon to distinguish the species in question. In the first place, the fact that *C. speciosa* blooms about two weeks earlier than *C. catalpa,* bears larger and showier flowers, fewer in cluster, will usually be a safe distinguishing feature. It cannot be too strongly urged upon catalpa planters *to grow their own trees from seed. By* this means the danger of obtaining the undesirable species is greatly lessened, since careful study of the seed characters offers an additional safeguard. If the prospective grower gathers his own seed, it will be well to obtain it from mature trees, if possible, since the bark characters offer striking contrasts in the two species. The bark of *C. catalpa* is scaly, peeling off in short strips, much as does that of the wild cherry. *Catalpa speciosa,* on the other hand, like the ash or the box-elder, has furrowed bark, not separating from the trunk in scales. Plates 29 and 30 show quite well these contrasting characters. While the pods of the hardy catalpa are usually longer, larger and straighter than those of the Southeastern species, this is not an invariable rule. The seeds of *Catalpa speciosa,* however, are quite readily distinguished from those of *C. catalpa,* in the fact that they are wider, have usually a more pronounced notch between the wings, and the tips of the latter are fringed with a brush of hairs which stand squarely out from the wings and are not drawn into narrow points (plates 34 and 35). *Catalpa kœmpferi* and its hybrids have the hairs on the seeds arranged much as in *C. speciosa,* but the seeds themselves are so much smaller and narrower that no confusion is possible (plate 36).

DURABILITY OF CATALPA TIMBER.

0ut of the vast mass of testimony on this point it will suffice to cite a few authorities:

In the Indiana Geological Survey for 1873, page 364, Prof. John Collet mentions an instance of a catalpa gate-post set in the ground near a schoolhouse in 1780, which, when cut up for fire-wood in 1871, was found still to be in fair condition. He further states that catalpa posts, set by General Harrison about the governor's residence in 1808, "were taken up a few years ago, and, being sound, were reset in another place."

Prof. T. J. Burrill, of the University of Illinois, obtained, in 1876, boards from a catalpa log two feet in diameter, which, according to testimony considered reliable by him, had lain on the ground about twelve miles from Cairo, Ill., for a period of 100 years.

In response to an inquiry, Doctor Burrill confirms the fact just recited in a letter dated February 24, 1902, as follows:

"Referring to the statement published in 1879 by Mr. E. E. Barney, I will say that I did secure from the Mississippi river bottoms, in Alexander county, Illinois,

boards sixteen feet long and eighteen inches wide, which had been cut from a log having lain on the ground at least 100 years. This log was lying across a stream, and had been used as a foot-bridge. The gentleman of whom I secured the boards had himself known of the log in its position for sixty years, and his father had reported it as being in that position forty years previous to the knowledge of my informant. The sap-wood had disappeared, and there was about an inch of decayed wood on the outside. The center, however, was entirely sound and still susceptible of taking a good polish. Some of these boards were shown at the Philadelphia Centennial Exposition.

"While collecting for this exposition, I found logs which had been buried in an embankment of some kind, and were then protruding from the earth, in a grade made by the Illinois Central railroad. This was in 1875. The cut by the railroad had been made sixteen or eighteen years before. How long the logs had been under the earth cannot be told. I identified the wood, however, as catalpa. They were too badly decayed to be used for exhibition purposes, but there was still a good deal of sound wood in the logs. Some stockades in southern Illinois made in part of catalpa trees show also the durable quality of this wood in connection with moist earth. Some of these timbers are known to have remained sound in earth for sixty years."

It is reported by Mr. E. E. Barney, in a pamphlet entitled "Additional Facts and Information in Relation to the Catalpa Tree," etc. (1879), page 5, that, according to old residents of Vincennes, Ind.,

"the old stockade built by the first French settlers of that place was largely from catalpa trees, which grow native in the forests there, and that when removed from the ground, nearly 100 years after they had been set, were perfectly sound and gave no indications of decay." He further says (same page): "Large catalpa trees back of New Madrid, on the Mississippi river, in southwestern Missouri, killed by eruptions in 1811, I am informed, in a letter received August 10 from a gentlemen living there, are still standing, perfectly sound, after sixty years, and, to use his expression, 'plenty of them.' One of these was recently cut down, and seven feet of the butt and seven feet of the top sent to me. The top, though worn to a point by the action of the wind and rain, is perfectly sound. The butt, though showing on the outside the result of long exposure, is as sound as it was sixty-nine years ago, when killed by the eruption."

Regarding these particular trees, there are two additional accounts. Mr. James M. Bucklin, C. E., writing from Knightsville, Ind., July l5, 1876, to Mr. John Simpson, the superintendent of the Terre Haute & Indianapolis railroad, quoted by Mr. Barney in a pamphlet published in 1878, says :

"In 1876 I found it (catalpa) in large bodies and in enormous height and size, three and one-fourth feet in diameter and fifty feet high, without a limb, in dense forests which extend south of Poplar Bluffs in southeastern Missouri, between the Big Black and the St. Francis rivers. I was then exploring a route for the Iron Mountain & Helena (Ark.) railroad. . . . Throughout that region the peculiar value of the tree is well known, not only for its durability, but for other properties invaluable to early settlers. Canoes are used exclusively on these rivers, and, when made of catalpa trees, never crack in seasoning or rot. Henly, the ferryman at Poplar Bluffs, had a canoe perfectly sound, three feet across the

gunwales, which he assured me had been in use twelve years. He afterwards informed me that he had seen catalpa trees, perfectly sound, back of New Madrid, on the Mississippi river, that had been killed by the eruptions of 1811. This statement was too incredible to make a note of, but it has since been confirmed by respectable citizens of New Madrid, who stated also that all the catalpa trees were killed at that time."

Dr. John Warder furnishes corroborative testimony to the same point in his article on "The Western Catalpa Tree," (Jour. Am. Ag. Ass'n, 1881) page 98, as follows:

"Near New Madrid there are many fence-posts which have stood and remained perfectly sound for long periods, twenty, thirty and even forty years. The story of the standing catalpa trees that were killed by the disturbances and the submergence of land, caused by the earthquake of 1811, which we have all been disposed to doubt, is, at this day, fully confirmed by ocular demonstration. In the lagoon there stand the broken shafts of noble trees; all other species submerged by the same catastrophe have crumbled and fallen into the water long ago, but these silent monuments of that convulsion still remain, not as living witnesses, but as dead memorials of the disturbance of level which caused their death, and their now approaching dissolution; but there have they stood seventy years, under conditions most favorable to decay."

In Mr. Barney's earlier pamphlet, page 9, he reprints a letter contributed by him to the *Railway Age* December 11, 1876, in which reference is made to a Mr. Wm. A. Arthur, a former superintendent of the Illinois Central railroad. The latter had journeyed with a friend up the Ohio river twenty miles from Cairo, Ill., and on a farm belonging to the latter's father reported finding "a gate-post which, he stated, he had assisted his father to put in position forty-six years previously. They dug around it and examined it carefully to the bottom, and found it as sound as the day it was planted; no signs of decay whatever."

These citations sufficiently indicate the extraordinary durability of catalpa timber in contact with the soil.

It is to be noted that the durability of catalpa timber is a quality of the mature wood, and that very young or unseasoned timber, or timber that has been cut during the early growing season, shows no special immunity to the attacks of fungi. Doctor Burrill writes from the University of Illinois:

"We find that trees four or five inches in diameter, cut green and used as posts, decay rapidly in the ground. Indeed, I have no evidence that young catalpa trees make in any case durable posts. On the other hand, the mature wood is exceedingly resistant to decay."

Mr. Geo. W. Tincher, of Topeka, Kan., furnishes the following information to the same point:

"During the year 1900 my attention was called to Some catalpa posts that had been in use for only four or five years, and were rotted off at the ground. The

owner was discouraged as to the lasting quality of the wood and thought a great mistake had been made in planting so many thousand in Kansas."

Samples of the rotted wood in question were sent to Washington, and the following extracts from two letters from Dr. B. T. Galloway, chief of the division of vegetable physiology and pathology, indicate in a general way the sources of decay of the wood, and point out the conditions under which even the most resistant woods yield to the attacks of soil fungi:

"The cause of the decay was a fungus working in the wood. This fungus, or fungi—for there may be two or three species present—is very abundant in the soil in Kansas and Nebraska, and soon causes the decay of wood in contact with it. The posts can be made to last longer if the part to be placed under ground is thoroughly charred on the surface and then soaked in hot tar. This, however, will only delay the work of the fungus. Of course, if the post has once begun to decay, this treatment will do very little good."

"These fungi gain entrance to the posts from the soil after they are set, and were probably not living in them before they were used. In many places in the states of the plains the soil is full of fungi of decay, especially in regions that are now, or formerly were, somewhat wooded, as, for example, near streams or in draws. You will probably find that trees grown in upland will be more suitable for posts than those grown in the lowlands, since they do not grow quite so fast and are more exposed, and so form harder wood. A very important point in cutting trees for posts is the time of year. The cutting should be done in the late summer, before the nitrogenous and sugary materials that fill the leaves have been withdrawn into the trunk and branches, preparatory to the shedding of the leaves. These sugary and nitrogenous substances are very favorable for the growth of fungi that may attack the posts, and will cause them to work much more quickly and destructively than if the wood were not filled with them. As you say, the catalpa is one of the most resistant woods to the various forms of decay, but even this wood decays under conditions favorable to fungi.

METHODS OF CATALPA CULTURE.

Seedlings.— Catalpa seed should be sown in the spring, in a seed-bed of finely pulverized soil, prepared as for garden purposes, and should be lightly covered, say to a depth of from one-half inch to one inch. It is advisable to sow at the rate of about twenty-five seeds to the foot, in shallow drill rows run about three feet apart, to permit horse cultivation. Grass and weeds must be rigorously kept down, and the rows cultivated with the hoe until the fourth or fifth leaf appears on the young seedlings, when the cultivator may be used for the remainder of the season. After the leaves have dropped in the fall, the trees, which should have reached a minimum height of from eighteen to twenty-four inches, should be dug, tied in bundles of about 100 trees each, and "heeled in" for the winter in dry, fine earth, closely packed, so as entirely to cover the bundles. Care must be taken that the location be such as not to permit the accumulation of standing water about the roots. In the North the time for setting out the yearling

trees should be in the spring, after the frost has left the ground. In the Gulf states, however, fall planting from the nursery row is possible.

THE PERMANENT PLANTATION.

The land for the permanent forest should have been under cultivation for at least one year. Prairie sod turned under early in the season, and allowed to remain until the following spring, will answer the purpose if put into a good state of cultivation. If land previously in cultivation be used, it should be thoroughly and deeply plowed the preceding fall, and well harrowed just before time for planting. The land is then marked off in one direction, with lines running the distance apart at which the trees are destined to stand in the row. In the opposite direction, and at right angles to these lines, dead furrows are run ten to twelve inches deep, as far apart as the rows are to stand in the plantation. At the points of intersection of the marked lines and furrows the trees are planted in the furrows, at a depth somewhat exceeding that at which they stood in the nursery rows. The planting may readily be carried on in the following manner: The bundles of young trees may be handled by one person, who sets them in place at the intersections, followed by a second who shovels the soil over the roots and presses it down. In this manner it is claimed that 2000 trees a day can be planted. The furrows should now be filled in with a plow.

Cultivation should be continued until about the last of August, to retain the soil moisture and keep down the weeds. Any weeds that appear after August will be caught by the frost before they go to seed. It must be remembered that a forest plantation requires in its early stages the same care and cultivation as a corn crop, and this care in the case of catalpa must extend over the first three or four years of the tree's life in the forest. During the first year, intermediate crops, such as corn, cow-peas, soy-beans, etc., may be grown between the rows, thus paying for the cost of cultivation. In the Yaggy plantation, at Hutchinson, Kan., two years after setting out in the permanent forest, the trees are cut down to the ground. From the stumps, exceedingly strong, vigorous and very straight sprouts spring up. Of these the best ones are permitted to grow. It is the experience there that trees thus treated form post timber quite as early as those which have not been cut back, and that they show, moreover, a distinct tendency to produce a smoother and straighter trunk. The question remains, however, whether the timber from such rapidly growing shoots will possess the lasting qualities of the more slowly grown wood.

The question as to the most profitable distance at which to set the

trees in a catalpa plantation must be regarded as unsettled. In the earlier plantations they were invariably set very close together, 4x4 feet being the usual distance. It was supposed that the dense growth, by causing the lower limbs to die and drop off, would force the concentration of the food materials into a straight bole.

The catalpa, however, differs from other forest-trees in that its dead limbs are not readily dropped, but are retained for an indefinite period, during which the growing trunk gradually encloses their bases, making knots, and affording to fungi points of access into the trunk.

In order to insure clean, smooth trunks, therefore, systematic pruning of the trees is necessary, and this should be begun when they are fix or six years old. Precise rules for pruning cannot be given, and much must be left to the common sense and experience of the operator. Inasmuch as the catalpa shows quite a distinct inclination to fork near the ground, care must be taken to check this tendency. At the first pruning, all limbs should be cut off up to within five or six feet of the ground, and the fallen branches should not be removed, since the smaller decaying twigs and leaves return to the soil a considerable amount of food material. The second pruning should take place at about the tenth year, when the trees should stand from seven to eight feet to the first limb. No more trimming is necessary until after the first crop of posts is cut. For low, young trees, an ordinary heavy corn-knife will be satisfactory as a pruning instrument. In all cases, the branches should be cut close to the trunk. Pruning may be carried on any time during the growing season. The disastrous results following lack of systematic pruning are illustrated in the forest at Farlington, Kan. In numberless cases the trees there have been allowed to retain all of their limbs, which have successively died as the trees have increased in height, and, not decaying and falling off, they now render the interior of the forest, in places, an almost impenetrable thicket (plates 10, 11, 12). The waste of wood material allowed to go into these lateral branches is something enormous in a great plantation.

The diagram (plate 40) of a four-year-old catalpa tree, whose roots and branches were carefully measured, will serve to illustrate the root space demanded by trees of this age. The roots average from eight to fifteen feet in lateral extension. The overcrowding of the soil in a plantation with four-year-old trees standing 4x4 feet can readily be imagined.

As throwing light on the distance at which to set catalpa trees in plantation, it will be interesting to review the opinions of Messrs. Geo. W. Tincher, of Topeka, Kan.; L. W. Yaggy, of Hutchinson, Kan., and

John P. Brown, of Connersville, Ind., three experienced and competent judges on the subject of catalpa planting. Mr. Tincher writes:

"The early advice given was that trees planted 4x4 feet (2700 to the acre) would, in from ten to twelve years, average one post to a tree. It is folly for any one to expect such results. One acre of ground will not sustain 1000 producing trees large enough for every one to make a post in ten years. So far as the 4x4 plan is concerned, I will say from personal experience, disappointment will surely come to any one expecting such favorable results. I have gradually reduced the number from 2700 to 1000 per acre. It may be that a few years hence I shall prefer to plant only 500. I will suggest the following plan for Kansas planters: Plant at the rate of 1000 trees per acre; have rows eight feet apart, setting the trees five feet apart in the row. . . . I have seen single rows of hardy catalpa growing perfectly straight when ten feet apart in the row. One acre of good ground may be expected to produce posts in ten years if planted on the above plan."

Mr. Yaggy writes (letter of February 28, 1902):

"You gave the tie dimensions as 6x8x8. I don't think that will be a satisfactory tie. If it would, the tree would have to be ten inches in diameter to cut that sized tie. My trees are barely more than half that diameter if they are that large, and they were planted twelve years ago. However, there have been 2000 trees to the acre, and trees cannot be planted and grown that thick for ties. If they were to be grown for ties, I think they would have to stand ten by ten feet, or about 500 to the acre; but in order to grow the trees straight enough to be most useful, they would have to be started probably not farther apart than I have planted mine, three feet ten inches by six feet, or five by five feet. If that is not done they will branch and fork too much. My idea is that if they were planted five by five and then thinned out at the right time so that each tree would have plenty of room, moisture, light, and air, standing in a deep sandy loam, with plenty of moisture underneath (but no standing surface-water), the trees could be grown ten inches in diameter in about twenty years. You will notice by the above that the increase in diameter in my trees was not quite one-half inch average per year. They are, however, planted almost as thick as corn-stalks, and they make up in height what they lack in diameter. . . . I plant my trees as one-year-old seedlings into a permanent plantation, three feet ten inches by six feet. I think, for similar conditions to mine, my method is most advantageous, the trees being nearly five by five, which insures straight growth. But in my method of planting you can plant a row of corn between the tree rows for the first two years, and the cultivation is thus cared for without any expense. It gives us better chance now to get our trees out through the six foot rows. In the places where I expect to grow large timber I have removed every second tree in the row, leaving them six feet by seven feet eight inches."

Mr. Brown writes (letter of March 1, 1902):

"Early planters invariably planted too closely. The catalpa is so rank a grower that the roots, in a few years, occupy all the space, rob each other, and invariably dwarf and stunt every tree if less than 8x8 feet (680 trees per acre). Every plantation which has been made with plants at less distance has proven a failure. Permanent trees should not be less than 16x16 feet, and all temporary plants set intermediate to give forest conditions should be removed within eight years. These are suitable for fence posts, etc."

It will be seen from the opinions quoted that a radical difference of views upon the subject exists among those competent to speak. The fundamental question is, Shall the plantation be made to develop a forest cover and a forest floor by close planting during the first five to eight years, or shall the trees be planted far enough apart to correspond to the arboreal conditions in a fruit orchard, where the openness of the tree cover necessitates continuous cultivation to repress the weeds?

By planting the rows eight feet apart, with trees standing five feet apart in the row, there would be 1079 trees to the acre. This seems to be about the highest possible limit for the initial planting. It appears reasonable that, with the trees set thus close in the row, the desired straightness of bole could be secured, while the eight feet of distance between the rows would allow considerable space for the development of an adequate root system, and would afford room for subsidiary crops during the first year or so. On the tenth year, by removing every other tree in the row, some 500 posts would be secured, and the plantation left with the trees standing 8x10 feet, with 544 trees to the acre. According to Mr. Yaggy's judgment, railroad ties could be grown profitably with the trees standing 10x10 feet apart, or 435 per acre, at the end of eight years. Mr. Brown thinks that the permanent plantation, at the end of eight years, should stand 16x16 feet, or 170 trees per acre. Perhaps this is the most desirable distance. The present tendency seems to be to plant at the rate of about 1000 trees per acre, reducing by thinning to about 500, in from the eighth to the twelfth year from planting. It is unfortunate that experience with different systems of planting, covering long periods of time, is not sufficiently extensive to enable a conclusive opinion to be rendered at present concerning the proper number of trees for the initial planting. It is safe to say, however, that more than 1000 trees per acre is not advisable. For upland planting fewer trees per acre should be set out than on bottom land with a water-table near the surface.

The rate of increase in diameter of catalpa trees varies altogether according to the soil, water-supply, and the distance at which trees stand in the forest. In the plantation of the University of Illinois, with trees eleven years old in the forest, and standing four by eight feet, the average increase in diameter in the interior of the plantation is five or six inches, an average of about one-half inch per year. This is the average rate of growth in the Yaggy plantation. There is no doubt that individual trees under favorable conditions, and with ample room, will increase in diameter an inch a year up to an age not determined. That this rate of increase can be maintained under forest con-

ditions seems improbable. Mr. Tincher writes in this connection concerning his own trees (February 24, 1902):

"On rich bottom land, 200 trees per acre can be made to average twelve inches in twelve years from planting, but the second twelve years would not average more than from one-third to one-half inch per year. Any one who has made a close study of tree growth will know this. I doubt very much if catalpa grown so quickly will make lasting timber for post, pole and tie purposes. I think trees grown slower will give better results. I prefer prairie soil for this one reason; the growth is slower, but when you sell a post it will give satisfaction. I have seen catalpa grown too quickly that would not last three years as a post.

"My best trees have only averaged a little over one-third inch per year since planting; still some of them will show a greater growth. It seems to me, if we could make the forest average about one-half inch per year, it would be the safer plan. At the same time, for lumber and inside work, trees grown faster would produce a beautiful grain and take a fine polish. It is possible to grow catalpa so every tree would average one inch per year. Some of them would make a greater growth. We have many trees in Topeka only nineteen years old from seed, that have been transplanted twice, that are twenty-two inches in diameter."

THINNING, HARVESTING, AND MARKETING.

The thinning process, begun at the eighth or tenth year by the removal of half the trees, is to be continued from year to year until there are about 150 to 225 trees left, which at the twenty-fifth year would be sufficient to occupy the ground. An interesting practice is being followed out at the Yaggy plantation, which is worthy of attention. That portion of the plantation which was set out in 1895 was removed from the land entire during the winter of 1900—'01, and the brush burned, after some of the stumps had been covered with sand to protect them. Last spring the stumps sprouted vigorously, those not covered remaining apparently uninjured, save that, the crowns being burned, the sprouts started from below. Besides being a cheap way for removing the brush, the advantage of burning the land over after cropping lies in the destruction of insects and parasitic fungi. If this can be done with no resultant injury to the roots of the trees, the practice is to be commended. The growth that sprouts from older roots will make is surprising. Three-year-old sprouts from five-year-old roots will often make timber of post size in four years. The age at which catalpa trees thus cut back will cease to sprout is undetermined.

Necessarily the entire cropping and burning off of the land is confined to plantations grown wholly for post timber; gradual thinning up to twenty-five years, being the practice where pole, tie and lumber stock is desired. Mr. Yaggy considers cropping for posts the more profitable at present, but has 100 acres on which large trees will be grown as an experiment. He writes: "I expect to treat most of my plantation in the above manner, as the returns will be quicker and

larger than by growing large trees; however, I am experimenting with about 100 acres in growing large timber. The greatest difficulty in doing this will be to kill out one-half or three-fourths of the trees, in order to give those remaining the field."

In general, the time for cutting catalpa trees for whatever purpose should be during the months of August or September, before the fall of the leaves and after the summer wood is well ripened. This will prevent the return to the trunk from the leaves of the soluble food materials which furnish nutriment for soil bacteria and other fungi. The wood should be well seasoned before sold. Timber cut during the early growing season and used immediately shows no special resistance to decay.

The cost of marketing is an important item, and this involves the question of the proper location of a catalpa plantation. Manifestly it should be near a railroad, or better, if possible, near several competing lines. Long hauls by wagon to the shipping station will materially cut down the profit, and should be avoided. If the plantation is primarily for producing post timber, it is wise to locate in a stock-raising district, since a ready local market for posts will always be found there. The cost of marketing varies. Mr. Tincher gives the cost of cutting, including the trimming of the remaining trees up to six or eight feet, at fifty cents per 100 posts, the sorting and cording of the posts not being included. Probably on a larger scale the expense would be less. Freight-cars will hold from 1800 to 2800 posts, depending on their size, and the freight-rate in Kansas for a distance of from thirty to sixty miles will average about one and one-half cents per post. At the present time no quotations exist for catalpa ties, poles or sawed lumber, because the timber is not on the market in sufficient quantity anywhere to cause a market price to be set. Posts six inches in diameter and seven feet long sell on an average of from ten to twelve and one-half cents apiece.

COST AND PROFIT OF CATALPA GROWING.

It is impossible to give data as to cost and profits in catalpa planting that will cover all cases, for the reason that in every plantation different factors of expense and profit enter in. Value of land, rapidity of growth of the trees, nearness to a shipping and marketing point, price of labor, etc., vary with the locality.

As good an example as any, and surely a reasonable one, is the Yaggy plantation. Those interested will find a very thorough discussion of the productive capacity and the profits of this plantation in 1900 in Bulletin 27 of the Division of Forestry, U. S. Department of Agriculture, entitled, "Practical Tree-planting in Operation," by J.

W. Toumey, pages 21 to 24. The table summarizing the cost of growing and marketing the crops is reproduced here.

From careful measurement of typical areas in the plantation, it was calculated that the gross value of the timber crop produced in ten years was, in January, 1900, $267.15 per acre. Following is an estimate of the cost and profit of the plantation per acre (pp. 23, 24).

"Counting the rent of this land at two dollars per acre, the expenses of growing the crop and marketing the product at the present time are therefore to be summarized for one acre as follows:

Rent of land ten years, at $2	$20 00
Cost of raising plants from seed	3 60
Cost of planting	3 20
Cost of cultivation, first year	1 20
Cutting back and sprouting	2 50
Cost of cultivation, third year	1 20
Cost of marketing crop	20 00
Total	$51 70

"Deducting $51.70, the total cost of growing and marketing the timber grown on one acre, from $267.15, which is the gross value of the product in hand, there remains a net value of $215.45 per acre, or, including the interest on the investment, an annual profit of $21.54. Allowing six per cent. compound interest on the expenditures, from the time incurred until the expiration of the ten years, the total expense per acre was as follows:

Year.	Amount expended.	Amount six per cent. compound interest.
First	$10 00	$17 91
Second	4 50	7 60
Third	3 20	5 10
Fourth	2 00	3 00
Fifth	2 00	2 84
Sixth	2 00	2 68
Seventh	2 00	2 52
Eighth	2 00	2 38
Ninth	2 00	2 25
Tenth	22 00	23 32
Total	$51 70	$69 60

"Deducting $69.60 from $267.17, the gross value, we have a net profit of $197.55 per acre.

"These results show the value of an acre at the present time, when the trees are but ten years old. It would be very unwise to remove all the trees at this time. If only a portion of the trees are marketed each year for the next ten years, and the trees cut out are distributed so as to give more sunlight to those that remain, the net profit per acre will be very much increased."

Mr. Yaggy writes (letter of February 28, 1902) as follows:

"In reference to the present producing value of my plantation, probably the greatest returns, for the present, at least, would be to cut the entire field off and sell the posts. There are now 2000 trees to the acre, and the trees will average two posts apiece, making about 4000 posts to the acre, that can be sold at an average of ten cents apiece. The stay posts and fire-wood will about pay for the

marketing, so that, with careful management, $400 per acre can be realized at present by taking off everything. On this basis, the plantation would yield an income of fifty dollars per acre per year. I expect to treat most of my plantations in the above manner, as the returns will be quicker and larger than by growing large trees."

It is the opinion of both Mr. Yaggy and Mr. Tincher that, by the time a catalpa tree reaches a size large enough to make railroad ties, it will be too valuable for lumber, or for telephone or telegraph poles, for it to be profitably cut up into ties. That, however, is a matter that cannot accurately be forecasted.

CATALPA FOR TIE TIMBER.

The question of obtaining a suitable tie timber is becoming a most vital one to the American railroad companies. This is sufficiently indicated in the report of the committee on ties of the American Railway Engineering and Maintenance-of-Way Association, issued March, 1901, as follows:

"Up to the present time each railroad company has found it best and most economical to use in its tracks cross-ties made from those timbers which are nearest to its territory and therefore the most available and economical. The value of these woods is consequently pretty well known to the adjacent railroad companies at the present time. For instance, it is well to the companies operating in the Eastern, Middle and some of the Western states that a life of eight and nine years is obtained in main tracks for white oak ties, and that they are the best ties which they can obtain. The Canadian roads are restricted to the use of cedar and hemlock for the most part, the Southern roads to yellow pine, and the Western roads to mountain pine and redwood.

"The Eastern and Middle states roads are now finding that they are compelled to go farther each year to secure the valuable white oak ties, and that at the same time the price is steadily increasing, indicating a growing scarcity of the supply. They will, therefore, make inroads on the timbers considered less valuable for cross-ties, such as yellow pine, hemlock, cedar, tamarack, mountain pine, and redwood, which additional consumption reduces the available supply for roads now using these timbers, and hence the tie question is becoming of importance to all the consumers.

"A great deal of attention to the forestry of the tie question has been given in Europe, and as practice in Europe is very often the forerunner of what will ultimately be done in this country, the government division of forestry is already doing valuable missionary work in that line.

"The subject of metal ties has received so little attention in this country, and the cost as compared with wooden ties is so great, that this does not appear at present to be a live question."

According to the "Statistical Abstract of the United States" for 1899, page 380, there were in operation in the United States in 1899 191,310 miles of railway.

Taking from the report above quoted statistics furnished by thirty-six representative lines, having a total trackage of 43,458 miles, the

average number of ties per mile is shown to vary from 2689 to 3148, with a general average of 2800. This would make a total of 535,668,000 ties in track in the United States in 1899. The percentage of the ties renewed each year varies considerably with the tie used, the amount of the local rainfall, and the summer temperature, since the growth of the timber-destroying fungi is most rapid in warm, humid climates. With white-oak ties, by far the most desirable in general use hitherto, the annual renewals in the north central states will average about 280 to the mile, or about ten per cent. of the total in track.

For example: The Vandalia line, operating through central and southern Illinois and Indiana, had 2,362,700 ties, all of white oak, in its 833.16 miles of track on June 30, 1900, an average of 1840 ties per mile. Of these, 237,157, or ten per cent. of the total, were removed in that year.

The Wabash railroad (Detroit division), operating 348 miles of road (sidings included), had in track June 30, 1900, 1,040,000 ties, of which all but 20,000 were white oak. Of these, 107,064, all of oak, were renewed during the year ending on the above date, making the per cent. of renewals during the year to the total of ties in track 10.3. As this is a main line from Detroit to Chicago, with a gross tonnage of 5,771,000 of rolling-stock passing over the track, and since the climatic conditions of the region through which the road runs are typical for a large area in the North Central states where a very heavy railroad business is done, the figure of ten per cent. may be considered a safe estimate of the number of white oak ties unfit for use on main lines and calling for removal each year, in roads operating west of the Alleghanies, east of the Mississippi, and north of the Ohio river.

The Kansas City, Fort Scott & Memphis railroad, operating through eastern Kansas, southeastern Missouri, northeastern Arkansas, and Mississippi, into northwestern Alabama, operating 1278 miles of road, laid with 4,623,044 ties, all of white oak, is reported as having renewed 527,337 in the year ending June 30, 1900. This slightly higher average of thirteen per cent. is what would naturally be expected, when the greater annual rainfall and the higher mean annual temperature of the greater portion of the region traversed are taken into consideration.

On the other hand, the Santa Fe, Prescott & Phoenix railroad, operating 145.17 miles, through the elevated arid region of northern Arizona, with 678,000 ties in track, all of pine—naturally in humid regions a very perishable wood—renewed only 63,734 ties—eight per cent.—bringing the pine for this road up to the standard of oak as a tie timber, on account of the exceedingly dry local climate, in which

the growth and multiplication of the fungus enemies of wood is very little favored.

With the Missouri, Kansas & Texas railway, operating 190,291 miles of road, through eastern Kansas, central Missouri, the Indian Territory, and eastern Texas, the percentage of renewals was ten per cent., the kind of tie used not being mentioned.

Taking a region fairly typical of a great portion of the Northwest, and the very unusual case of a road laid exclusively with red cedar—the James river division of the Chicago, Milwaukee & St. Paul railroad, with a track of 339 miles, the percentage of removals was as low as 5.5 in the year mentioned.

The life of a railroad tie varies, as has been said, with the kind of timber used, and for each kind with the climatic conditions of the region in which it is laid. In this regard the life of the tie depends, of course, upon exactly the same conditions as affect the decay of other timber, with this exception, that tie timber being laid upon a better-drained substratum than the adjacent country usually affords, the agencies of decay are relatively less active. This must be markedly the case where railroads use, as is generally the case to-day on main lines of important roads, rock or burnt clay "gravel" as ballast.

Taking the country as a whole, the life of ties in track, where the wood has not been treated chemically, is shown to be about four years for pine, eight to ten for white oak, and eleven for redwood. From the statistics of the thirty-six roads above referred to, the general average of the percentages of ties annually removed to the total in track is nine per cent. From this it would appear that the number of new ties put in track in 1900 amounted in round numbers to 48,000,000, worth, at forty cents apiece, $19,200,000, and there is good reason to believe that this estimate is too conservative. The annual mileage increase in the United States is subject to considerable fluctuation, depending upon variations in the business situation which appear from year to year in the different parts of the country. The average increase for the decade preceding 1899 was 3500 miles per annum. According to this, the trackage in the United States in 1909 will have increased 35,000 miles, calling for 98,000,000 new ties, or 9,800,000 a year. What will these ties cost, and where will they come from?

Following is a table taken from page 7 of the report previously quoted, and giving the cost of untreated cross-ties to thirteen important lines of railway.

COST OF UNTREATED CROSS-TIES.

Name of road.	Size of tie.	Kind of wood.	Distance hauled to local distributing point.	Per cent. of second-class ties used.....	Cost delivered at side of track....	Cost per tie for loading on cars.	Cost per tie for 100 miles hauled.....	Cost for local distribution....	Cost for putting in track ordinary renewals..	Total cost per tie in track.....	
			miles.		*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	*cts.*	
S. P. Ry.....	7 in. x 8 in. x 8 ft.....	Redwood.....	225	40	.38¼	.01	.01	.00½	.10½	.52½	All obtained locally.
M. C. R. R	6 in. x 10 in. x 8 ft.....	Oak	50	13	.45	.01½	.04¾	.01	.10	.60	
"	6 in. x 10 in. x 8 ft.....	Cedar	50	13	.40	.01½	.02½	.01	.10	.53¾	
Wabash R. R.....	6 in. x 8 in. x 8 ft.....	Oak	46	11	.40	.01½	.05	.01	.10	.55	
N. Y. C. & H. R. R. R...	6 in. x 9 in. x 8 ft.....	Y. pine.....	150	10	.59	.01½	.04	.01	.10	.77½	
P. & R. R. R.....	7 in. x 7 in. x 8½ ft.....	Y. pine.....	.....	20	.65	.01½	.....	.....	.15	.81½	
"	7 in. x 7 in. x 8½ ft.....	Chestnut.....	.....	20	.45	.01½	.....	.....	.15	.61½	
L. & N. R. R.....	7 in. x 9 in. x 8½ ft.....	Oak	.....	.....	.45	.01½	.....	.01	.10	.57½	
"	7 in. x 9 in. x 8½ ft.....	Y. pine.....	.....	.....	.23	.01½	.....	.01	.10	.35½	
B. & A. R. R.....	7 in. x 7 in. x 8 ft.....	Y. pine and chest..	100	52	.55	.01	.06	.01	.14	.77	
D. & R. G. R. R	7 in. x 7 in. x 8 ft.....	Red spruce.....	100	5	.33	.01	.00½	.01	.01½	.37	
Mo. Pac. Ry.....	6 in. x 8 in. x 8 ft.....	Oak	8	.....	.32	.01½	.05	.00½	.06½	.40½	
L. S. & M. S. Ry.....	7 in. x 10 in. x 8½ ft.....	Oak	125	.....	.58	.....	.03⅓	.01	.11½	.74$\frac{7}{6}$	
P. F. W. & C. Ry.....	7 in. x 8 in. x 8½ ft.....	Oak	175	25	.55	.....	.....	.01½	.15	.71½	
C. P. Ry.....	6½ in. x 8 in. x 8 ft.....	Cedar	50	10	.23	.01	.04	.02	.09	.37	
U. P. Ry.....	7 in. x 7 in. x 8 ft.....	Fir	300	1	.50	.....	.01⅓	.01½	.10	.65½	
"	6 in. x 8 in. x 8 ft.....	Oak	230	3	.56	.....	.017	.01½	.10	.71½	
"	8 in. x 8 in. x 8 ft.....	Wyo. pine.....	200	5	.40	.....	.02¼	.02	.11	.57½	
"	7 in. x 8 in. x 8 ft.....	Cedar	250	5	.56	.....	.016	.01½	.10	.71½	

From this it is apparent that there is a considerable range of variation in the cost of ties in track. While the yellow-pine ties cost the Louisville & Nashville road only 35 cents in track, the same kind of ties cost the Philadelphia & Reading 81½ cents apiece. The difference is seen to be due almost entirely to the primary cost of the ties delivered at the distributing points—23 and 65 cents, respectively; the cost of distributing and laying being nearly the same in both cases. From the same table it will be seen that oak ties vary from 32 to 56 cents delivered, or from 40½ to 71½ cents in track. In view of the disappearance of the white oak as a source of supply, the question of substitutes becomes a vital one. It has been found that the life of ties has been greatly lengthened by injection with various chemicals.

On page 5 of the report previously quoted, the subject of the preservation of ties by chemical processes is discussed.

"Creosoting is the standard mode of tie preservation in England. It is much the best, but it is expensive. It costs there from twenty-five to sixty-five cents a tie, in accordance with the quantity injected, and would cost still more in this country, giving a life of from fifteen to twenty-seven years in the track. American roads can hardly afford to apply this process to ties, costing, untreated, about one-third as much as the European ties, but may be contented with inferior processes. These are chiefly 'burnettizing' and 'zinc-tannin,' giving a life of from ten to fifteen years; but there may be advantages to the 'zinc-creosote' process, worked in Germany since 1874, which there costs 19.2 to 20.4 for each first-class tie, and it is said to give them a life of from twelve to eighteen years.

"It is to be expected that, having made much the same class of mistakes as the Europeans did in the beginning, *i. e.*, imperfect work, for lack of knowledge, we shall now gradually improve our practice and obtain better work than we have done. There is nevertheless a marked economy obtained by the pioneer roads. Let us take the Southern Pacific as an example. The untreated pine costs about fifty cents each when laid in their track in their natural state, and last four years. This produces a charge of twelve and one-half cents per year per tie; while if, when treated, they cost, say, sixty-six cents each when laid in the track, and last at least 8.25 years, they produce an annual economy of eight cents per tie. The economy will vary on different roads; on some there will be none at all. Some railways are able to obtain white oak ties costing forty-eight cents each in the track, and lasting eight years, or six cents a year per tie; while others obtain cedar, cypress, or redwood, to cost, say, sixty-six cents each when laid, and lasting eleven years, thus again producing an annual charge of six cents per tie; but on many roads the durable woods are so far exhausted that they must resort to the inferior woods and treat them chemically to prolong their life. Each railway must consider the problem for itself, and the present report can only report general facts. The annual tie renewals vary greatly on different lines. Data recently compiled by the Texas Association of Superintendents of Railways show that the ties replaced on an average for nine years in that state run all the way from 160 a year per mile for cypress, thus indicating a life of sixteen years, on a line 6.7 miles long, to 555 a year for oak, or a life of about five years, on a line 192 miles long. The latter road pays twenty-five cents apiece at the distributing

points, the ties thus costing about forty-five cents each in the track, and it could probably afford to have them treated if it were assured as to the best process to use under its circumstances. We may now expect, during the next few years, to have a number of new processes brought forward, but it will take a long time to determine their efficiency."

To sum up the present situation in the United States in respect to railroad ties, the best class of timber for ties hitherto available, the white oak, is nearing exhaustion. The substitution of steel ties seems out of the question from a practical standpoint. Two alternatives present themselves.

It is possible to utilize cheap woods which, in a natural state, rapidly decay, by injecting them with chemical preservatives, or to grow forest plantations of long-lived woods adjacent to the lines of road. In the arid regions of the Southwest it may be possible (until the supply gives out) to use soft woods to advantage without preservatives, as in the case of the Santa Fe, Prescott & Phœnix railroad, in Arizona. In states which border on the lower Mississippi river and its southern tributaries, the cypress, a long-lived timber, may furnish a supply of ties for some time to come. Indeed, if railroad companies were to acquire title to cypress forest land, and manage it on scientific forestry principles, there is no question but that this timber would form a valuable source of supply to many lines of railroad for an indefinite time in the future. But with the present prevalent custom of railroads to buy their timber from lands not owned by them, and with the reckless exploitation of timber resources now generally going on, it will be merely a question of a few years when a "tie famine" will face American railway systems. Even the "soft woods" available from native forests form a comparatively limited source of supply. When these woods are used, there is to be added to the cost of delivery at the railway line the cost of shipment to the injecting works, the cost of injection itself, and of reshipment to the distributing points. This will bring their cost, in many cases, above that of white oak. By the best processes of chemical treatment now used in America and found financially practicable, the length of life of the soft-wood ties may be brought up to from eight to fifteen years, or to about the normal life of untreated white oak.

Nevertheless, even with this expedient, the question of a tie famine is only postponed, not disposed of. In fact, the whole problem of obtaining railroad ties is essentially a local one for each railroad. The greatest economy lies in having tie timber growing as close as possible to the track of the railway itself. While the temporary existence of supplies of various kinds of more or less desirable timber contiguous to their routes is enabling some lines of railway to get

cheap ties at the present time, this is not the case for the majority of American roads, and particularly for those of the Eastern states and the upper Mississippi basin, where the greatest mileage and heaviest railroad business is found.

There seems to be no more satisfactory outlet to the difficulty than for the railways to raise their own ties in forest plantations adjacent to their rights of way.

For this purpose *Catalpa speciosa* possesses more and greater advantages than any other indigenous tree. It is readily grown over a wide range of territory and on a great variety of soils. The living tree has no known fungus enemies, and is subject to the attack of but one species of insect. The growth of the tree is rapid and its productiveness from the timber standpoint high, in consequence. Its relatively extremely small amount of bark and sap-wood is another highly advantageous feature which enhances its timber value.

Concerning the practical worth of catalpa wood for tie timber, as determined by actual experience, some data fortunately exist. A pamphlet now comparatively rare, to which reference has already been made in this bulletin, entitled "Additional Facts and Information in Relation to the Catalpa Tree, *Catalpa bignonioides*, and its Variety, *speciosa,*" by E. E. Barney, a railroad-car builder, of Dayton, Ohio, appeared in 1879. On page 9, under the caption, "Will catalpa make a serviceable railroad tie?" Mr. Barney says:

"This is a matter of conjecture in part. I think it will, for the following reasons: Its durability is unquestionable; it is very elastic; and, contrary to what most suppose, it is very tough. I subjected pieces one inch square to a breaking pressure—twelve inches between supports.

Catalpa broke under a pressure of			703	pounds.	
Ash	"	"	" 800	"	
Oak	"	"	" 709	"	
Oak	"	"	" 577	"	Mean, 809 pounds.
Oak	"	"	" 1141	"	

The catalpa deflected three times as much as the ash or oak before breaking.

"Five thousand pounds pressure on blocks one inch square by three inches long compressed:

Oak	10–16 inch.	Norway pine	6–16 inch.
"	10–16 "	White walnut	5–16 "
"	8–16 "	Yellow pine	6–16 "
Catalpa	7–16 "	Black walnut	10–16 "
"	9–16 "	" "	8–16 "
"	7–16 "	Ash	14–16 "
White pine	5–16 "	"	6–16 "

"These samples were taken at random, and would indicate that catalpa will bear the pressure to which it is subjected when used as railroad-ties. Two catalpa railroad-ties were placed in the track near our office, five years ago, and twelve one year ago. All hold their spikes well and show no signs of mashing more than oak on each side of them, and over both of which heavily loaded trains pass almost hourly. The road-master, who has watched them with interest, says he has had no better ties on the line of his road.

"Mr. D. Axtell, superintendent of the Missouri division of the Iron Mountain railroad, writes that the catalpa ties placed in the track of his road ten years ago are perfectly sound; that the rail had worn into some of them from one-half to an inch, and it has been repeatedly proven that the catalpa is far superior, for ties, to white oak or any other kind of timber grown in that latitude."

On page 30 of the same pamphlet appears a letter from Mr. Axtell, as follows:

CHARLESTON, MO., February 22, 1879.

E. E. Barney: DEAR SIR—There is nothing to indicate that the catalpa ties in our track near Charleston, Mo., do not hold spikes sufficiently well. Nearly all the spikes are in the same holes originally made when driving them, over ten years ago. There has been no spreading in the track. I have examined the few ties the rails have settled into, and find none that will not last a number of years by turning them over. These ties are from six to eight inches face. If they were wider, as you suggest, there would be more resistance to crushing. With the joint fastenings now in use, I see no objection to making ties, as you propose, from logs twelve inches or more in diameter, by sawing them through the middle, and placing the round side down. The bearing surface would thus be increased 50 to 100 per cent.

A further communication from the same person, quoted on page 1, is as follows:

"In regard to the durability of catalpa it is useless to multiply words. Fence-posts twenty years in the ground are always as sound as when first put in, and no decayed catalpa logs are ever found in the swamps. A section of catalpa log known to have lain on the ground in the swamps fifty years is now in the office of the land department of the road, in St. Louis, and is as sound as it ever was."

Dr. John A. Warder, of Dayton, Ohio, president in 1881 of the American Forestry Association, and vice-president of the American Agricultural Association, and whose name Englemann has linked with the species name of the hardy catalpa, published in the *JournaI* of the latter society, in 1881, pages 79 to 102, a memoir entitled "The Relations of Forestry to Agriculture. The Western Catalpa Tree." On page 98 Warder says:

"On the St. Louis & Iron Mountain railroad, near Charleston, Mo., there is a portion of the track laid eleven years ago on catalpa sleepers which is yet sound, while many of the oak fence-posts enclosing the road, though planted since it was built, have needed to be replaced. The oak ties last scarcely five years on the same soil and exposure. Mr. David Axtell, the intelligent engineer in charge of this part of the road, reports that catalpa holds the spikes well enough, and that when the ties become mashed they are no longer rejected, but simply turned over, so as to present a new bearing. Some that have been thrown out by trackmen have been used as fence-posts, and bid fair to last many years."

Mr. John P. Brown, C. E., of Connersville, Ind., secretary of the

International Society for Arboriculture, says, in bulletin 1 of the society (1901), entitled "The *Catalpa speciosa,*" page 7:

"Several catalpa cross-ties were placed in the C. C. C. & St. L. railroad, Cairo division, in 1879, one of which was taken out last summer (1899), having been in constant use for twenty years. Mr. J. W. Cowper, engineer maintenance of way, officially reports of this tie as follows: 'This catalpa tie, taken out of the track three miles north of Harrisburg, was put in in 1878, in mud ballast. The wood is perfectly solid, showing very little sign of decay. . . . With tie-plates and good ballast, those ties would, I think, without doubt, last fully thirty to thirty-five years.' "

In order to elicit further information relative to the more recent use of the catalpa for ties, letters of inquiry were sent to the chief engineers of 139 lines of railways in the United States, Canada, and Mexico. Answers have been received from 108, of whom ninety-five report no knowledge of or experience with catalpa ties. Many of these letters, however, express interest in the matter and manifest a desire for information.

A number, bearing more or less directly upon the investigation, are quoted in whole or in part. The italics are inserted.

ILLINOIS CENTRAL RAILROAD COMPANY,
CHICAGO, February 6, 1902.

In reply to your letter of January 29, will state that while it would give me pleasure to give you any information in my power concerning the practical results obtained in the use of catalpa cross-ties I am unable to do so, as there are no records of any having been used by this company. I will state, however, that *this company is taking a great deal of interest in the cultivation of Catalpa speciosa, and arrangements are just being made for putting in a plantation of 160 acres, with a view of experimenting with the same.*

Yours very truly, W. L. HARAHAN, Chief Engineer.

THE DULUTH & IRON RANGE RAILROAD COMPANY,
DULUTH, MINN., February 3, 1902.

I beg to acknowledge receipt of your letter of January 30, requesting information about my experience with catalpa railroad-ties. I regret to say that it has never been my good fortune to come in contact with catalpa ties, as, with the exception of two years spent in western Indiana, I have been pioneering in the Northwest since 1871. I am aware that, especially in the Southwestern states and territories, catalpa has been used quite extensively for ties, with very satisfactory results, so much so that some of the roads have gone to the expense of starting nurseries for producing their own tie timber in the future. *I hope the culture of this tree may prove a success, because I can see the time approaching very fast when our supply of native cedar, tamarack and pine will be exhausted, just the same as happened with the oak, and ultimately the choice will be a wooden tie carried a long distance, possibly clear across the North American continent, at great expense, and the metallic tie.* Thanking you for the courtesy, I am, very truly yours, R. ANGST, Chief Engineer.

ST. LOUIS & SAN FRANCISCO RAILROAD COMPANY,
ST. LOUIS, MO., February 14, 1902.

Answering yours of 8th inst. in reference to catalpa as an economic tree, I will give you such experience as I have had myself and through others on this specimen of the forest. I cannot believe that the catalpa ties would successfully resist the crushing strains under ordinary railway traffic, unless used with a tie-plate; the wood is not heavy, nor dense, nor sufficiently strong, we think, to withstand the constant pounding of our heavy-loaded trains on the rail. This timber will hold spikes as well as oak, or any other timber now in use for ties. *If used with a tie plate, as stated above, I believe the catalpa tie of standard size (6x8x8) would last not less than fifteen years, and perhaps longer.* The few experiments made with this timber that can be authenticated have not yet shown the full life of the catalpa tie. We have on several occasions attempted to trace experiments in this direction, and have always been led to a standstill, for the reason that we could not find that a systematic test had been made. A number of years ago we had a few of these catalpa ties brought up from southern Illinois, and they were used as an experiment in the Springfield yards, at Springfield, MO., on the old K. C. & M. railroad. They were laid in a wet place, under constant switching traffic. *These few ties did not decay, but were pounded to pieces, as there were no tie-plates used in connection with them. The road-bed at that time was not in first-class shape, so that the test was made under the worst possible conditions, and, of course failed. . . .*

Very truly yours, H. P. JACQUES,
Purchasing and Timber Agent.

COLORADO & SOUTHERN RAILWAY COMPANY. ("Colorado Road.")
DENVER, COLO., January 31, 1902.

I beg to acknowledge the receipt of yours of the 29th, relative to use of catalpa for ties. I have had no experience whatever with this timber, and should be pleased to see your bulletin, when issued, as it is a subject in which I am interested. *We may possibly set out some catalpa trees in Colorado and try the experiment of growing them.* Yours, H. W. COWAN, Chief Engineer.

THE WABASH RAILROAD COMPANY,
ST. LOUIS, MO., February 19, 1902.

I have your letter of February 17. We have no catalpa ties on the road, so far as I am advised, *but I desire to say that while they will probably not hold spikes as well as white oak ties, this would not be an especially objectionable feature. The matter of ties holding spikes is of comparatively small moment in these days, in view of the fact that railroad-tracks are kept in better line and surface than they were in former years, better ballast being used and tracks being maintained in altogether better condition in every way. There is little difficulty with spikes drawing out of the ties, no matter what sort of timber is used. With the present heavy traffic there is scarcely any tie that will prevent the rail from cutting in. This is prevented, however, by the use of tie-plates,* and the plates are coming into use very rapidly for the purpose of preventing the cutting away of the tie by the rail. *I am inclined to the opinion that catalpa ties will do as well as anything we have, and perhaps be more durable than the timber in common use.* I shall be pleased to give you any further information I possibly can.

Yours truly, W. S. LINCOLN, Chief Engineer.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RAILWAY COMPANY.
(Big Four Route.)

CINCINNATI, OHIO, January 28, 1902.

Referring to yours of January 15, in regard to catalpa. *We have some catalpa ties in our track that have been in a large number of years, some of them fifteen and twenty years. They are apparently sound as to condition of timber, but are pretty badly cut by the rails. I believe, however, that by using tie-plates under the rail the catalpa will make an excellent tie. If they will last twenty years it will be economical to furnish tie-plates for use with them.* Yours truly, GEO. W. KITTREDGE, Chief Engineer.

ST. LOUIS SOUTHWESTERN RAILWAY COMPANY.
ST. LOUIS SOUTHWESTERN RAILWAY COMPANY OF TEXAS. (Cotton-belt Route.)

TYLER, TEX., January 31, 1902.

In replying to your favor of the 27th inst., I beg to advise that I have had no experience with the catalpa as a tie timber. *We use it on this road, however, for fence-posts and find it very satisfactory, and consider the life of it at about twenty years. There is no doubt but it would make a very lasting track tie, but had better probably be used in connection with metal tie-plates.* It may be at a disadvantage at holding the spikes on sharp curves, but would, in my opinion, make an excellent tie on straight track. . . .

Yours very truly, M. L. LYNCH, Chief Engineer.

EVANSVILLE & TERRE HAUTE RAILWAY COMPANY,
EVANSVILLE, IND., January 15, 1902.

Replying to your favor of the 21st inst., in regard to catalpa timber, we are not using this class of timber for ties; *we are using it, however, for fence-posts, and can* say *that we have used the same for the last fifteen years. We find it very desirable timber for this purpose,* but it is scarce in our part of the country and at the present time very hard to obtain. E. H. PFAFFLIN,
Acting Superintendent and Chief Engineer.

HOUSTON & TEXAS CENTRAL RAILROAD COMPANY,
HOUSTON, TEX., February 5, 1902.

In reply to your favor of January 29, ult.: We have had no experience with catalpa for tie or post timber, but would think that it would do well. The soft woods, such as cypress, cedar, and pine, give splendid results when "tie-plated" so as to prevent the crushing of the fiber by the rail. Cypress is largely used by our company for ties, and seems to be particularly adapted to our moist climate in resisting decay. Yours, J. M. LEE, Chief Engineer.

THE TEXAS & PACIFIC RAILWAY COMPANY,
DALLAS, TEX., February 14, 1902.

I have yours of the 12th inst. We have never used any catalpa ties. *I know something of the value of catalpa as posts. I know where posts of this wood have been in use as much as thirty years, down in Louisiana, which is as hard a climate on timber as any in the United States.*

From my knowledge, I would say that it holds the spike very well, and, while it is soft, yet the almost universal use of tie-plates now overcomes the objection of the softness of the wood. For this reason, I can see no reason why its use should not be entirely satisfactory.

Yours truly, B. S. WATHEN, Chief Engineer.

SOUTHERN MISSOURI & ARKANSAS RAILROAD COMPANY,
CAPE GIRARDEAU, MO., February 3, 1902.

Yours of the 27th: I am sorry to say that I have had no practical experience with catalpa ties. *I have no doubt, however, from my general information obtained from parties who have used it, that it would be a most excellent tie timber. I have no doubt that the day will come when we will have* to *cultivate timber for our ties, or else pay four times as much as we do now, putting in steel ties.* Yours very truly, S. V. COOMBS, Chief Engineer.

CHICAGO & EASTERN ILLINOIS RAILROAD COMPANY,
CHICAGO, January 24, 1902.

Yours of January 21 in regard to the use of catalpa ties: I have had absolutely no experience, and know practically nothing about this wood. This company does use large numbers of white cedar ties, which, in my judgment, are softer and less able to hold spikes than the catalpa. Of course, if used on curves at all, tie-plates must be used with them. Yours truly,
M. S. DAWLEY, Chief Engineer.

THE FORT WORTH & DENVER CITY RAILWAY COMPANY,
FORT WORTH, TEX., March 12, 1902.

Your favor of the 15th duly received and noted, and in reply will say that I am unable to find that any catalpa ties have ever been used on any of our track; but *from what I have learned of the qualities of Catalpa speciosa, it seems to me to be excellently adapted to use for ties, etc.*

Yours very truly, E. F. VINCENT, Resident Engineer.

ERIE RAILROAD COMPANY— OFFICE OF THE PRESIDENT,
NEW YORK, March 17, 1902.

I find a number of hardy catalpa ties were placed in this track about twenty-five years ago, and some of them remained in service twenty years. Further than that I am unable to obtain any definite information. *It would appear, however, that this timber resists decay longer than any of the several kinds of wood which we are using for ties at the present time.* Concerning its ability to wear under heavy loads, I am unable to say, as the service in that direction was much less severe twenty years ago than it is to-day.

Yours truly, D. HILLARD, Assistant to President.

RIO GRANDE WESTERN RAILROAD COMPANY,
SALT LAKE CITY, UTAH, February 18, 1902.

Yours of February 12: We have not yet had sufficient experience with the catalpa tree to furnish you with any reliable data, as we only had them planted last spring. We have a nursery of some 60,000 trees, which have grown very rapidly, and these will have to be set out this spring along the line of the road. The young trees are planted in rows, and in good black loam, were carefully taken care of, and raised under irrigation. They were planted, if I remember correctly, in the month of April, and made a strong, healthy growth of from six to eight feet during the year. After the transplanting takes place in the spring, we will be able to tell you more about it.

Yours truly, A. E. WELBY, General Superintendent.

(For photograph of catalpa nursery above referred to, see plate 9.)

SOUTHERN INDIANA RAILWAY COMPANY,
BEDFORD, IND., January 31, 1902.

Referring to your letter of the 21st instant in regard to the use of catalpa cross-ties, in reply will say that we have never used any ties made of this timber on this line, and I know nothing about them from actual experience. I would, however, make the suggestion that they could be used in connection with some form of tie-plate, the same as cedar and hemlock ties.

Yours truly, F. W. RANNO, Engineer Maintenance of Way.

CHICAGO & NORTHWESTERN RAILWAY COMPANY.
CHICAGO, January 31, 1902.

Answering your inquiry of January 22, will advise that this company has never made use of any catalpa ties, and therefore I have no information to give as to its value for that particular purpose. *I hope that you may be able to develop something in that line, as the necessity for a good material in ties is becoming very urgent.* Yours, EDWD. C. CARTER, Chief Engineer.

MICHIGAN CENTRAL RAILROAD COMPANY,
DETROIT, MICH., February 21, 1902.

Referring to your letter of February 1, ult., I am very much interested in the culture of the *Catalpa speciosa,* and have some 25,000 or 30,000 plants at various points which I trust will find soil and climatic conditions such that they will develop with a fair degree of rapidity. *The only catalpa tie in our system that I know anything about was a tie put in about 1885. It was not a particularly good sample when it was put in, but, so far as I am able to discern, it is about as good as it ever was.* Doubtless the wood is too soft to be used without tie-plates, when the ties are laid consecutively, but as we have oak ties on either side of this catalpa, and as an eighty pound rail, five inches at the base, has been used on this tie for pretty near its entire term of service, *I do not find that it has cut much or that its holding power of spike has diminished any, and I have the utmost faith that, if the catalpa can be grown in a variety of climatic and soil conditions, the culture of it will be a feature of very great importance to railroads.* My plantations are altogether too young to form any forecast. From previous culture we have given that particular type of tree, for shade purposes, it seems to bear out the claim that the forestry commissions have made, that it will increase its diameter pretty nearly an inch a year up to some growth, the magnitude of which I am uncertain. I have endeavored on our system to establish plantations where the climatic conditions will be somewhat dissimilar, and where the soil conditions will be entirely so.

Yours truly, A. TORREY, Chief Engineer.

From the letters quoted, it is evident that there is no objection to the use of a soft wood as tie timber, provided it will not readily decay, and provided tie-plates are used to prevent the rail from cutting into the face of the tie. It is furthermore evident from the letters received from the chief engineers of the St. Louis & San Francisco, the "Big Four," the "Cotton Belt," the Evansville & Terre Haute, the Texas & Pacific and the Michigan Central railway companies that catalpa wood, in their experience, has actually lasted, either as tie or post timber, for from fifteen to twenty years, or more, without chem-

ical treatment, and that there seems to be a distinct economy in using it for tie timber in connection with tie-plates. The committee on ties say in their report (page 12):

"Tie-plates have now become a well-established article of manufacture. Those principally in use consist of flat-rolled steel, with ribs and surfaces of various forms. Their utility for saving soft ties is so well established that it seems superfluous to report in favor of their use."

The suggestion has been made that railways might utilize the vacant space along their rights of way by planting catalpa trees, to be subsequently used for posts and ties in the adjacent track. While this may be possible, to a limited extent, where the right of way is on a level, uniform grade, free from rocks and ditches, and where cultivation for the first three years may therefore be possible, it seems unlikely that one or two rows of trees, thus grown, would be able to create sufficient shade to keep out weeds and undergrowth, which latter would naturally act as a check to the development of the trees themselves. In other words, a "forest floor" could not be formed, and it is doubtful whether such a system of planting would yield satisfactory results from a practical standpoint. The Pennsylvania railroad (I. & V. div.), tried the experiment of growing catalpa trees along the right of way for shade rather than for timber purposes. The result is indicated in the two following letters, from prominent officials of the line.

PENNSYLVANIA LINES WEST OF PITTSBURG—I. & V. DIVISION,
OFFICE OF SUPERINTENDENT, INDIANAPOLIS, IND., February 8, 1902.

In reply to your favor of February 4, relative to catalpa trees along the right of way of the P. C. C. & St. L. Railway Company (Pennsylvania line), in the year 1883 we planted about 86,000 trees on the Indianapolis division, between Indianapolis and Richmond, and on the Richmond division, between Richmond and Logansport; they are, therefore, about eighteen years old, and some of the trees have attained a diameter of about twelve inches or more, depending on the soil in which they were planted. When set out, they were small shoots about two feet high. The original object in setting out these trees was more especially for ornamental and shade purposes. In order to prevent them from interfering with telegraph lines, the trees have been topped or cut close to the trunk several times; this has more or less retarded their growth. It is the intention to utilize the trunks which are large enough for fence-posts and ties some time in the near future. A number of trees have been damaged, due to fires which were started on right of way by passing engines. The general growth of trees, however, has not been up to the expectation of the parties who advocated the planting of this particular species of tree. In setting out these trees no special pains were taken—the section men digging a hole of sufficient breadth and depth to properly accommodate the roots, and the same soil was again thrown back around the roots. No fertilizer of any kind was used. I trust this information will be of service to you. Yours truly, M. W. MANSFIELD, Superintendent.

PENNSYLVANIA LINES WEST OF PITTSBURG—INDIANAPOLIS DIVISION,
COLUMBUS, OHIO, February 19, 1902.

Your letter of February 5 to Mr. Ohliger, superintendent, Richmond, Ind., regarding the catalpa trees between Indianapolis and Richmond, Ind., has been referred to me as engineer of the division, and I beg to report as follows: About eighteen years ago several thousand catalpa trees were set out on the right of way on both sides of the track between Indianapolis and Columbus. It was intended to beautify the company's property, and, after the trees had grown large enough, to utilize them for cross-ties and fence-posts. After some eight or ten years it was found that the rapid growth of the trees caused the limbs to interfere with the telegraph lines, and a yearly trimming was necessary, and as it is considered that this expense is not justified by the benefit derived from the trees, those under the telegraph lines are being gradually removed. Where the trees are no detriment from either of the above causes they have been allowed to remain as a matter of appearance. It is not found that the size or shape of trees of this kind make them available for ties. Possibly five per cent. of the trees thus far cut are of the proper dimensions for ties, and about forty per cent. for one fence-post from each tree. The remaining fifty-five per cent. of the trees are worthless after cutting. The ties and fence-posts secured from the trees have not been in use long enough to enable us to state from our experience as to the wearing qualities of the timber. On a whole, the experiment was not considered a success. Yours, D. B. JOHNSON, Engineer Maintenance of Way.

CATALPA FOR POST AND POLE TIMBER.

The same qualities which render the catalpa valuable for railroad-ties apply to its use for posts and for telephone and telegraph poles. There is no reason why every farmer should not be able to devote sufficient land for the growing of catalpa to insure a constant supply of post timber for home purposes. It has been demonstrated that in reasonably good soil, with a fair water-supply, and not planted closer than 5x8 feet, a catalpa forest will produce posts in from eight to twelve years. It has been further demonstrated that trees a few years old, when cut back to the ground, will produce timber of post size within about four years. The further advantage of catalpa wood for post timber, in addition to its specific resistance to decay, lies in the fact that the wood does not check or split, allowing staples used in wire fencing to fall out and the wires to drop to the ground. The lightness of catalpa timber, as compared with that of the Osage orange and other species frequently used in the West for posts, makes it easier to handle and increases the number of posts which a team can haul in each load. Where large stock ranges are to be fenced this will be an important item for consideration.

As to the durability of catalpa posts, sufficient information has already been given in the discussion of railroad-ties. A further illustration is afforded by plates 37 and 38, from photographs furnished by the United States bureau of forestry.

For telegraph and telephone poles the advantage of wood so resist-

ant to decay as catalpa is sufficiently obvious. In its native forests, the catalpa has been known to obtain a height of 100 feet; a height amply sufficient for pole timber of all classes. It must be remembered, however, that these trees grew in alluvial bottoms, where the soil was exceedingly rich and the water-supply abundant. Such results can scarcely be expected from Kansas catalpa plantations on upland soil. It is quite possible, however, that on river-bottom land trees tall enough for telephone poles may be grown in about twenty-five years. It is hardly to be expected that individual farmers will enter upon the growing of large forestry plantations, covering a period of a quarter of a century, on land valuable for annual crops. But there is no doubt that, if a catalpa plantation be set out with the intention of growing timber for post purposes, it will prove a safer and possibly a more profitable investment in the long run than a fruit orchard. When the fungus and insect pests, the freezes and droughts which affect the productivity of an orchard are taken into consideration, together with the necessity for a longer cultivation of the trees, a catalpa forest presents itself as a far simpler business venture. There is but one insect known to attack the catalpa (the *Sphinx catalpa)*; no report of its ravages having affected the Kansas plantations has thus far been received, however. The immunity of catalpa wood to decay means the existence of certain chemical compounds in the tissues which render them antiseptic to saprophytic fungi. The presence of this compound or compounds likewise renders the living tree remarkably free from plant diseases caused by parasitic organisms. An investigation of the nature and composition of this substance is now under way at this station.

LUMBER VALUE OF CATALPA WOOD.

At the present time there is no catalpa timber being offered in the market for lumber purposes. That the wood would be exceedingly valuable for lumber is demonstrated by the occasional specimens that have been sawed, finished, and made into furniture. The open grain of the wood enables it to take a “filler” easily, while in color and marking there is scarcely a more beautiful native lumber product. It is to be hoped that the future will see a sufficient extension of catalpa-forest planting to bring the lumber into market as a staple article. Lumber companies would probably find a catalpa plantation for lumber purposes a very profitable investment. With corporations, whose life is perpetual, provided the investment is secure and the profits certain, the length of time required for a realization on the investment is not a matter of such vital importance as to an individual planter, who desires returns within his own lifetime.

COMMERCIAL CATALPA PLANTATIONS.

The forests at Belmont and Bertrand, Mo.: One of the earliest railroads in the West to commence the growing of trees for post and tie purposes was the St. Louis, Iron Mountain & Southern Railroad Company, which started two plantations of catalpa trees in the late '70's, in southeastern Missouri. Concerning these Mr. Kerrigan, superintendent, reported as follows, in a letter printed on page 15 of a document entitled "Preliminary Report on the Forestry of the Mississippi Valley, and Tree Planting on the Plains," by F. P. Baker, published by the United States Department of Agriculture in 1883 :

"We have no trees planted on our road except 50,000 catalpa trees on right of way near Charleston, Mo. We have a plantation or farm of catalpa trees (100,000 trees) on the Belmont branch, eighteen miles from Belmont, Mo. The above were all raised from seed. We also have a catalpa farm of 150,000 trees at Bertrand, Mo., about twenty miles from Bird's Point, on the Cairo branch of this road. These were planted in June, 1880, from slips. Have been cultivated twice, and are now in fine, thrifty condition; will average about eight feet high, and will not require any cultivation after next year."

Neglect of these plantations on the part of the railroad company, necessitated by temporary financial stringency, resulted in their utter failure. The following interesting letter from Mr. Hansen, the assistant engineer of the road, is in sad contrast to Mr. Kerrigan's report in 1883.

MISSOURI PACIFIC RAILWAY.
ST. LOUIS, IRON MOUNTAIN & SOUTHERN RAILWAY COMPANY.
ST. LOUIS, MO., February 15, 1902.

Replying to your favor of January 22, written to Mr. H. Rohwer, chief engineer of the Missouri Pacific Railway Company, and by him referred to me, I have the following report to make: In southeastern Missouri, many years ago, the St. Louis, Iron Mountain & Southern Railway Company planted two farms of catalpas, but change of management caused same to be neglected. Dull times struck the railroad company and the two plantations were neglected; no allowance being made for their care. Grass growing up among the trees, a fire catching the grass killed and scorched a great many of them. Finally the plantations were leased to parties for farming purposes, and the young trees were cut off. Some of the trees got large enough to make fence-posts. They will grow in almost any kind of soil; black sandy loam, black sticky gumbo, or sandy land. The best, tallest and largest in this vicinity grow in the timber land in our swamp bottoms. *There are fence-posts on the division of the Belmont branch now in use, sound and good, which have been there over twenty years.* I am sorry that the catalpa growth was neglected here as it has been. This is all the information I am able to give you on the subject. Yours truly,

M. A. HANSEN, Assistant Engineer.

THE FARLINGTON FOREST.

During the fall of 1877 the Missouri River, Fort Scott & Gulf railroad commenced plantations of different kinds of trees at Farlington, near Fort Scott, Kan. Mr. J. M. Buckley, roadmaster, in his report dated October 15, 1878, says:

"The catalpa have made the greatest improvement, especially the yearlings, and in my judgment it is economy in time and expense to plant none older than one year, . . . The catalpa has certainly proved to be the strongest grower and most tenacious, and at present rate will come to maturity years before other varieties are of sufficient size to be of utility."

The firm of Douglas & Son, of Waukegan, Ill., had the contract for setting out this plantation. Of the Farlington forest, Mr. Douglas writes, in a letter dated October 24, 1882, and quoted on page 14 of the "Preliminary Report on Forestry," etc., just cited, as follows:

"Three hundred and twenty acres were planted, and we are now planting 180 acres more. That will be finished before winter sets in, or before April 1, 1883. The plantation consists of catalpa (*speciosa*), with the exception of a few acres. They are all planted four by four feet apart, containing 2720 trees to the acre. The land is prepared the same as for corn, and the trees are planted with spades. The catalpa trees planted in 1878, after four summers' growth, are ten to fifteen feet high and two and one-half to three and one-half inches in diameter; three years, five to nine feet; two years planted, two and one-half to six feet (a drought last year); one year planted, three to four feet. On rich land these trees shade the ground after two years' cultivation. On poorer land they require three years' cultivation."

Concerning the present condition of the Farlington forest, Mr. H. P. Jacques, purchasing and timber agent for the 'Frisco system, now owners of the plantation, writing from St. Louis, Mo., under date of February 14, 1902, says:

"Our plantation at Farlington for catalpa trees was planted between the years 1879 and 1882, and contains 640 acres, of which, approximately, 550 were planted almost entirely with *Catalpa speciosa* (the Western or hardy catalpa). The other trees on the property were in small numbers, and not practically successful, namely, black walnut, black cherry, white ash, and bois-d'arc. They were planted 4x5 feet apart, and allowed to grow until about ten years old, when about one-fourth of the standing trees were cut and allowed to remain on the ground, being of no value. Since then, we have systematically thinned the standing trees, and intend to continue this work as we are doing it now until the trees eventually stand about eight feet apart, and until such time as we shall begin to cut for telegraph and telephone poles, of which there will be a large number. After the cutting of this class of products, the trees, we think, will be left to stand about eight to sixteen feet apart, to be used as railroad-ties when ties become sufficiently valuable, as they are sure to be. We are now thinning this plantation, and expect to pile up about 60,000 standard railroad posts, and about 100,000 country fence-posts."

This plantation was visited by a representative of the Kansas Experiment Station in August of last year, just after the close of the prolonged drought of that summer. In addition to the facts furnished in the above letter, Mr. Andrew Throndson, the superintendent of the plantation at Farlington, supplied some interesting data. The trees when first planted were one year old from the nursery. The first pruning was done in 1890, or eight years after the planting was finished. According to the superintendent, it would seem that a regular system of thinning was not adopted at the outset, and that trees were taken out for post timber rather indefinitely, and wherever it seemed to the advantage of the plantation to do so. The soil is very uneven in quality, and the yield, therefore, very unequal. The northwestern portion holds the best trees at the present time. In some parts of the plantation fully one-third of the trees have been removed, leaving about 1800 to the acre. About one-fourth of the trees were supposed to have been taken out eleven years ago, leaving about 2000 to the acre at that time. According to the superintendent, from 500 to 600 posts per acre have been obtained in the process of thinning, and from some acres 1200 to 1500 posts, on account of trees in some cases making from two to four posts.

The posts when cut average not smaller than four inches in diameter at the tip. Some pole timber, tip diameter six inches, and twenty-six feet long, has been obtained, but how much the superintendent could not say. The cost of growing he estimated at about thirty-three dollars per acre, including trees, labor, and cultivation for three years. During the year 1900-'01, 120,000 posts have been taken out of the entire plantation.

As a general criticism it must be said that in the Farlington plantation the trees were set closer together than experience would possibly justify to-day. The thinning was not systematically followed out, so as to leave the trees at fifteen years of age standing 8x8 or, perhaps better, 8x16 feet. The result is that the catalpa plantation as a whole, in the body of the forest, presents the appearance of a forest of saplings. A large number of the trees do not exceed four to six inches in diameter. Systematic pruning has not been followed out, but the trees as a whole have been allowed to retain their limbs. Since the catalpa in forest does not readily drop dead limbs, as do other trees, a tree unpruned tends to form a straggling, irregular growth. This is shown to a regrettable degree at Farlington. Many of the trees in the forest there retain all of the dead limbs on their trunks down to within one or two feet of the ground.

By rigid and systematic pruning this plantation may possibly be brought up to a fair degree of effectiveness, but the crookedness

in growth of so very many of the trees, caused by lack of pruning in earlier years, will prevent the forest from ever yielding in marketable timber what should have been its normal output from the present time forth.

At the present date, twenty years since the conclusion of the last planting at Farlington, a good yield of tie timber should be expected. As a matter of fact, however, taking the plantation as a whole, no timber of diameter sufficient for anything but posts can be hoped for until several years after the thinning to 8x16 feet, planned by the railroad company. The plantation, thickly planted as it is, and drawing an immense amount of water from the soil, withstood the effects of the last season's drought most remarkably, the leaves showing scarcely any sign of wilting after a period of fourteen weeks in which but 6.65 inches of rain fell.

THE TINCHER FOREST.

This plantation, owned by Mr. Geo. W. Tincher, of Topeka, Kan., is located two and one-half miles west of Wilsey, Morris county, Kansas, on high prairie upland. Nine acres were planted in the year 1899, with the rows running north and south, and the trees planted 5x7½ feet. In 1900 a twenty-acre tract was planted, 5x14 feet, the rows running east and west. Thirty-one acres were planted in 1885, having the trees 4x4 feet. Mr. Tincher is taking out half of the 1885 planting, by removing every other row. The cost of this thinning to him is fifty cents per 100 posts, the remaining trees to be trimmed up to six or eight feet above the ground. In some places this section of his plantation will produce 2000 posts per acre, while a small portion will furnish none at all. Mr. Tincher considers the planting of trees 4x4 feet a serious mistake, and says: "My own place, with the first planting of 1885 *will not produce a single tie.* The same can almost be said for the Farlington forest, with their first planting, of 1878."

While the trees of the Tincher plantation have made a slower growth than they would have done on bottom land, the owner considers that this is compensated for by the consequent greater hardness of the wood and its longer life in service. The young trees on this plantation are in vigorous and healthy condition, and give good promise of success. In the older portion of the plantation, the 4x4 planting has certainly resulted in the formation of a fine forest floor, but the trees there are otherwise suffering under the same disadvantages as the Farlington forest. The trees in this plantation have averaged from one-third to one-half inch annual increase in diameter.

THE UNIVERSITY OF ILLINOIS FOREST.

The following description of this catalpa plantation is an extract from a letter received from Dr. T. J. Burrill dated February 24, 1902:

"Replying to yours of the 23d instant, I will say that we have a plantation of catalpa trees on the grounds of the University of Illinois, in connection with experimental planting of many other varieties. In 1871 seeds were planted of *Catalpa bignonioides*, or the tree native to the southern and eastern portion of the United States, but at this time the difference between this species and that now called *C. speciosa* was not recognized. Ten years afterwards seeds of the latter were obtained and planted in nursery rows. When two years old the seedlings were removed to the experimental plantation and planted 4x8 feet apart. They have since been thinned out from time to time, so that the trees now stand about 8x16 feet distant. The first-mentioned variety was injured, however, five or six years after the date of planting, by frost, so that in nearly every case the heart of the trees now standing is decayed. Nothing of the kind has happened to *C. speciosa*. As is the case with many other trees when planted by themselves, these have not developed in the latter years very rapidly. The average diameter of trunks one foot above the ground is, in the midst of the plantation, about five or six inches, while those at the end of the rows are eight to ten inches. Some of the same trees planted out by themselves, cultivated for a few years and then left in the sod, are usually about one foot in diameter. At the present time the trees in the plantation of *C. speciosa* are fully as large as *C. bignonioides.*"

THE YAGGY FOREST.

The catalpa plantation owned by Mr. L. W. Yaggy is situated in the Arkansas river valley, four miles west of Hutchinson, Kan. The soil is a loose, sandy loam, with occasional patches of clay. The water-table lies from six to twelve feet below the surface, and the trees have never suffered from drought. The oldest plantation, of 120 acres, was set in 1890. Eighty acres were planted in 1891, and 240 acres in 1892. The latest plantation was set out in 1895, and the land in trees amounts to about 500 acres at the present time. The trees were grown from seedlings on the plantation and set out when one year old. At two years the trees were cut back to the ground and allowed to sprout during one season. The next season all sprouts were cut away except the most vigorous one on each stump, which was allowed to remain to form the final tree. Cultivation was continued until the fourth year. In the youngest plantation the roots are five years old from setting, while the trunks are three years old. This is the finest of the several plantings, the trees being straight, well-pruned, and with high crowns. Some of the trees were cut back to the ground in the winter of 1900–'01. In such cases, where but one sprout has been allowed to grow from each stump, sprouts will average eight feet in height. Some of the trees, at the age of three years from the cutting back, are large enough for post timber. The first thinning of the oldest part of the plantation was done in 1897 and 1898.

The trees are cut as a rule after reaching the size at which they will make two posts to a tree, the lower post having a diameter at the butt of from four to six inches, and the upper one of about three inches. The lower posts sell for ten cents apiece, and the upper ones for from four to six cents. Roadways are run through the plantation, along which the cut trees are piled, and from which they are hauled to the saw. The Yaggy forest, being on bottom land, has furnished conditions more nearly approximating to those where the catalpa is found native than does any other in this state. The plantation is especially interesting for the valuable experiments in cutting back the young trees and in burning the land over after cropping, the result of which is given elsewhere.

ACKNOWLEDGMENTS.

Acknowledgment of thanks is due numerous railway engineers of maintenance of way, throughout the country, for courteous responses to requests for information, and for valuable data supplied in many cases; to the Union Pacific and the Kansas City, Fort Scott & Memphis railway companies, for transportation furnished to the large plantations at Farlington, Kan.; to Messrs. Geo. W. Tincher, of Topeka, L. W. Yaggy, of Hutchinson, Kan., and Mr. John P. Brown, of Connersville, Ind., for abundant information based on actual experience in catalpa-growing; and to Dr. C. S. Sargent, of the Arnold Arboretum, Cambridge, Mass., and Dr. William Trelease, of the Missouri Botanical Garden, St. Louis, Mo., for data of a botanical nature.

SUMMARY.

1. *Historical Outline.*—Two species of catalpa native to the United States: *Catalpa catalpa* (*C. bignonioides*), indigenous in the Southeast, and *Catalpa speciosa* in the central West. Planting of the Southeastern species in the West long caused confusion between the two trees, since both were planted together indifferently, under the supposition that they were of the same species. The low, scraggy habit and the tendency of the tops to winter-kill, seen in many catalpa trees, and peculiar to *C. catalpa*, was a supposed characteristic of all catalpa trees. *C. speciosa* first distinguished as a separate form by Warder in 1853; first described by Engelmann in 1880.

2. *Descriptive Characters.—Catalpa speciosa* distinguished from the other native species by greater stature, hardiness north of the forty-fourth parallel, north latitude; larger flowers, fewer in panicles, and appearing about two weeks earlier than those of *C. catalpa;* by furrowed rather than scaly bark; by wider and more deeply notched seeds, bearing a fringe of hairs not drawn to a point, as in *C. catalpa*

3. *Durability of Wood.*—Wood of *C. speciosa* is remarkable for

durability in contact with the soil. Well authenticated and reliable observations give life-record of 100 years for timber from large, mature specimens. Seasoned timber from trees ten inches or more in diameter will last fifteen to thirty years in continuous contact with the soil.

4. *Catalpa Culture.*—Seed sown about twenty-five to the foot, in shallow drills one inch deep. Spring sowing best in Northern states. Seedlings "heeled in" over winter, and set permanently following spring. Planting should not be closer than 5x8 feet. Thin to 10x8 from the eighth to twelfth year. Thinning continued until trees stand 20x16 feet, or 16x16 if original planting was 8x8. Crops of corn, etc., can be grown between eight-foot rows first year after setting. If cut to ground second year from setting, and single sprout allowed to grow, resulting trunk will be straighter than if not cut back. Sprouts from older roots produce post timber in four years. Pruning necessary for formation of straight trunks—first pruning in fifth or sixth year; second in the tenth year. Trees in forest increase in diameter from one-third to one-half inch annually, if not planted closer than 5x8 feet (1000 trees per acre). Trees standing 16xl6 feet (170 per acre) may increase in diameter one inch annually up to about twelfth year. From that time on, probable annual rate of increase will be one-half inch. Post timber produced in from seven to ten years; tie timber, telegraph and telephone poles in from fifteen to twenty-five years.

5. *Special Need of Tie Timber.*—White oak, the best tie timber hitherto used, nearing exhaustion. Expense of chemically treating cheap ties of perishable wood is great. Metallic ties are out of the question on American road-beds. Strong demand exists for durable tie timber to replace oak. In 1900 there were 535,668,000 ties in track in the United States. Renewals in that year, 48,000,000, worth, at forty cents apiece, $19,200,000—nine per cent. of the total in track. If laid with catalpa ties, annual renewals would not exceed four per cent., counting life of catalpa ties at but fifteen years; they have been known to last twenty years. Annual saving of expense of renewals thus affected, estimating the cost of catalpa ties also at forty cents apiece, $10,600,000.

6. *Post and Pole Timber.*—Durable quality of catalpa renders it especially valuable for fence-posts and for telephone and telegraph poles. Value for post timber lies not only in its resistance to decay, but also in its not checking or splitting with age.

7. *Commercial Plantations.*—First catalpa forest planted in southeastern Missouri in the late '70's by the St. Louis, Iron Mountain & Southern railroad. Not cared for and finally abandoned.

Farlington plantation, near Farlington, Kan., owned by the 'Frisco system, has 640 acres, planted between '79 and '82. Trees planted four by four feet. Not regularly thinned or pruned; consequently trees have not made proper development. Thinning now going on, and plantation may yet be successful.

The Tincher plantation of sixty acres, near Wilsey, Kan., is successful and promising, producing in some parts of the plantation 2000 posts per acre, at ten cents each. Trees well pruned and properly thinned. A commercial success. Soil, upland prairie.

The Yaggy plantation, situated in the Arkansas river valley, near Hutchinson, Kan. About 500 acres in trees. Conditions of this plantation better adapted for growth of catalpa than those of any other in the state. Cropped entirely for posts. Trees in splendid condition, and the plantation a decided success.

8. *Cost and Profits.*—Cost and profits in catalpa-growing depend on local conditions. Careful estimates based on the Yaggy forest give total cost of growing and marketing timber on one acre for ten years as $51.70; gross value of product in ten years, $267.15; net profit, $215.45; net profit, less six per cent. compound interest on expenditures, $197.55 per acre; net annual profit for first ten years,$19.75; owner's estimate of present gross value of product (three years later than above valuation) $400 per acre; annual income of plantation at present, as estimated by owner, $50 per acre.

Horticultural Department.

ALBERT DICKENS, M. S., Acting Horticulturist.
G. O. GREENE, B. S., Assistant.

The Catalpa Plantations at the Agricultural College.

THE earliest planting of catalpa by the Agricultural College was made in 1872. The trees were a part of a mixed planting made on the old College farm. Prof. E. Gale, in a report made to the State Board of Agriculture, and published as a part of the Transactions of the State Board of Agriculture, 1872, page 430, says in regard to the soil: "The land selected for this purpose was that least adapted to the cultivation of cereals or root crops of any now broken up on the College farm. This selection, all things considered, was thought best, for it is, in general, this quality of soil—the high, gravelly and broken ridges—which should ultimately be planted to forest." Speaking of the planting as a whole, he says: "As was anticipated, the growth of the young trees has not been as vigorous upon this soil as it would have been upon lower and richer land, but still abundantly sufficient to give the most encouraging promise of future success." Speaking of the growth of the catalpa, in this planting, he says: "The catalpa has made a growth of from twelve to twenty inches from seed."

In part II of the Fifth Biennial Report of the State Board of Agriculture, 1885-'86, page 159, in "Notes from the Experimental Tree-planting at the Agricultural College," Prof. E. A. Popenoe says regarding the catalpas planted in 1872: "*Catalpa speciosa. On* poor gravelly clay soil, planted much more closely than the white ash, not thinned, excepting by the removal here and there of trees for posts. Stand about twenty-five feet in height, and have an average circumference of about fifteen inches; the largest trees twenty-two inches at four feet from the ground. Trunks more likely to fork or carry large branches below than those of white ash."

It will be noted from the foregoing quotations that the catalpas, even on this exceedingly poor soil, were being cut for posts when not more than thirteen years from planting. Having been planted so long before the establishment of the Experiment Station, accurate records are wanting. Some posts have been cut nearly every season; in 1901 sixty-five were cut from this planting. It is evident from the information available that the ground has paid as high a rental as

good land has paid in farm crops. The trees have not renewed from sprouts as readily as have the trees on lower, richer land, but have done fairly well in this respect. At this date, November, 1901, nearly thirty years from planting, and with good rent for the past sixteen years, this plat of ground of about three-fourths of an acre contains 350 trees, which would cut at least 610 good posts. This does not represent all the value of this planting, for the soil is evidently very much better than when the trees were planted. The leaves have given texture to the soil, which now shows some considerable humus in its composition. The ground is now practically under forest conditions, and seedlings of box-elder, mulberry, elm, ash, oak and red cedar are found growing among the catalpas. Plate I shows one of the best of the trees now growing in this planting; it is twelve inches in diameter and over thirty-five feet high. Some idea of the growth of underbrush and young trees may be had from the same plate.

In the spring of 1888 the horticultural department of the Experiment Station planted about two and sixth-tenths acres of the old College farm to catalpas. The soil of this plat, while not so decidedly poor as that of the planting of 1872, is very thin, and is underlaid by a hard, poor subsoil. Plantings were made four feet by two feet; four feet by four feet, and four feet by eight feet. All were given good, clean cultivation for two years. The third season the trees set eight feet by four feet were cultivated; those set closer were large enough to make cultivation difficult. The ground was well shaded and fairly well covered with leaves, so the lack of cultivation did not seem to affect their growth. Each season the trees were trimmed to prevent their branching too low for the formation of good posts. Results show that the time required for trimming was well spent.

In the rows set four feet by two feet, many of the trees died or were cut out within a few years after planting, before the wood was of any value. Subsequent thinnings gave wood and stakes enough to pay for the work. This planting, for the last eight or nine years, has been practically a four-by-four-foot planting. The trees which were removed seemed to have little effect in causing a taller, straighter growth; the trees in the four-feet-by-two-feet block showing little difference in height and somewhat less in diameter; in other words, the additional trees were of no benefit, but, on the contrary, were a detriment. In a part of this planting where the trees had been left at the original distances until 1900, the trees in one of the four-foot rows had more than twice the amount of posts and wood as the trees two feet apart.

Comparing the plantings originally 4x4 and 4x8, the thinner plantings have given the best results. Ten rows, 4x4 feet, 117 feet

feet long, contained 251 trees, having 85 good posts. Ten rows, 8x4 feet, 117 feet long, grew 228 trees, having 280 good posts. The trees in the wider rows have a greater average height and diameter; the average diameter in the planting 4x8 feet apart being slightly under six inches; in the rows, 4x4 feet apart, the average diameter is nearly four and one-fourth inches. The average height is about the same, eighteen feet.

In some cases, where trees were thinned by cutting off just above the ground, the new shoot from the stump made such a straight, rapid growth that the cutting back seemed to secure the formation of straighter posts. As might be expected, the second-growth posts grow to a suitable size for use in less time than was required for the first growth of trees. The comparative value of the first and the second growths for posts is a subject for further observation.

Catalpas have been used for shade and ornamental trees on the College campus, around the buildings, and in the clumps and belts. Given a sufficient amount of room, in a good soil, the catalpa trees have made a fairly rapid growth, and usually have made a pleasing symmetrical form, the foliage, while not especially heavy, is sufficient for good shade, and the blossoms add to its appearance in their season. Plate 5 shows a clump of catalpas near the Domestic Science building. The soil is of only medium quality, and the trees are of a very good size for fourteen seasons' growth.

Plate 6 shows a very fine specimen of the Golden catalpa; the tree is graceful and symmetrical, rather heavier in foliage than most of the trees of this species. It is 36½ feet high, 15 inches in diameter at two feet from the ground, and 13½ inches at four feet from the ground. The yellow tint is quite conspicuous in the early part of the season, but is much less so after midsummer. Young trees show the yellow shade much more than the older ones.

Specimens of the Purple-leaved catalpa have been grown on the College campus. The purple tint is much more conspicuous in the younger trees, and with these the colors are most vivid in the early part of the season. The specimens grown here have been grown on a soil of medium quality, and have made but a moderate growth, inclining to be shrubby. Probably the best results in the way of foliage would be secured by cutting back severely and growing as shrubs.

The Japanese catalpa, *Catalpa kæmpferi*, has made rather a low, shrubby growth on the College campus. It presents a fine appearance when in bloom, carrying a heavy load of flowers. In the fall, after the leaves are fallen, it presents a rather unique appearance, the large number of slender pods giving the branches a drooping effect.

A number of Teas' hybrid catalpas were set in the timber belts

on the College campus. These have been somewhat variable in form and growth, but have, on the whole, made good growths and fine trees.

Some of the trees set in a cooperative experiment with the division of forestry, Department of Agriculture, are evidently of the Southern species, *Catalpa catalpa.* They were killed to the ground in February, 1899, and have been seriously injured by cold in other seasons. Doubtless much of the dissatisfaction with the catalpa has been caused by the setting of other species than *speciosa.*

Posts set ten years ago in the Experiment Station vineyard are still in very good condition, and there is no doubt that they merit the general favor in which they are held. The wood not suitable for posts makes very fair fuel. It burns readily and lasts well for so light a wood. Plate 7 shows the cross-section of a catalpa planted in 1880 and cut in 1900. Plate 8 shows the section of a board cut from the same tree. The trunk made a board eight feet in length, the width of that shown in the plate. When cut, this was a fine, healthy tree, with a spread of at least twenty-five feet. The best development of the belt in which it grew demanded its removal.

Trees of suitable size for sawing have been used by the mechanical department for various purposes. Mr. W. L. House, foreman of the college wood-working shops, says in regard to the catalpa wood: "It has a beautiful grain, polishes easily, and takes a fine finish. It has sufficient strength for the various kinds of cabinet work, and is desirable in every way for this purpose. For wide surfaces it joins nicely, matching the grain easily. It works easily, either with the lathe or with hand tools, and is, in every respect, a valuable wood for the finisher and cabinet-maker."

NURSERY NOTES.

Seedlings of the catalpa are easily grown. No difference has been noted in the vitality of seed gathered in the fall and stored in a dry, cool place and in that which had hung on the trees until spring. Good stands have been secured by planting in rows of suitable width for cultivation, dropping the seeds quite thickly in the row and covering rather shallowly, about one inch deep. Plantings made when the ground is in good, warm condition have succeeded better than plantings made very early or very late. On good soil and with good care, the growth of catalpa seedlings have been from one to five feet the first season. One-year-old trees are best for planting. In the planting of 1888, yearling trees have made posts as soon as two-year-old trees. The yearling trees are easily set by laying off the rows with a plow or lister, followed by a little work with the spade, care being taken to firm the soil well when the tree is put in position. Setting in

the spring is usually most successful, and should be done before the buds are much swollen. As with all trees that are being transplanted, care must be taken to prevent drying. If the roots be exposed for only a few minutes to the sun or drying winds, the chances for success may be seriously reduced.

CONCLUSIONS.

The catalpa plantings made by the College and the Experiment Station have given encouraging results. On very poor soil the catalpas have been a paying crop. Almost any other cropping of this land would have reduced its fertility, while the crop of trees has unquestionably been beneficial, both by preventing washing and by the addition of some humus.

On good soil the growth has been proportionately better. The trees have made a more rapid and vigorous growth, producing trunks of suitable size for posts in from seven to ten years, and in twenty years trees have grown to a size sufficient for heavier uses, or for lumber for finishing or cabinet work.

The most desirable distances for planting probably vary somewhat for different soils and locations. Rows eight feet apart, with the trees five or six feet apart in the row, would seem, from our observations, to be a good distance for general planting. With the rows eight feet apart, corn or some other rowed crop may be planted for at least one season.

Good clean cultivation should be given for several years. Attention should be given to trimming the trees, to avoid low branching.

Cutting back to the ground usually secures a rapid growth of smooth straight wood.

The young trees are easily raised, transplant readily, grow rapidly, and endure extremes of drought, heat, and cold.

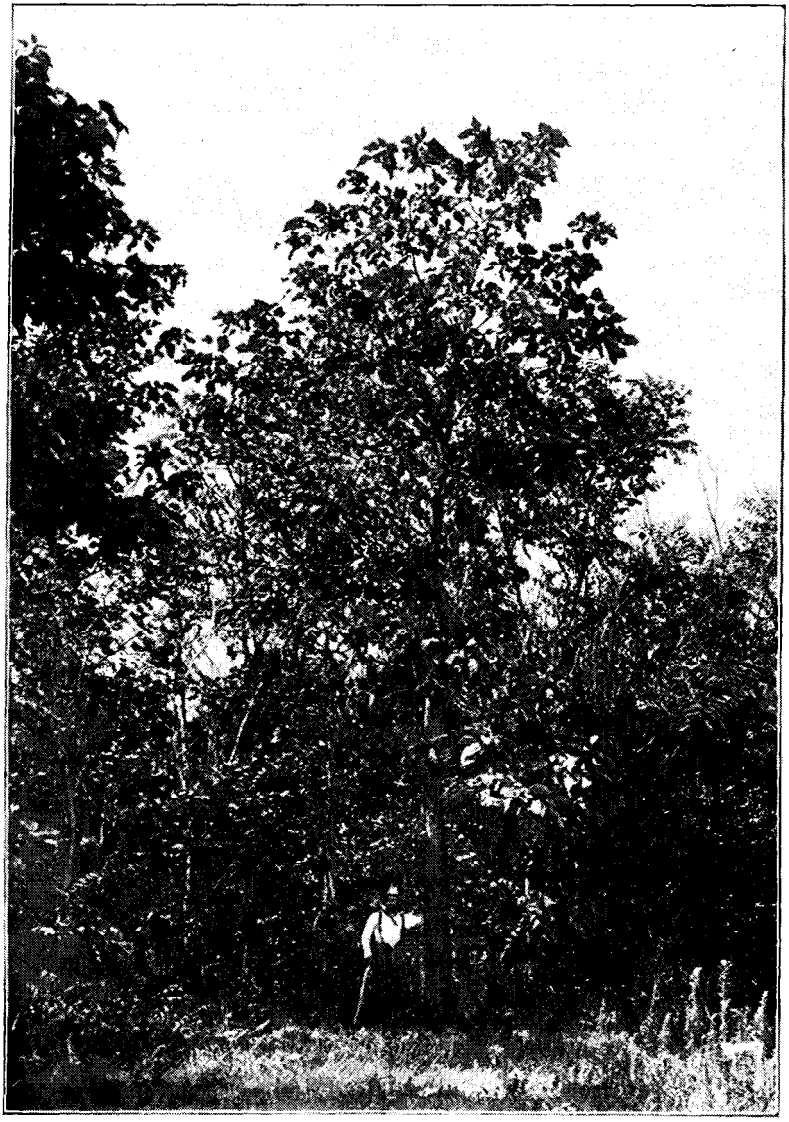

Plate 1. Agricultural College plantation of 1872.

Plate 2. Experiment Station plantation of 1888. Trees eight feet by four feet.

Plate 3. Experiment Station plantation of 1888.
Trees four feet by two feet, after thinning.

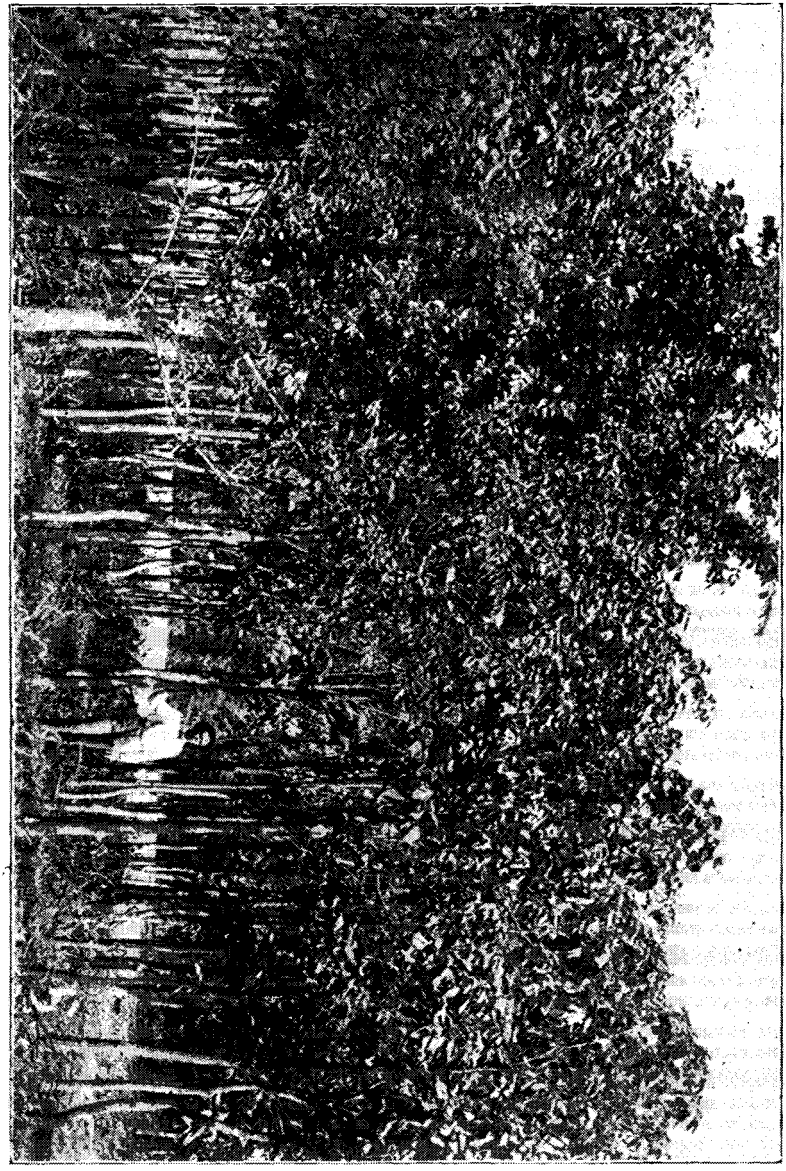

Plate 4. Experiment Station plantation of 1888. Trees four feet by four feet.

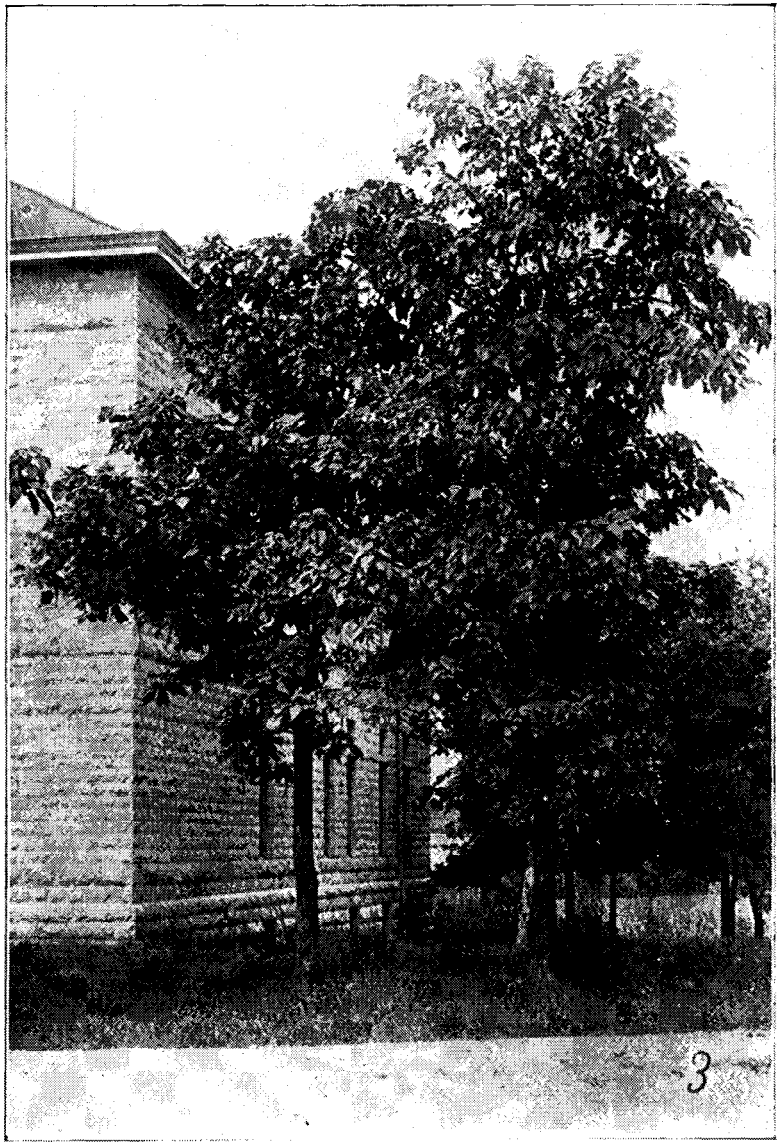

Plate 5. Catalpas used for shade-trees at Agricultural College.

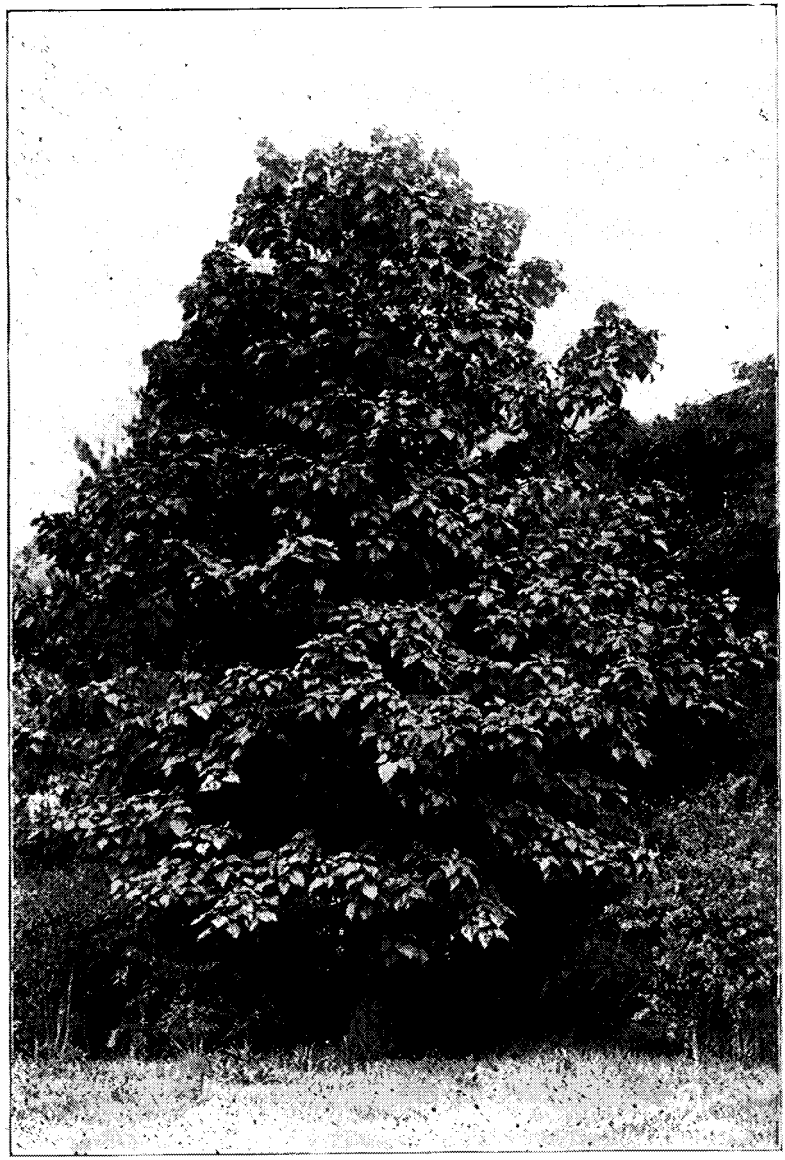

Plate 6. Golden catalpa on Agricultural College campus.

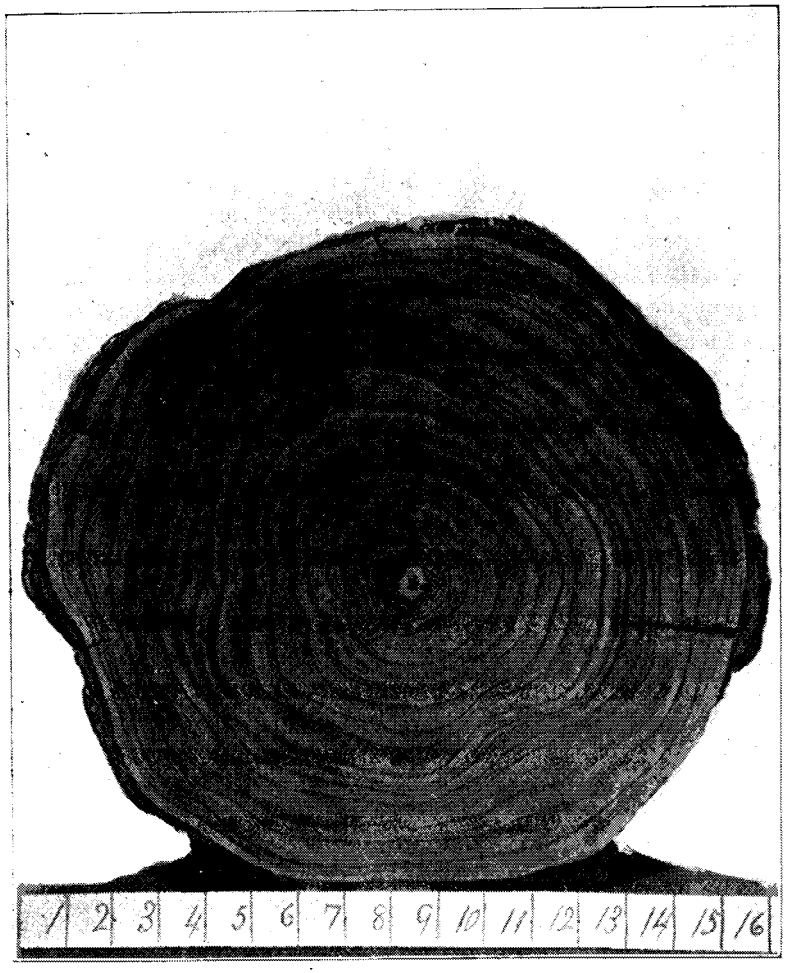

Plate 7. Cross-section of catalpa grown on Agricultural College campus.

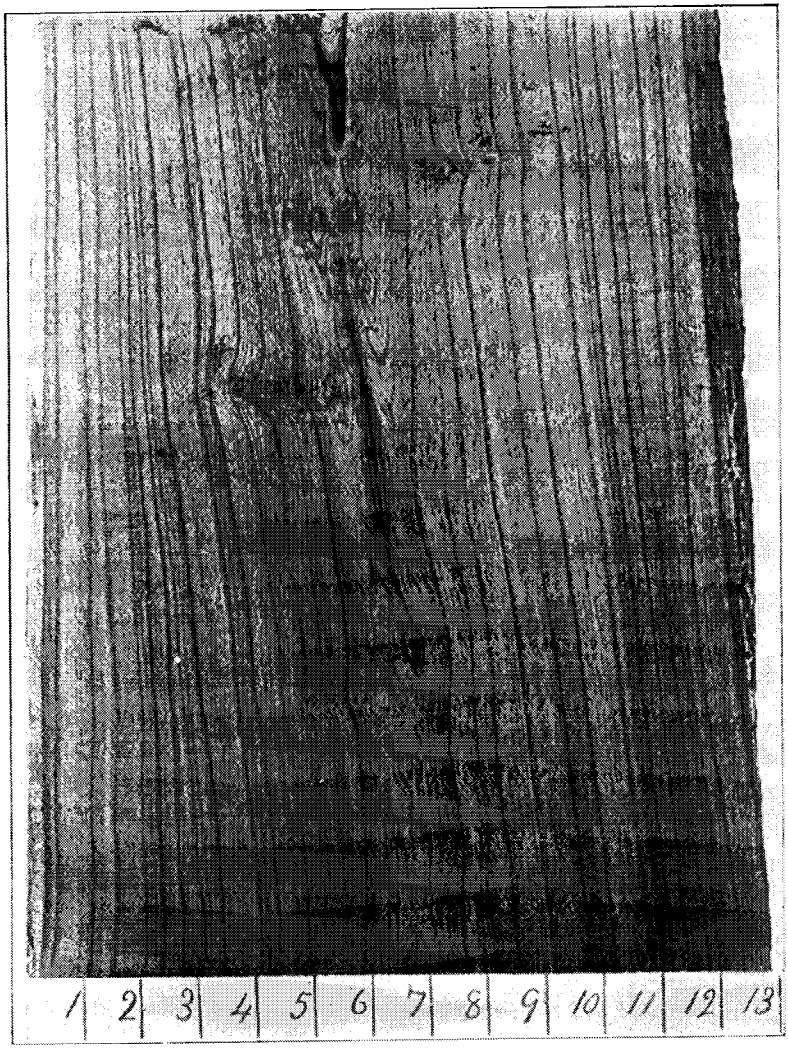

Plate 8. Section of board from catalpa tree grown on Agricultural College campus.

Plate 9. Nursery of 60,000 irrigated catalpa trees at Provo, Utah; one season's growth from seed; property of the Rio Grande Western Railway Company. From photograph furnished by Mr. J. P. Brown, Connersville, Ind.

Plate 10. Exterior view of catalpa plantation of 640 acres, at Farlington, Kan., the property of the 'Frisco railroad system.Individual trees standing outside the forest have attained large size. Low branching from lack of pruning.

Plate 11. Farlington plantation—interior view. Trees too close together, and lower branches retained.

Plate 12. View similar to preceding, along a wood road in the Farlington forest.

Plate 13. General view of Tincher forest, Wilsey, Kan.

Plate 14. Tincher forest, Wilsey, Kan.

Plate 15. Tincher forest, Wilsey, Kan. Interior view, where some thinning has been done.

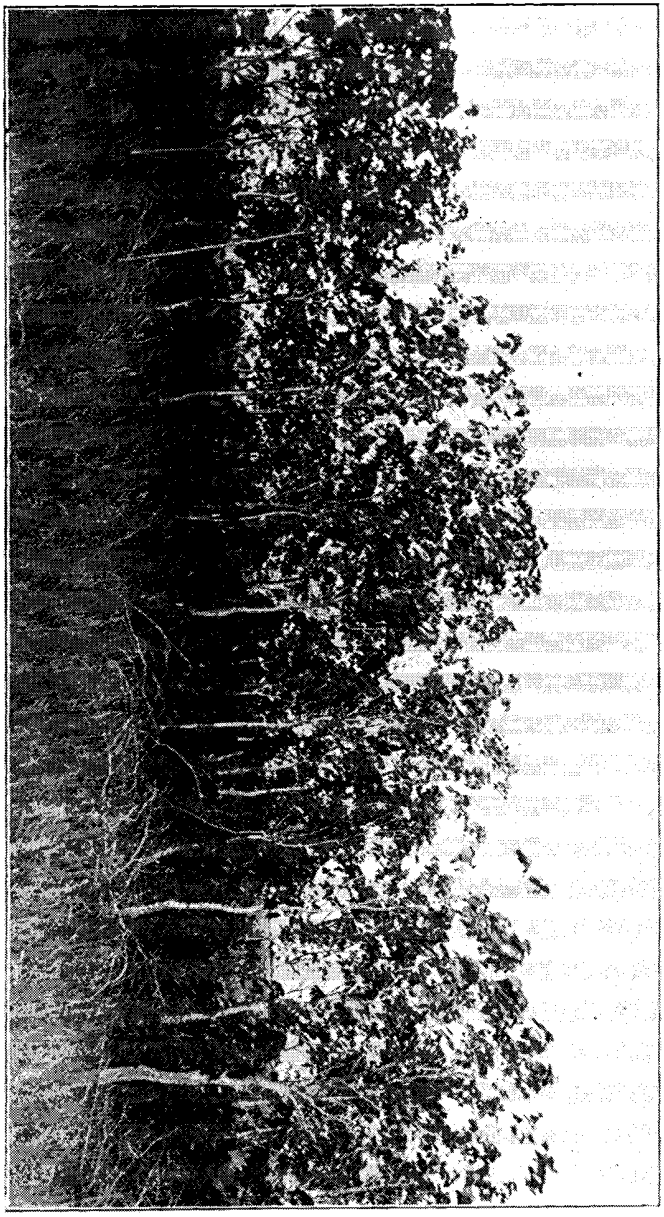

Plate 16. Tincher forest, Wilsey, Kan.

Plate 17. Yaggy forest of 580 acres, at Yaggy, near Hutchinson, Kan. General view along the exterior of eight-year-old plantation.

Plate 18. Yaggy forest. Three-year-old sprouts growing from roots five years old from the nursery. Growth cut back two years after setting, with rapidly growing sprouts, forming clean, straight trunks as a result.

Plate 19. Yaggy forest. Ten-year-old trees. Average diameter, six inches. Best trees removed.

Plate 20. Yaggy forest. General view in older portion of the plantation.

Plate 21. Yaggy forest. Eight-year-old trees, averaging four inches in diameter. Some trees have reached eight inches.

Plate 22. Yaggy forest. Catalpa posts piled for shipment. Two tiers 8 feet high, 175 feet long.

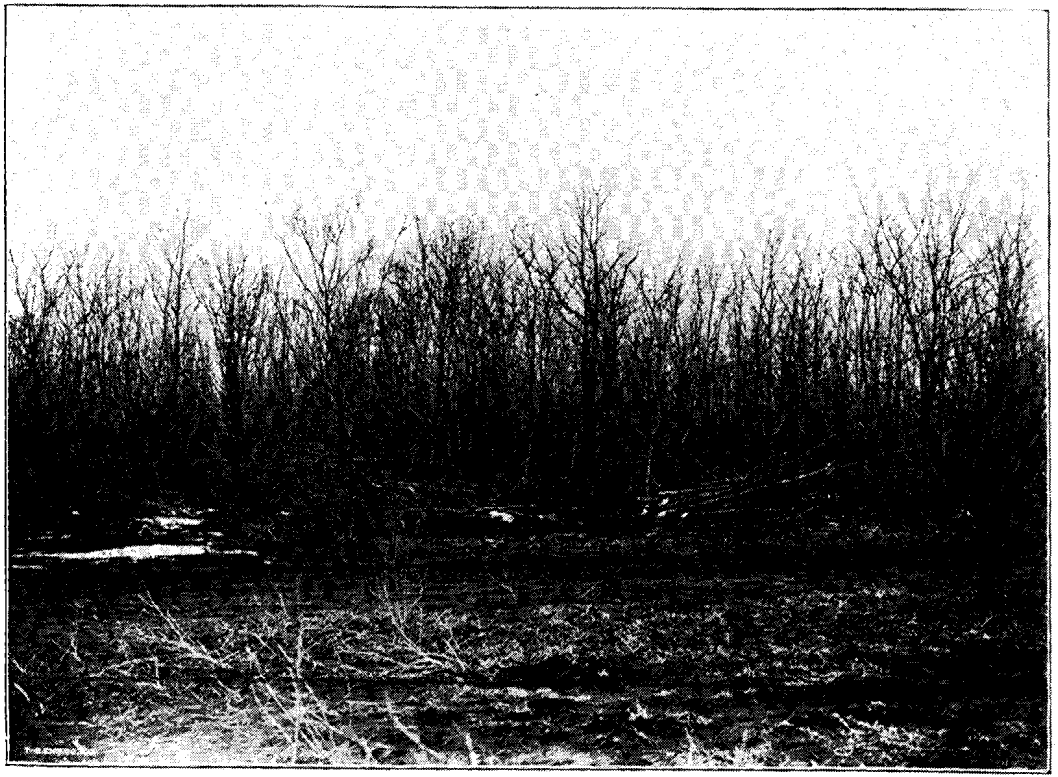

Plate 23. Yaggy forest. Posts piled along roadway in ten-year-old plantation.

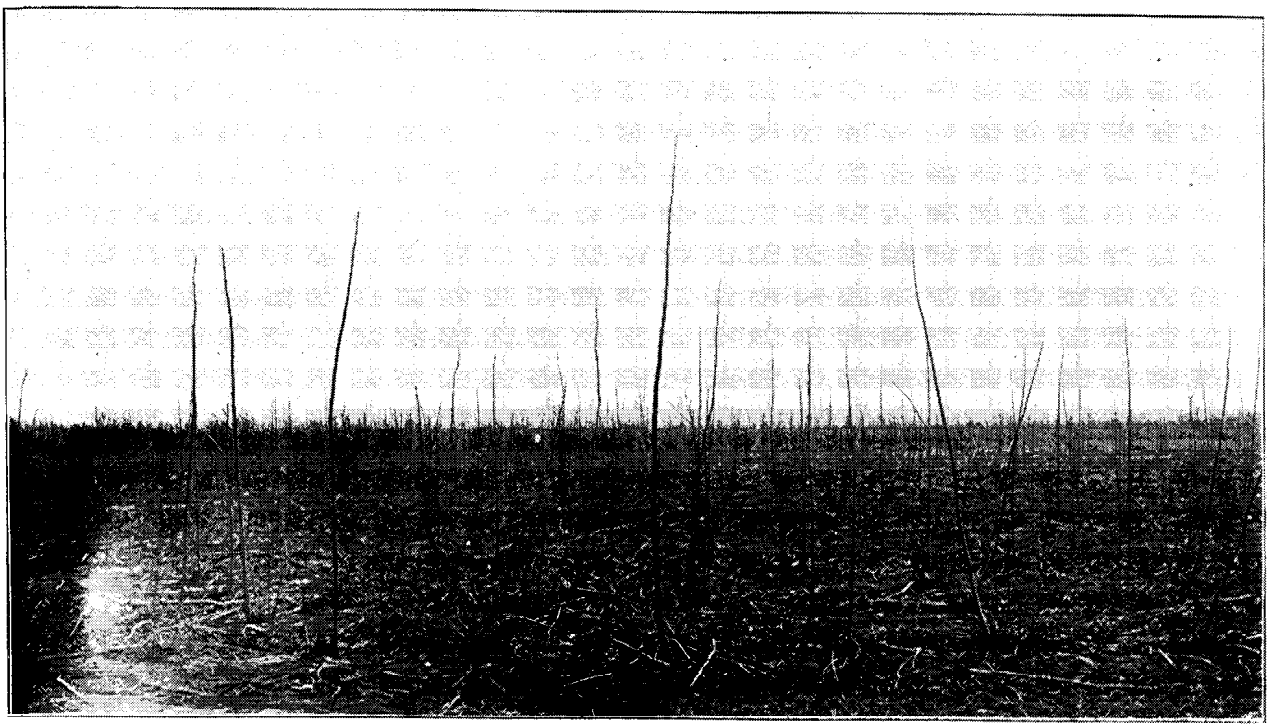

Plate 24. Yaggy forest. Ten-year-old roots from which trees were cut in 1900, and brush partly disposed of by burning on the spot. Young sprouts one year old.

Plate 25. Yaggy forest. Trees to left and extreme right two years old from five-year-old stumps. Two rows of one-year-old sprouts from stumps of the same age.

Plate 26. Golden catalpa, a form of *Catalpa speciosa* Ward, in winter condition, grounds of the Kansas State Agricultural College. Tree figured in plate 6 in summer condition. Allowed to form a low, full system of branches for ornamental purposes. Early pruning would have made a straight bole.

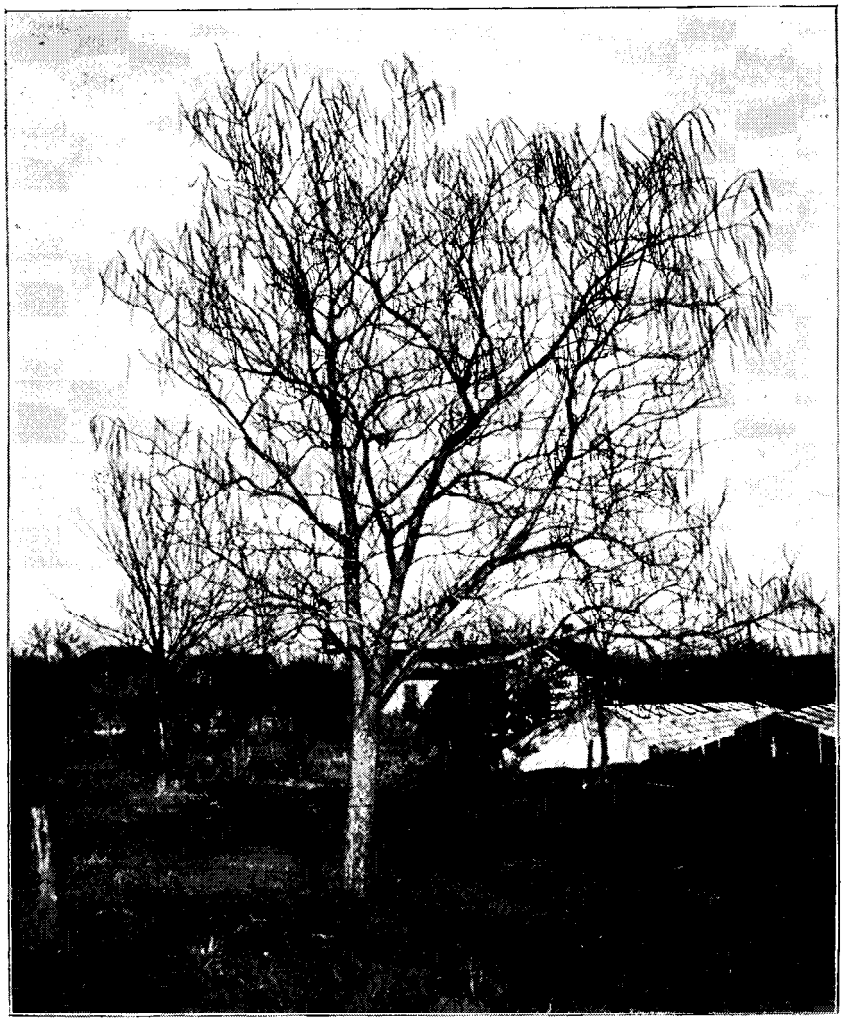

Plate 27. *Catalpa catalpa*, Ward, (*C. bignonioides* Walt.), Manhattan, Kan. Note relative abundance of pods in clusters as compared with plate 26.

Plate 28. Four trees of *C. catalpa* Karst. (*C. bignonioides* Walt.), Manhattan, Kan. The tops of all of these are dead, giving the trees a "stag-headed" appearance when in leaf.

Plate 29. *Catalpa speciosa* Ward, Manhattan, Kan., showing characteristic deeply furrowed bark, not peeling off in scales, as in plate 30.

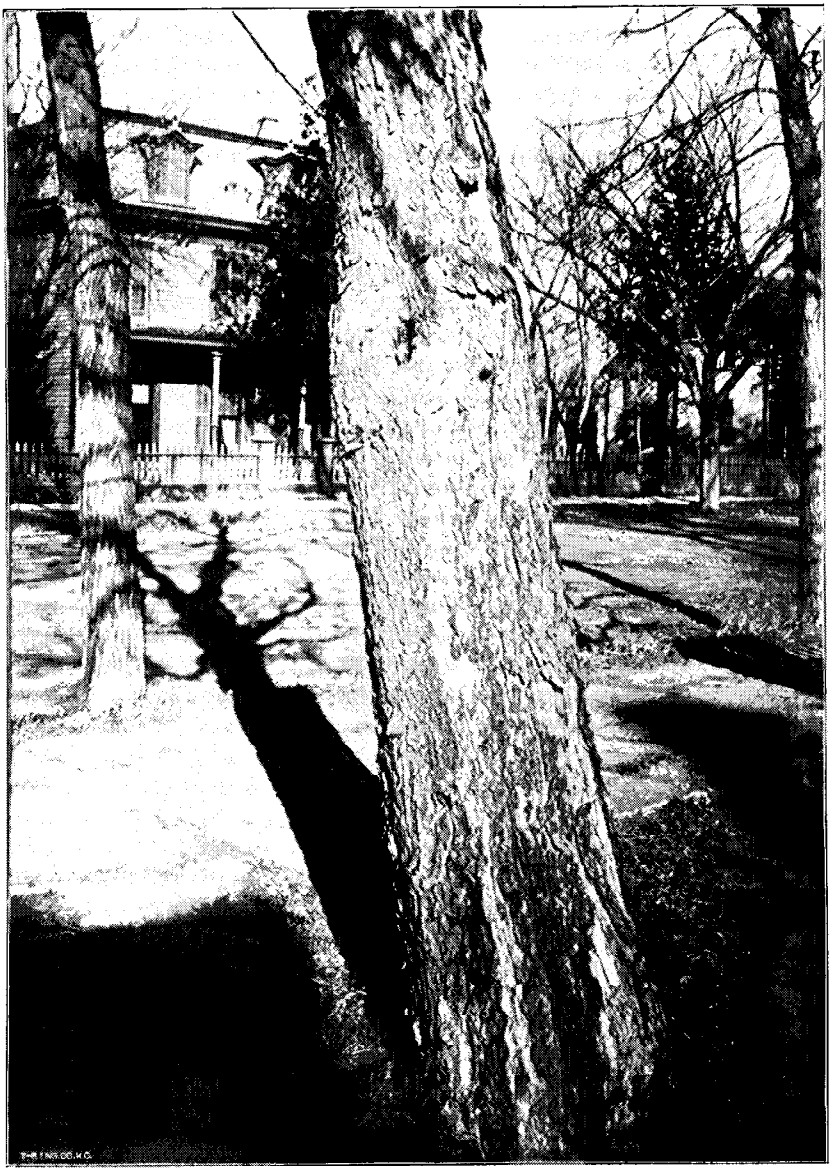

Plate 30. *Catalpa catalpa* Karst., Manhattan, Kan., showing characteristic scaly bark.

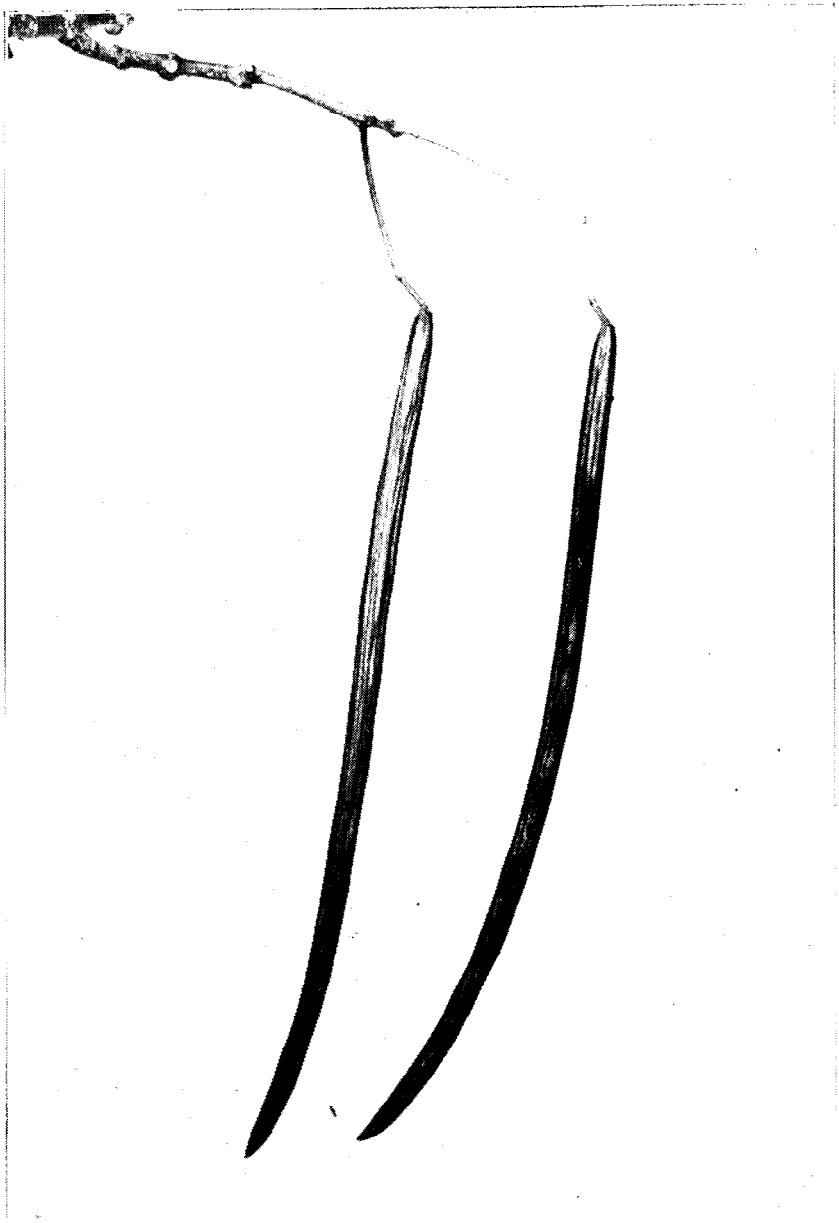

Plate 31. *Catalpa speciosa* Ward. Fruiting branch, one-third natural size.

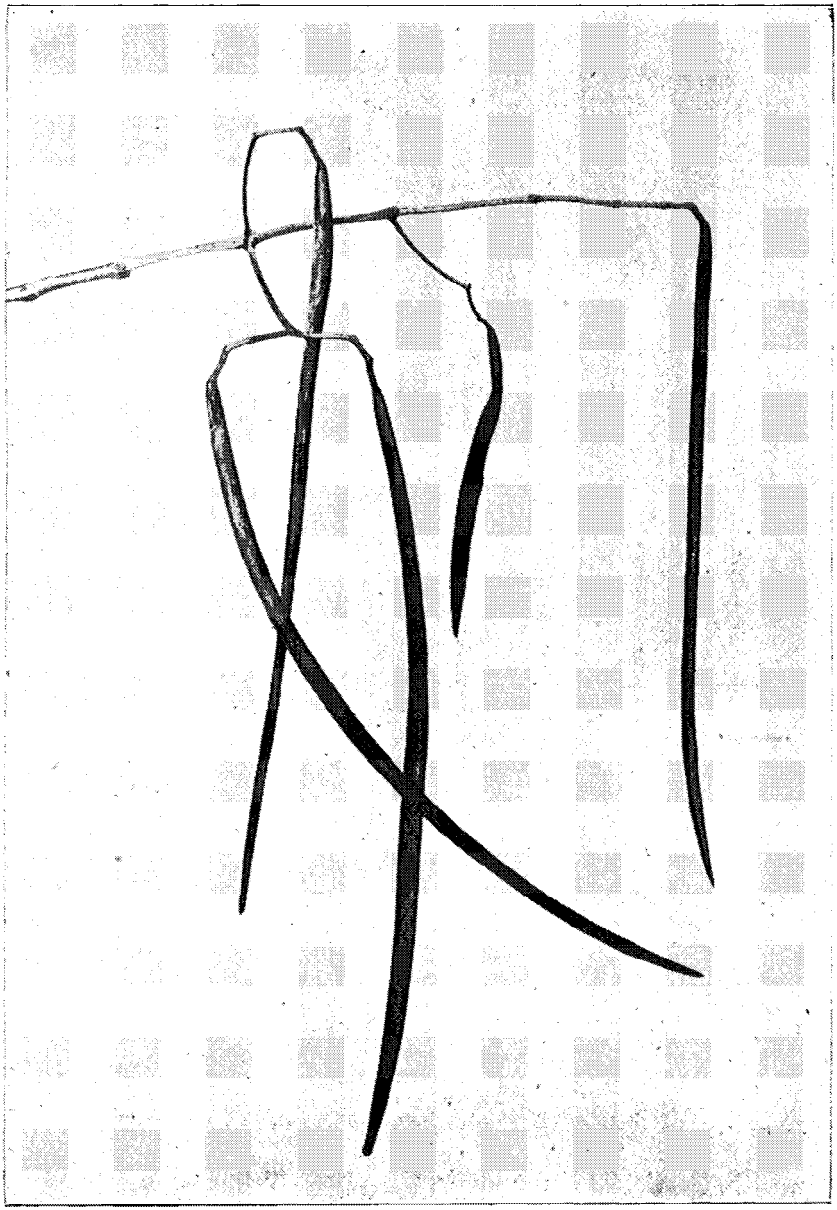

Plate 32. *Catalpa catalpa* Karst. (*C. bignonioides* Walt.) Fruiting branch, one-third natural size.

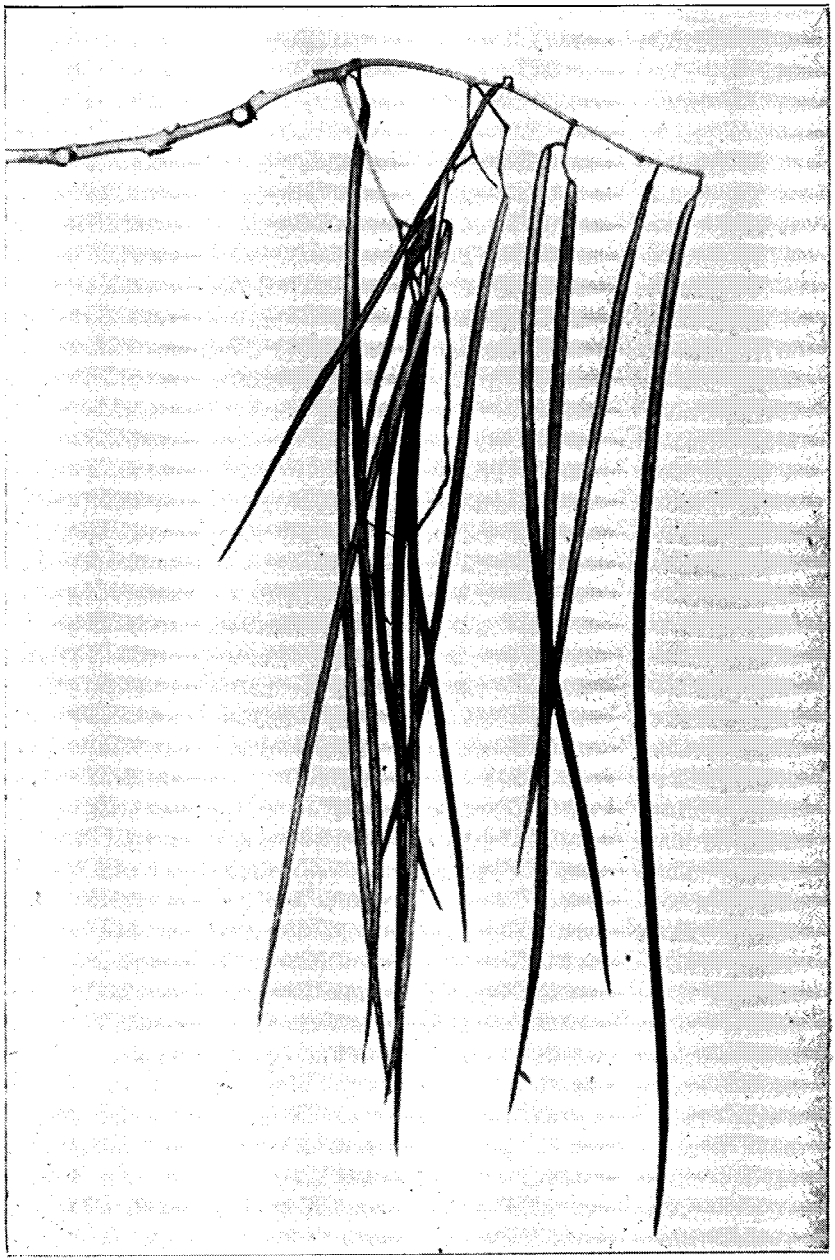

Plate 33. *Catalpa kæmpferi*, Sieb. & Zucc. Fruiting branch, one-third natural size.

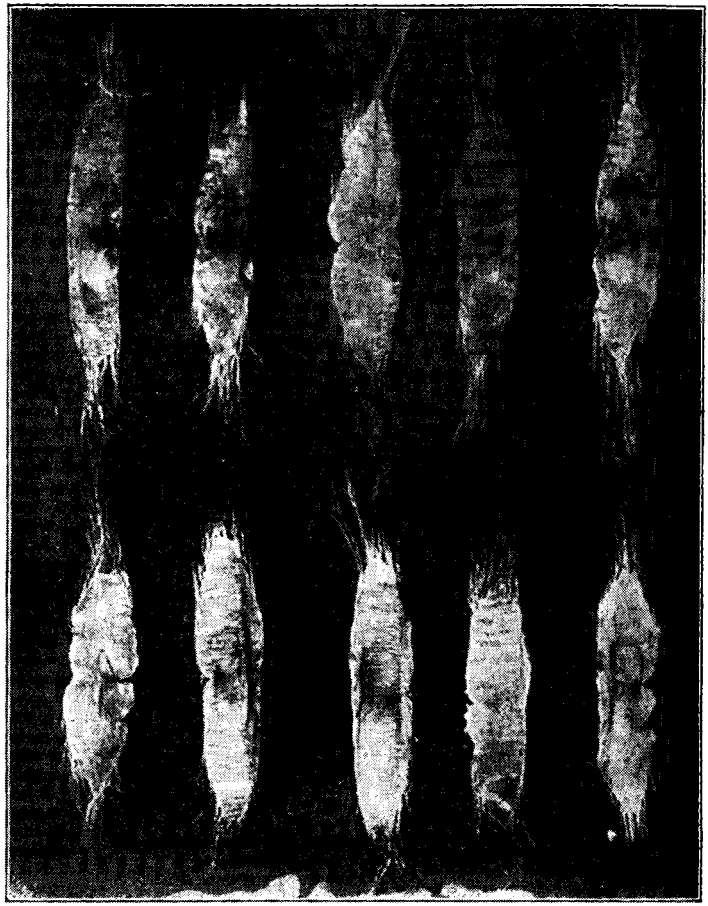

Plate 34. *Catalpa speciosa* Ward. Seeds, natural size.

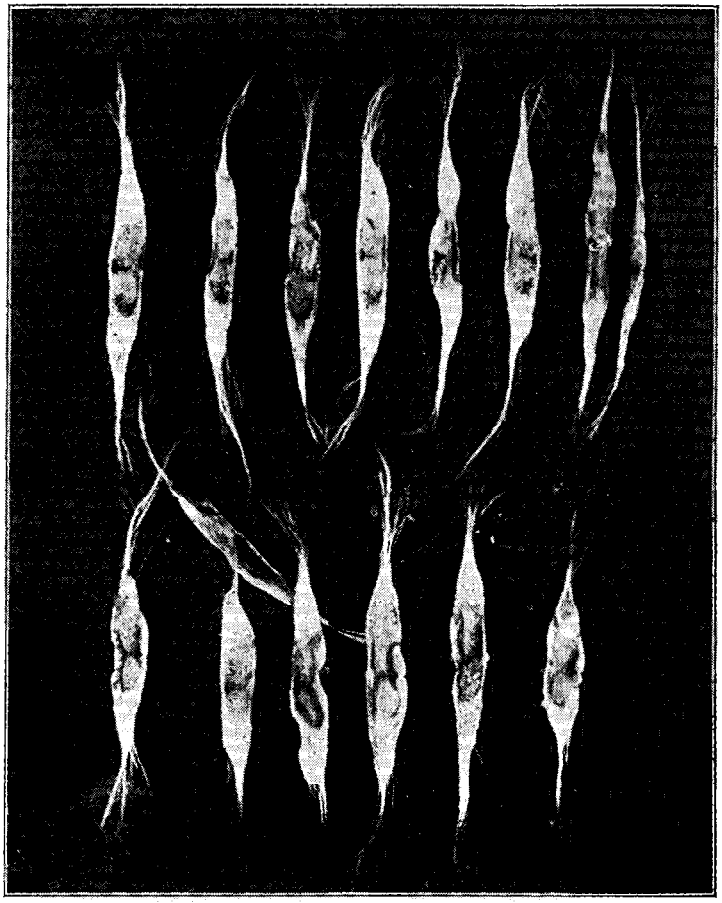

Plate 35. *Catalpa catalpa* Karst. (*C. bignonioides,* Walt.) Seeds, natural size.

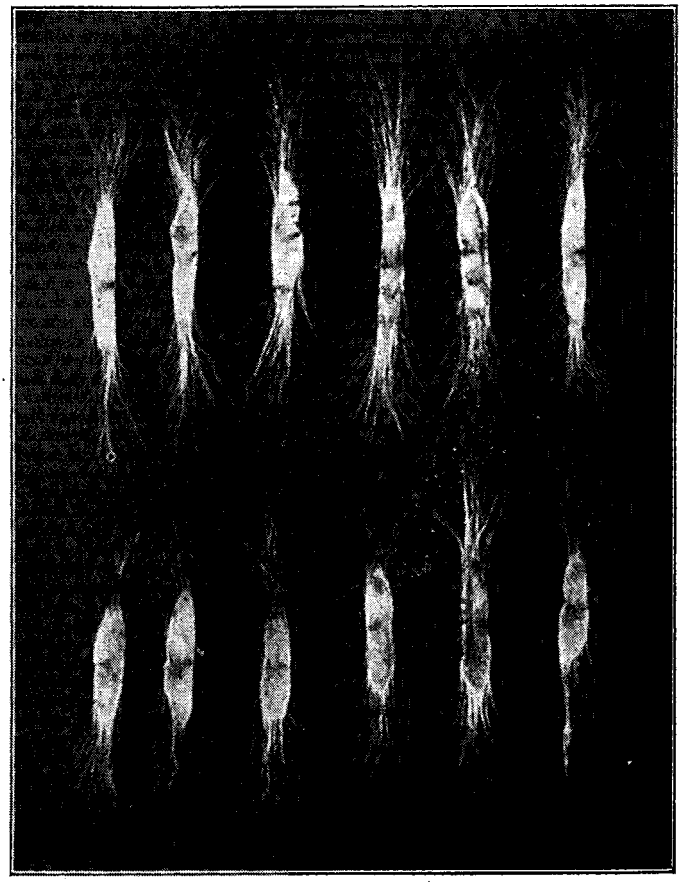

Plate 36. *Catalpa kæmpferi*, Sieb. & Zucc. Seeds, natural size. This particular tree possibly a hybrid with one of the American species.

Plate 37. From photograph furnished by United States Bureau of Forestry. Post from timber of *Catalpa speciosa* Ward, five or six years old, in ground for fifteen years. Note sound character of the wood shown in the cut face, to the left at the base of the post.

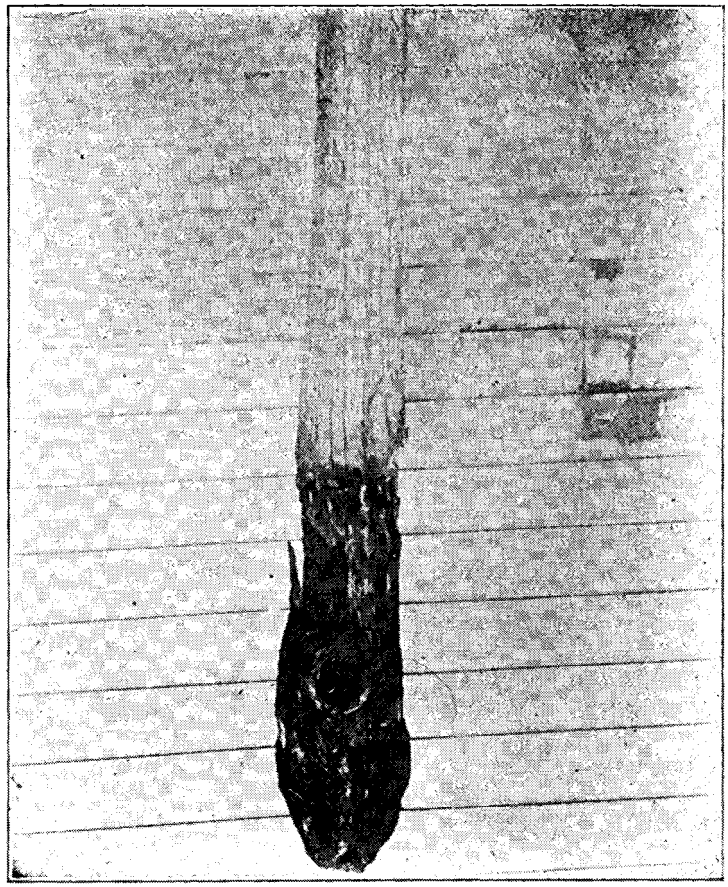

Plate 38. From photograph furnished by the United States Bureau of Forestry. Post from timber of *Catalpa speciosa* Ward, from eight-year-old tree, in the ground constantly for twelve years. Wood injured more by termites than by decay.