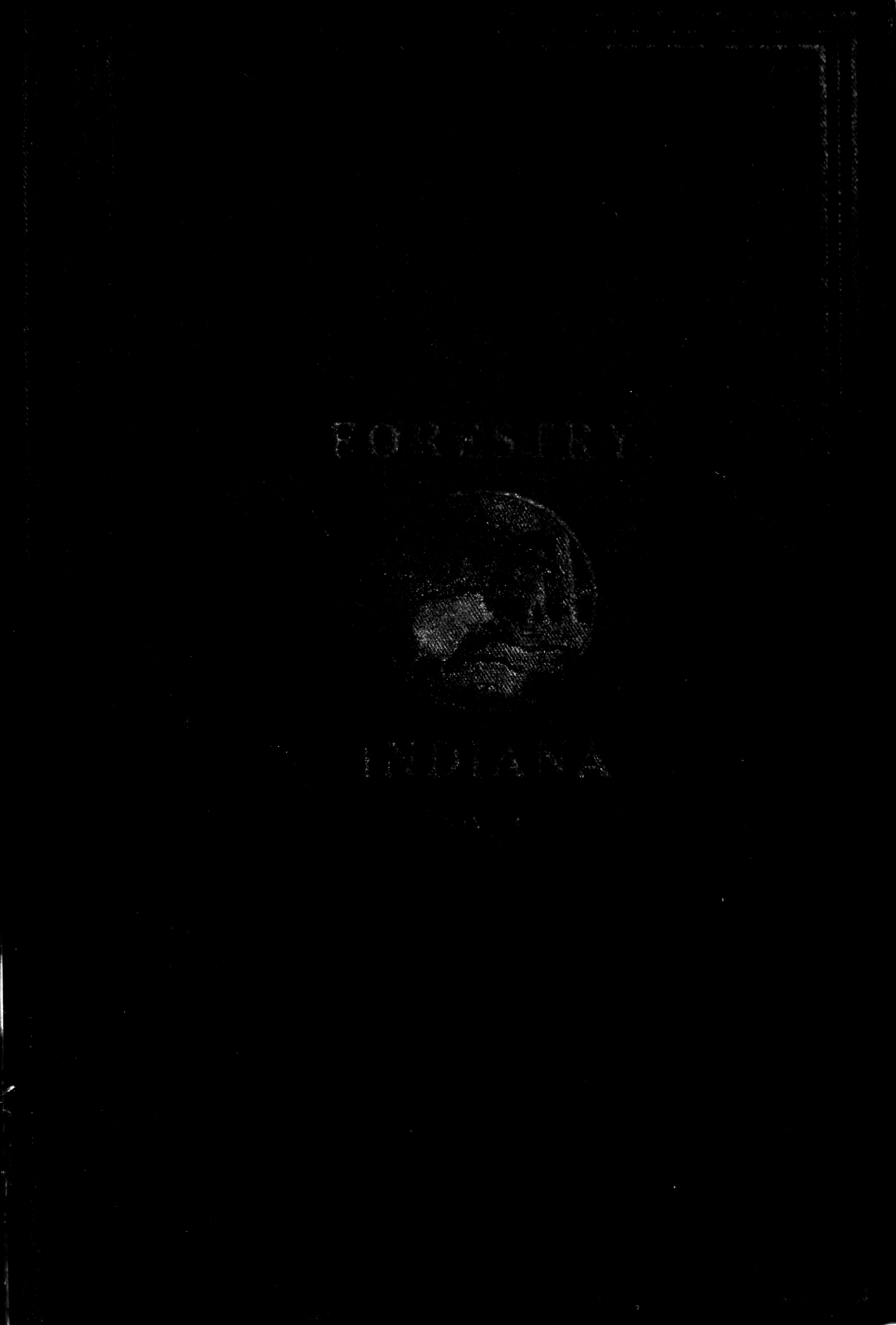

FORESTRY
INDIANA

Barton W. Evermann

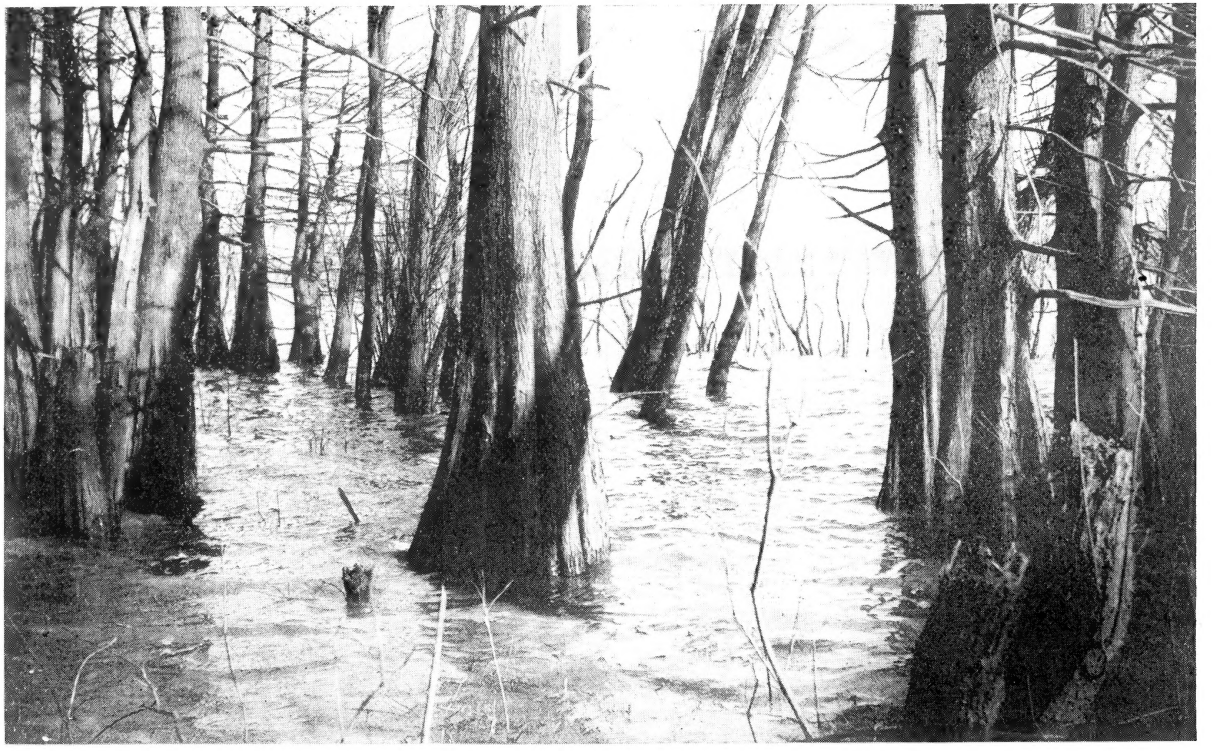
5/4/12

Compliments of

State Board of Forestry

Indianapolis, Indiana

☞We have placed you on our permanent mailing list for all publications issued by this department. It is earnestly desired that we may be favored with all of your publications.



CYPRESS (Taxodium distichum) on the west shore of Hovey Lake in Posey County. This is near the northern limit of the range of this species.

STATE OF INDIANA

Eleventh Annual Report

OF THE

State Board of Forestry

1911

CHAS. C. DEAM, Secretary

To the Governor

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1912

PLATE 132.

COUNTY MAP OF INDIANA.

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
DECEMBER 1, 1911.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, December 26, 1911.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

W. H. O'BRIEN,
Auditor of State.

DECEMBER 26, 1911.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

MARK THISTLETHWAITE,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, December 26, 1911.

L. G. ELLINGHAM,
Secretary of State.

Received the within report and delivered to the printer December 27, 1911.

ED. D. DONNELL,
Clerk Printing Board.

Letter of Transmittal.

INDIANA STATE BOARD OF FORESTRY,
INDIANAPOLIS, INDIANA,
December 1, 1911.

Hon. Thomas R. Marshall:

Sir—As required by Section 4 of the act establishing a State Board of Forestry, approved March 1, 1901, we submit herewith the Eleventh Annual Report of the Board of Forestry, beginning with October 1, 1910, and ending with September 30, 1911.

Very respectfully,

S. BURKHOLDER, President.
CHAS. C. DEAM, Secretary.

Indiana State Board of Forestry.

OFFICIAL MEMBERS, 1911.

SAMUEL BURKHOLDER, President.....Crawfordsville.
STANLEY COULTER.....Lafayette.
ARTHUR S. NOWELS.....Columbia City.
WILLIAM M. WALTMAN.....Bean Blossom.
CHAS. C. DEAM, Secretary.....Bluffton.
EMMA L. STREIBICH.....Indianapolis.

OFFICE OF SECRETARY.

Room 110, State House, Indianapolis.

Contents.

Illustrations.

PLATES.

FIGURES.

Financial Statement.

OCTOBER 1, 1910, TO OCTOBER 1, 1911.

Annual Appropriation by the General Assembly, 1909.

1.	Office—		
	Salary of secretary of board	$1,800 00	
	Salary of stenographer to secretary	600 00	
	Salary of four board members	400 00	
	Mileage of four board members	58 28	
	General office expense and mileage	1,000 00	
	Total		$3,858 28
2.	Forest Reservation and Experimental Station	$3,000 00	

Expenditures.

Office—Salary:		
Chas. C. Deam, secretary of board	$1,800 00	
Nora M. Slattery, stenographer to secretary	464 51	
Emma L. Streibich, stenographer to secretary	125 00	
Samuel Burkholder, board member	100 00	
Samuel Burkholder, board member, mileage	12 40	
Stanley Coulter, board member	100 00	
Stanley Coulter, board member, mileage	16 36	
Arthur S. Nowels, board member	100 00	
Arthur S. Nowels, board member, mileage	14 40	
William M. Waltman, board member	100 00	
William M. Waltman, board member, mileage	15 12	
Total		$2,847 79
Office—General Expense:		
Office supplies	$491 27	
Postage	120 98	
Mileage	145 45	
Hotel	55 45	
Livery	66 50	
Telephone	43 30	
Photographic supplies	54 04	
Surveying	8 00	
Express	11 40	
Total		$996 39

Reservation Expenses:		
Labor	$2,386 88	
Household supplies, hardware and tools	71 68	
Hay and corn	76 47	
Seedlings and seed	106 60	
Construction material	179 38	
Sawmill work, filing tools, etc	21 66	
Board for board members	11 75	
Freight	43 74	
Telephone and repairing	16 60	
Carbide	15 00	
Blacksmithing	22 65	
Paints, oils and brushes	38 65	
Livery	7 50	
Express	70	
Total		$2,999 26
Receipts from sales at Forest Reservation and Experimental Station and remitted to State Treasurer upon recommendation of State Auditor		$71 30

Introduction.

That the source of our timber supply within a few generations will be an acute and vital question is not a prophecy, but the statement of a fact, easily deduced from the ever-increasing price of lumber and the fast-vanishing forests. That the use of such substitutes as fibre, steel, stone and cement will not solve the problem is also a fact that is not disputed. No apology is needed for insisting that a question of such great economic importance should engage the attention of both Federal and State governments. There is hope in the vigorous efforts put forth by many of the States and by the United States Forest Service to conserve our forests, but their efforts should be made more vigorous and far-reaching.

It is much to the credit of Indiana that the question of our future timber supply received official recognition about ten years ago. At that time our legislators decided that the solution of the problem was to be found in educating the people in timber culture and in the management of their woodlots, three million acres of which existed at that time.

Accordingly, a State Board of Forestry was created and a forest experimental station of 2,000 acres was purchased on which to demonstrate timber culture. Since that time much has been accomplished in changing public sentiment from a destructive to a constructive management of our forests. The question has been presented to the public through the press, public schools, farmers' institutes, civic federations, women's clubs, etc., until now almost everyone knows something about the forestry movement, and many woodlot owners are practicing scientific forestry. The work at the forest experimental station has been developed until it is, today, the best demonstration of the growing of hardwoods in the United States.

The policy of the present board of forestry is a continuance of that of its predecessors. The work of the past year has been to develop the experiments in progress at the forest experimental station and to forcibly present the forestry problem to landowners, and to the teachers and pupils of the public schools of the State. The people should know how important it is to have

an adequate supply of timber and also that there are thousands of acres of eroded hillsides and wornout fields in Indiana which should be planted to forest trees. On investigation, however, it will be found in a majority of the cases that the owners of such lands are too poor to bear the expense of reforesting, so that this important work is neglected and conditions annually become worse.

It is becoming more and more evident to students of this problem that the burden of reforesting and protecting such lands should be transferred from the individual to the State, because individuals will not invest in an enterprise in which they are compelled to wait so long for returns as the growing of timber entails. In view of the preceding situation it is recommended that the State acquire by purchase as funds permit such lands of the State as will not permanently support agriculture and devote them to scientific forestry.

Such a recommendation is not without precedent, since many States are acquiring large holdings under various legislative enactments. Notable are the following: The Wisconsin forest reserves comprise approximately 427,000 acres, of which over 100,000 acres were purchased at an average price of $3 per acre. The State of Pennsylvania has purchased 962,580 acres at an average price of $2.24 per acre, and has under contract the purchase of about 40,000 acres more, making in all over a million acres. The Adirondack and Catskill reserves of New York comprise 1,641,523 acres, 850,829 acres of which were condemned and purchased at an average price of $4.42.

It is very evident that if, in our own State, any substantial advance is made there must be a recognition of valuable trees on the part of the woodlot owner. In order that this may be possible a list of trees of the State has been prepared. By the aid of this list and the accompanying keys the landowner will be able to determine the composition of his woodlot, to decide what species he desires to increase in number and what species he desires to reduce, and to estimate with some fair accuracy the value of his stand. It is believed that the application of the knowledge contained therein will result in a vastly improved and more profitable management of the existing woodlots.

STATE BOARD OF FORESTRY.

Reservation.

On another page in this report will be found a study of the rate of tree growth in respect to diameter and volume. This shows that for a given time that the different species of trees, as well as the individuals of the same species, vary considerably in diameter and volume. Why this variation? The answer to this question is valuable to the man who expects to plant forest trees and to the woodlot owner. They are interested in knowing which species of trees grow the fastest and will produce the greatest amount of merchantable wood products in a definite period.

However, as yet we have only an imperfect knowledge of how to make our forest trees produce the most in the shortest space of time. Additional information is desirable, which must be obtained by experiments which will extend over long periods of time. The habits of each species of trees are fixed by heredity, and man, in cultivating them, is obliged to meet the requirements of each species or change their habits by breeding.

Many experiments are now in progress at the forest experiment station, in which the habits of many species are being studied and an effort is being made to discover the laws of tree growth. The different species are studied as units, and the several species are contrasted and compared.

The experiments now in progress are for the most part to determine the relation of the more important species to soil and moisture conditions; the effect of pure and mixed stands; the effect of spacing on the rapidity of growth and quality of product; the kind and amount of pruning that should be done; the effect and value of cultivation. The results of the above experiments must be deferred for future reports, since they have not been in progress a sufficient time to warrant conclusions.

Several auxiliary experiments have been undertaken which will take several years to complete. Since a preliminary report was made last year on the experiment to determine what time of the year the several species of trees make their growth, the data obtained this year on this experiment are here given.

EXPERIMENT TO DETERMINE THE PERIODICITY OF GROWTH.

The experiment of determining the periodicity of the growth of some of our most valuable species of trees, which was begun last year, was extended this year to include ten trees each of ten species. The measurement of the growth of the terminal of the tree was taken to the nearest tenth of an inch and the measurements were taken at intervals of fifteen days throughout the growing season. In considering this year's results it should be borne in mind that a severe drought set in the first of May and continued until the middle of August.

The species measured, age and number of trees used in the experiment are as follows:

Trees number 1 to 10, yellow poplar, five years old.
Trees number 11 to 20, black locust, five years old.
Trees number 21 to 25, black walnut, seven years old.
Trees number 26 to 30, black walnut, four years old.
Trees number 31 to 35, catalpa, five years old.
Trees number 36 to 40, catalpa, three years old.
Trees number 41 to 50, chestnut oak, seven years old.
Trees number 51 to 60, chestnut, seven years old.
Trees number 61 to 70, pecan, seven years old.
Trees number 71 to 80, coffeenut, five years old.
Trees number 81 to 85, ash, seven years old.
Trees number 86 to 90, ash, four years old.
Trees number 91 to 100, elm, four years old.

The measurements and the date taken are as follows:

Tree Number.	May 16th.	May 31st.	June 15th.	June 30th.	July 15th.	July 30th	August 14th.	August 29th.
1	4.4	13.5	17.6	20.3	21.9	22.2	22.2	22.4
2	1.7	13.8	16.2	18.6	22.4	23.6	23.6	24.5
3	.3	4.5	9.3	12.6	17.5	20.2	20.5	20.9
4	1.	15.8	23.1	30.2	36.9	40.8	40.8	41.
5	3.9	16.	21.5	25.8	31.8	33.7	35.6	35.6
6	.4	5.5	8.1	10.7	11.5	11.7	11.7	11.9
7	2.9	13.9	20.1	23.4	25.8	26.2	27.	27.
8	2.	11.2	16.7	21.2	25.1	26.8	27.	27.3
9	2.7	13.7	19.6	24.3	30.5	33.9	36.9	37.1
10	2.5	12.	19.1	22.6	25.4	26.3	26.8	26.8
11	2.4	7.8	12.5	15.8	26.4	27.3	27.3	.....
12	4.2	14.4	25.5	32.7	42.5	44.4	44.4	.....
13	3.5	12.	16.8	21.9	26.1	26.4	26.5	.....
14	3.	13.5	20.7	21.6	23.	Br'k'n off		
15	3.1	12.2	17.	18.2	18.3	19.1	19.2	.....
16	2.2	13.5	25.4	34.9	44.8	45.2	45.5	.....
17	2.5	12.4	18.4	22.9	24.2	24.1	24.1	.....
18	1.5	12.6	23.	36.3	50.5	55.2	55.3	.....
19	2.2	13.2	18.6	22.6	26.7	26.7	26.7	.....
20	1.2	12.5	16.5	17.3	17.3	17.3	17.8	.....
21	.4	11.4	16.7	18.8	19.6	19.6	19.6	19.8
22	.2	6.1	7.6	7.6	7.6	7.6	7.6	7.7
23	0.	8.1	12.1	12.8	13.2	13.2	13.3	13.3
24	.4	11.9	17.5	19.4	20.6	20.6	20.6	20.6

Tree Number.	May 16th.	May 31st.	June 15th.	June 30th.	July 15th.	July 30th.	August 14th.	August 29th.
25	.5	8.9	10.9	11.4	11.1	11.	11.	11.
26	1.7	12.	20.2	27.3	27.8	28.1	28.1	28.1
27	2.5	21.3	24.5	27.2	36.6	37.8	37.9	37.6
28	3.1	17.7	21.6	23.	26.5	26.8	26.9	26.6
29	2.1	2.5	7.9	11.5	12.2	12.2	12.2	12.3
30	2.	13.7	19.5	24.5	32.1	33.	33.	33.
31	6.9	20.5	24.1	27.9	28.7	28.8	28.8	.....
32	4.3	21.5	22.8	23.	22.7	22.7	23.	.....
33	4.3	15.8	16.3	17.7	20.3	20.1	20.4	.....
34	4.8	19.3	21.6	23.9	24.5	24.4	24.4	.....
35	4.5	13.4	14.9	15.6	16.3	16.6	16.4	.....
36	4.4	16.5	17.6	19.6	32.6	34.9	35.	.....
37	6.1	20.2	24.4	29.4	37.5	38.9	39.	.....
38	3.9	14.8	18.4	24.7	33.7	33.4	32.7	.....
39	6.2	22.4	24.6	30.5	37.5	38.2	38.2	.....
40	10.7	19.4	19.6	20.	22.8	22.8	22.9	.....
41	7.5	7.8	7.8	7.9	8.4	11.1	11.1	11.2
42	5.1	5.2	5.7	5.7	5.2	5.3	5.4	5.4
43	3.4	3.4	3.4	3.9	8.3	8.5	8.5	8.5
44	7.1	7.3	7.3	7.4	9.4	9.7	9.8	9.8
45	13.7	15.	15.9	27.6	33.7	33.7	34.	34.
46	6.1	6.3	7.	12.5	22.9	22.9	23.	23.
47	5.8	5.9	8.	19.7	21.8	22.	22.	22.2
48	12.3	12.3	12.3	12.3	19.6	21.9	21.8	22.
49	5.1	6.2	6.6	13.	13.7	13.5	13.5	13.5
50	1.4	1.5	3.5	7.7	7.7	7.7	7.8	7.8
51	5.8	11.5	15.6	17.8	18.3	18.3	18.6	18.6
52	2.6	7.	8.6	10.2	11.3	11.5	11.6	11.6
53	2.9	7.1	8.9	9.8	9.8	9.9	9.9	9.9
54	1.2	4.2	4.4	4.8	14.2	14.3	14.5	14.5
55	2.3	4.7	5.9	9.3	10.8	14.8	14.9	15.
56	2.3	3.4	5.9	8.5	9.7	9.7	9.8	10.
57	1.4	2.5	Br'k'n off					
58	.9	Br'k'n off						
59	6.	15.2	19.7	23.5	27.7	27.7	27.7	27.8
60	4.4	12.2	15.	17.7	19.	19.	19.	19.
61	6.	11.7	14.3	16.9	17.4	17.4	17.4	17.4
62	10.5	19.4	21.	20.8	21.	21.4	21.4	21.2
63	4.1	15.	16.7	18.5	19.8	20.	20.	19.7
64	.7	11.8	14.4	16.1	16.4	15.9	16.2	16.3
65	.8	9.	10.	10.8	10.8	10.9	11.	10.8
66	3.9	10.5	13.5	14.	14.5	14.7	15.	15.
67	.7	9.7	12.3	15.9	15.9	15.9	15.9	15.9
68	6.2	14.8	16.3	16.3	16.8	16.9	16.9	16.9
69	.3	4.1	8.1	11.	12.2	12.4	16.1	16.8
70	0.	1.7	2.2	3.4	6.1	6.5	6.7	6.7
71	12.3	21.5	21.5	21.6	21.8	22.	22.2	.....
72	11.1	16.3	16.3	16.3	16.3	16.3	16.4	.....
73	16.	25.2	25.4	25.5	25.7	25.9	26.	.....
74	11.9	13.5	14.3	14.3	14.4	14.4	14.4	.....
75	9.4	15.5	16.4	16.5	17.7	19.1	19.8	.....
76	13.9	23.	23.	23.	23.	23.	23.	.....
77	11.2	15.8	15.8	15.8	15.8	15.8	15.8	.....
78	6.7	17.4	18.	18.	18.	18.	18.5	.....
79	11.	19.5	19.6	19.6	20.	20.	20.	.....
80	11.6	28.	28.	28.	28.	28.4	28.5	.....
81	17.	22.7	22.7	22.9	22.9	23.	23.1	.....
82	13.2	22 5	23.	23.	23.	23.1	23.3	.....
83	16.4	21.3	21.3	21.3	21.3	21.3	21.3	.....
84	17.3	25.7	25.8	25.9	25.7	25.6	25.6	.....
85	14.8	31.1	31.3	31.4	31.4	31.3	31.3	.....
86	17.5	23.	23.	22.8	22.8	22.6	23.6	.....
87	15.7	29.	29.	28.9	28.8	28.9	29.	.....
88	4.7	18.4	21.3	21.4	21.5	21.4	21.4	.....
89	13.9	21.3	21.3	21.3	21.3	21.3	21.5	.....
90	15.1	21.2	22.4	22.7	25.3	25.8	25.8	.....
91	1.6	3.	3.	3.1	3.3	3.3	3.3	3.3
92	0.	13.4	25.3	35.3	45.	51.3	52.4	53.1
93	15.1	22.5	22.5	23.4	32.	33.4	34.9	34.9
94	7.8	13.2	14.5	16.5	25.1	25.4	25.6	26.4
95	9.7	23.3	31.3	31.5	46.7	55.7	56.3	56.3
96	11.5	24.2	32.9	42.1	53.4	61.4	62.5	62.5
97	10.7	18.1	18.9	19.4	19.6	28.6	28.7	Br'k'n off
98	11.4	19.5	21.8	22.1	32.2	37.	37.7	38.2
99	7.	9.5	10.2	17.5	27.5	28.5	29.	29.
100	9.8	23.1	28.1	30.2	39.1	49.5	49.5	50.2

The average growth of the species for the fifteen-day intervals is as follows:

	May 16th.	May 31st.	June 15th.	June 30th.	July 15th.	July 30th.	August 14th.	August 29th.
Poplar	2.18	11.99	17.13	20.97	24.88	26.54	27.21	27.45
Locust	2.58	12.41	19.44	24.42	29.98	31.74	31.86	
Walnut	1.29	11.36	15.85	18.35	20.73	20.98	21.02	21.
Catalpa	5.61	18.38	20.43	23.23	27.66	28.08	28.08	
Chestnut Oak	6.75	7.09	7.75	11.77	15.07	15.63	15.65	15.74
Chestnut	2.98	7.64	10.50	12.70	15.10	15.65	15.75	15.80
Pecan	3.32	10.77	12.88	14.37	15.09	15.20	15.66	15.67
Coffeenut	11.51	19.57	19.83	19.86	20.07	20.29	20.46	
Ash	14.76	23.62	24.11	24.16	24.40	24.43	24.59	
Elm	8.46	16.98	20.85	24.11	34.39	37.41	37.99	39.32

The average growth of the species at the end of the monthly intervals is as follows:

	May 31st.	June 30th.	July 30th.	August 29th.
Poplar	11.99	20.97	26.54	27.45
Locust	12.41	24.42	31.74	31.86
Walnut	11.36	18.35	20.98	21.
Catalpa	18.38	23.23	28.08	28.08
Chestnut Oak	7.09	11.77	15.63	15.74
Chestnut	7.64	12.70	15.65	15.80
Pecan	10.77	14.37	15.20	15.67
Coffeenut	19.57	19.86	20.29	20.46
Ash	23.62	24.16	24.43	24.43
Elm	16.98	24.11	37.41	39.32

The growth of the species at the end of June, expressed in the percentage of the year's growth, is as follows:

	Per Cent.		Per Cent.
Poplar	76	Chestnut	80
Locust	77	Pecan	92
Walnut	87	Coffeenut	97
Catalpa	83	Ash	99
Chestnut Oak	75	Elm	61

Another experiment, on which a preliminary report may be made, is one "to determine whether the lobing of the catalpa leaf has a specific significance, and to what extent the lobing is influenced by cultivation, pruning and the age of the tree." This experiment was undertaken to refute or corroborate the idea held by some persons that the true catalpa speciosa never has lobed leaves. In this experiment the leaves on 130 trees were counted

in 1910 and 1911. The total number of leaves, the number with one lobe and the number with two lobes were counted. The trees used were selected from four tracts of catalpa of different ages. Ten consecutive trees, selected from an average row, constitute a group, which is the unit used in this experiment. One or more units were selected from each tract. Some of the units were from parts of the tracts that had been cultivated and pruned, and other units from parts that had not been cultivated or pruned.

A detail of the counts of the several groups is not given, and only the totals of the several groups are given at this time. In 1910 ten of the 130 trees contained lobed leaves. In 1911 twenty-nine of the 130 trees contained lobed leaves. Five trees only had lobed leaves both years. It will be noted that twenty-nine of the 130 trees had lobed leaves one year and entire leaves the next.

CULTIVATION AND PRUNING OF THE EXPERIMENTAL TRACTS.

The younger plantations were cultivated with a two-horse cultivator and the older ones with a one-horse cultivator. Some of the older tracts were given cultivations and hoeings that were not necessary for the forest growth, but in order to make the tracts accessible to visitors it was necessary to keep down briars and weeds.

The value of pruning is demonstrated in each tract. A part of each tract is permitted to grow without pruning and the remainder receives some kind of pruning. The purpose of pruning is to obtain a straight tree and to prevent it forming a permanent fork. In the main the coppice method appears to be the most economical and satisfactory method of accomplishing the above results, especially with walnut and catalpa.

Last spring the greater part of Tract No. 5 was coppiced. This tract was planted to walnut in 1905, and since the species is not well adapted to the soil the trees have not made a rapid growth and a majority of them had a bushy top and only a few an upright leader. Seven thousand six hundred and forty-two were coppiced and only 52 failed to sprout from the stump.

Extensive experiments have been started in the coppicing of catalpa. The purpose of these experiments is to obtain information on the following points: To learn if the catalpa should be coppiced when 1, 2 or 3 years old. To determine if coppicing at one time of the year produces more favorable results than at an-

cther, and if all the coppice shoots should be permitted to grow one year and then remove all but one, or should all but one be removed when they are about fifteen inches high. To study the effect of high and low stump and the value of treating the stumps with an antiseptic.

The amount and cost of cultivation and pruning for the year 1911 are as follows:

Number of Tract.	Number of Acres.	Number of Times Hoed and Cultivated.	Cost of Hoeing and Cultivating.		Cost of Pruning.		Total Expense.
			Total.	One Acre Once.	Total.	Per Acre.	
1-A	.65	1	$0 87	$1 34	$0 35	$0 53	$1 22
1-B	1.24	1	1 40	1 13	70	56	2 10
2	2.38	1	5 55	2 33	1 58	66	7 13
3	2.98	1	1 75	58	4 37	1 43	6 12
4	1.96	1	37	18	3 15	1 60	3 52
5	6.69	1	6 40	95	6 48	96	12 88
16	5.64	1	7 93	1 35	2 10	37	10 03
20	.18	2	60	1 66	09	50	69
21	2.71	1	5 65	2 08	1 75	64	7 40
22	.27	.....	.....	.....	35	1 29	35
23	.51	3	1 76	1 15	18	35	1 94
24	2.89	3	13 21	1 52	1 40	48	14 61
25	8.83	5	22 95	51	.....	.....	22 95
26	1.71	.....	.....	.....	1 05	61	1 05
27	.62	.....	.....	.....	53	85	53
28	9.92	4	34 54	84	.....	.....	34 54
29	.10	1	14	1 40	09	90	23
30	.07	1	14	2 00	05	71	19
31	.60	3	2 85	1 58	09	15	2 94
32	.52	.....	.....	.....	70	1 34	70
33	6.40	4	25 75	1 00	3 84	60	29 59
34	3.79	4	27 46	1 80	.....	.....	27 46
36	4.11	1	10 30	2 50	1 93	47	12 23
37	6.22	4	48 40	1 94	1 58	25	49 98
38	2.14	4	21 09	2 46	56	26	21 65
39	4.18	4	33 22	1 98	88	21	34 10
40	2.53	4	25 47	2 51	1 40	55	26 87
41	5.04	2	30 00	2 62	1 93	38	31 93
42	1.02	3	7 30	2 38	1 40	1 37	8 70
43	5.78	4	22 04	95	.....	.....	22 04
44	3.90	4	13 12	84	35	09	13 47
Total..	95.49	.....	$370 27	$1 54	$38 88	$0 67	$409 15

Average cost of hoeing and cultivating one acre once..... $1 54
Average cost of pruning per acre..... 67

Field Planting.

All of the field planting contemplated was completed, but under adverse conditions. The work was delayed on account of heavy rains until late in the season, and was at last done when it was too wet for the best results. Immediately after planting it turned dry and there was practically no rain for over three months.

Over one-half of the tulip trees planted appeared at first as if they would perish, but after the August rains they began to leaf out near the base. The black locust also had a hard struggle, but did well after the rain. Practically all of the ash, elm and sycamore seedlings that were planted this spring survived, but the growth was retarded by the long drought which occurred during the growing season.

The following planting was done: The two ravines which were cleaned and plowed last fall were planted with seedlings of elm and sycamore in alternate rows 3½ feet apart and 3½ feet apart in the rows. They received no cultivation, and before fall they were overtopped by the weeds, but not before the trees had made most of their growth. The soil being moist in the ravines the trees all lived and the growth was excellent.

The vacancies in tract 28 caused by the death of the walnut and hickory were filled with seedlings of the same species.

The 2-year-old ash in tract 34 were reinforced with 920 1-year-old ash seedlings.

Tract 25.

The general surface is a flat ridge with an eastern aspect, gradually sloping on the north to a ravine and somewhat abruptly sloping on the south to a ravine. Average elevation, about 530 feet. Area, 8.83 acres. The soil is a light clay loam. The general shape is that of a square, the south boundary being irregular, since it follows the ravine.

This tract is an experiment in growing tulip or yellow poplar for the final stand with a financial rotation in view. It is designed in this experiment to determine, if possible, the most profitable way to manage a forest crop of this species.

Accordingly, the tract was divided as nearly as possible into four equal parts, with a space of twelve feet between the divisions for a turn row. The divisions are designated as follows: Part 1, containing one-fourth of the tract; part 2, containing one-fourth of the tract; part 3, containing seven-thirty-sixths of the tract; part 4, containing eleven-thirty-sixths of the tract.

The tract was plowed late in the fall of 1910, and this spring, just before planting time, it was disced and marked out, 4x4 feet, at a total cost of $3.09 per acre. The four parts were planted on April 27, as follows:

Part 1 was planted with tulip and locust, alternately, 8x8 feet apart. This part contains 697 tulip and 697 locust. Corn was planted in the cross-sections between the trees as an undercrop. The trees and corn in this part received five cultivations during the season.

Part 2 was planted with tulip, 8x8 feet apart. This part contains 1,394 trees. Corn was planted in the cross sections between the trees as an undercrop. The trees and corn in this part received five cultivations.

Part 3 was planted with tulip and locust, alternately, 4x4 feet apart, and received five cultivations. This part contains 2,362 tulip and 2,362 locust.

Part 4 was planted with tulip, 4x4 feet apart, and received five cultivations. This part contains 6,787 trees.

The tract was planted with seedlings twelve to eighteen inches long. The tulip cost $3.20 per thousand, delivered, and the locust $2.10 per thousand, delivered.

A tabulated statement of the items of expense and credits for the several parts for the year is as follows:

Part 1.	Preparation of the ground, seedlings and planting	$12 76
	Fertilizer for corn, planting corn and five cultivations	8 57
	Cutting and husking 38 shocks of corn	4 93
	Total	$26 26
	Credited by 28 shocks of fodder at 10 cents each and 47 bushels of corn at 50 cents per bushel	27 30
	The undercrop pays all expense to date with a balance of	$1 04
Part 2.	Preparation of the ground, seedlings and planting	$13 54
	Fertilizer for corn, planting corn and five cultivations	8 57
	Cutting and husking 38 shocks of corn	4 93
	Total	$27 04

	Credited by 38 shocks of fodder at 10 cents each and 47 bushels of corn at 50 cents per bushel	27 30
	The undercrop pays all expense to date with a balance of	$0 26
Part 3.	Preparation of the ground, seedlings and planting	$25 91
	Five cultivations	5 47
	Total	$31 38
Part 4.	Preparation of the ground, seedlings and planting	$43 37
	Five cultivations	7 08
	Total	$50 45

The items of expense and credits on each part will be added each year, so that the value of each part may be obtained at any time by crediting the account with the estimated value of the stand. Thus a comparative value of the four parts may be obtained and a satisfactory answer be given to the question which one of the four parts is the most remunerative at any period. A comparison of the four parts will also show which method of management will produce the best quality of wood and on which part the diameter and volume growth has been the most rapid.

The question naturally arises, which of the parts will be the most remunerative in fifty, seventy-five or 100 years? Let a prediction be made for a period of fifty and seventy-five years, using in the discussion silvicultural experience, current prices, present uses of the wood and the present proximity to market. Of course it would appear safe to assume that in fifty years, labor would be cheaper and stumpage value higher. In the following discussion, additional expenses, such as interest on land investment, taxes and management are not considered, since they would be about equal on the four parts.

By referring to the preceding tabulated statement of the items of expense on part 1, it will be observed that at the end of the first year it had an asset of $1.04, which should be considerably increased by the proceeds of next year's undercrop. In about twelve years the part could be thinned by cutting out the locust, which at this time should be large enough to make an average-sized fence post, with a stumpage value of 8 cents each. It will be noted that when the trees are planted 8x8 feet apart that few of them would be totally suppressed by this time, and since the stand was complete in the beginning it appears that a loss of 14

per cent. by death, by suppression and by being undersized would be a liberal allowance. This leaves 600 trees valued at 8 cents each, or a total of $48 to be credited to this part, which alone is a fair rental for the quality of ground planted, and an important item if it would be found necessary to terminate the investment at an early period. The assets on this part, at 6 per cent. compound interest, carried to the end of fifty years, would amount to $458, and at the end of seventy-five years to $1,964.

Part 2 also ends the year with an asset which would be increased by next year's undercrop equal to that of part 1. Now the thinnings on this part under twenty-five years could be utilized practically only for fuel, pulp and excelsior. Fuel of this species and size in this State would have little or no stumpage value. Since there is no pulp mill in the State, long transportation would cancel the stumpage value. There is, at present, but one excelsior factory in the State, and timber of this size would have little or no value. In this part the final cut is about the only source of revenue that could be expected. The asset at the end of the first year on this part of 26 cents, at 6 per cent. compound interest, in fifty years would amount to $5, and in seventy-five years to $19.

Part 3 ends the year with a debt of $31.38, which may be liquidated when the locust are large enough to cut. Planted as near as the trees are in this part, it would take the locust at least fifteen years to equal in size those in part 1 in twelve years. Now it is problematical how many of each species in this part would be suppressed by this time. It is fair to presume that at least half of each species will have been suppressed. This would leave 1,181 locust to be cut, with a stumpage value of 8 cents each, or $94.48 for the part. The original cost of $31.38 at 6 per cent. compound interest for fourteen years amounts to $70.72, which, subtracted from $94.48, leaves an asset of $23.76, which, carried at 6 per cent compound interest to the end of fifty years, amounts to $183, and at the end of seventy-five years to $784. This part also has the advantage of being a safer investment, and, when compared with the other parts, a smaller loss would be sustained in proportion if it was found necessary to discontinue the investment at an early period.

Part 4 ends the year with a debt of $50.45. The value of the thinnings on this part would be similar to that of part 2, and the only source of revenue that could be expected would be the

final cut. Now the original item of expense of $50.45, at 6 per cent. compound interest, in fifty years would amount to $929, and in seventy-five years to $3,982.

The following is a comparative financial statement of the parts at the end of fifty and seventy-five years, based upon the preceding figures and figuring parts 3 and 4 to contain the same area as parts 1 and 2 and proportioning the cost accordingly:

	At 50 Years.	At 75 Years.
Part 1 has an asset of	$458 00	$1,964 00
Part 2 has an asset of	5 00	19 00
Part 3 has an asset of	235 00	1,008 00
Part 4 has an indebtedness of	759 00	3,258 00

Each part would also have a credit of the standing tulip, which no doubt would vary somewhat in each part. The most rapid diameter growth would be expected in part 1, where the trees are the farthest apart. The greatest number of trees to the acre would be expected in parts 2, 3 and 4. The best quality of wood would be expected in parts 3 and 4. Now the question remaining unanswered is, will the greater number of trees and quality of wood on parts 2, 3 and 4 equal the value of the undercrop and the early crop of locust in part 1. The difference between parts 1 and 4, expressed concretely, is $1,217 at fifty years and $5,222 at seventy-five years.

The foregoing hypothetical statement of the maturity of this tract is given to show the anticipated value of this experiment. Attention is called especially to the value of an undercrop in reducing the cost of a forest investment and the value of an early rotation of the crop. An early rotation diminishes the risk of fire, of windstorm and of the damage by insects and disease. It also gives greater security against decline in prices, removal of the markets and against a loss occasioned by some unexpected reason for ending the investment.

TRACT 43.

The greater part of this tract is a gentle eastern slope. The east third is low and flat. The natural drainage is to the south, through a shallow depression near the east side. Average elevation about 540 feet. The soil is a light clay loam. The area is 5.78 acres.

This is an experiment in planting an old cleared field with ash, elm and sycamore. It is designed to show the effect and

value of planting ash in a pure stand at a distance of 8x8 feet apart with corn as an undercrop. All of the tract that is adapted to the growing of ash was planted with that species. The low ground was planted in a similar manner with elm and sycamore in alternate rows. The value of pruning, if any, will be demonstrated by pruning one-half of the tract and leaving the other half to grow without pruning.

The tract was plowed last fall, disced and marked out 4x4 this spring at a total cost of $3.20 per acre. The seedlings used were twelve to eighteen inches in length. The ash were grown in the nursery on the reservation and are estimated to cost $1.75 per thousand. The elm seedlings cost $6 per thousand, delivered. and the sycamore $11.20 per thousand, delivered. The items of expense on this tract for the year are as follows:

Preparation of ground, seedlings and planting	$51 19
Seed corn and planting the corn	5 22
Fertilizer	3 75
Four cultivations	13 32
Cutting and husking the corn	16 88
Total	$90 36
Credited with 123 shocks of fodder at 10 cents and 153 bushels of corn at 50 cents	88 80
Expense balance	$1 56

This tract will be cultivated and undercropped in corn next year, and the undercrop should more than pay the expense of cultivation, which will start the plantation free of debt.

TRACT 44.

This tract is comparatively level, with the natural drainage to the east. The soil is a thin clay loam. Average elevation, 625 feet. The area is 3.90 acres.

This tract was begun in the fall of 1906 by planting the seeds of chestnut and walnut, in rows five feet apart and five feet apart in the rows. Every third row was planted with walnut. The planting resulted in a fair stand of walnut, but the chestnuts failed to grow and elm seedlings were planted in their stead, and they also failed to grow.

This spring the spaces between the rows of walnut were plowed and two rows of locust planted in each space. Locust is adapted

to the soil and was planted as a nurse crop, to be removed when the plantation needs thinning. The locust at that time should be of sufficient size to have some commercial value.

No account was kept of the items of expense of this tract prior to 1910. The items of expense for the present year are as follows:

Preparation of ground, 3,562 locust seedlings and planting	$22 68
Four plowings and hoeings	13 12
Total	$36 10

The locust seedlings practically all grew and did fairly well, considering the dry season and that they were set late in the season on account of the wet spring.

FOREST CLEANING.

Very little forest cleaning was done during the year. All that was done was near the administration building and along the roads at odd times by the custodian and teamster. About one hundred and fifty dollars was spent in cleaning and grubbing the old fields for the fall and spring planting.

INSECTS.

The insect damage this year was of little consequence.

The tract of Kentucky coffeenut was attacked by the blister beetle about the middle of July and was partially defoliated. The injury was so late in the growing season as to be of little damage, since, by actual measurement, it was found that the coffeenut had completed its growth by the first of June.

Last year, in September, many of the beetles (Xyloryctes satyrus) burrowed into the ground at the base of the ash trees in Tracts 1-A and 1-B. It was anticipated that the larvae would attack the roots of the trees, but this year no trace of either larvae or adults has been seen. The ground around the trees was bare, and it may be that the beetles perished during the winter.

The larvae of a species of Datana partially defoliated the pecan last year, but they did not appear this year.

A blight suddenly appeared in the tract of chestnut in June and several of the trees were partially killed before it ceased.

This year the catalpa sphinx appeared about June 15th in Tracts 40 and 42, and in the fall in Tract 33. The second brood appeared about September 15th. The damage was slight, since

only a few trees were completely defoliated. The sphinx appeared in patches, attacking five to eight trees in a place and usually only partially defoliating them. In Tract 33 they were noted in four places only.

Last year the locust borer attacked several of the largest trees of the two older locust plantings, but no evidence of them was seen this year.

The locust twig borer attacked the locust in Tract 25, which was planted this year. It is estimated that 25 per cent. of the terminals have been injured.

FOREST FIRES.

Great precaution is exercised to prevent fires. No fire escaped on the reserve during the year, neither was it invaded by fire. No hunting or smoking is permitted, and hunting and forest-fire signs are posted in conspicuous places on the reserve and every few hundred feet around the boundary. The fire lines are carefully kept and a supply of fire-fighting apparatus is kept in readiness at two points on the reserve.

GENERAL IMPROVEMENTS.

The condition of some of the buildings was such that it was decided to do the following painting: The barn near the administration building was given two coats, the porch of the administration building was given one coat, and the traction line station, which is the property of the reserve, was also given two coats. All the buildings on the reserve are now well protected with paint.

The roof of the old shed in which tools, were kept was so badly decayed that it no longer protected the tools, so that it was necessary to put on a new roof. An examination of the building showed that it had no foundation and that the structure was supported by wood posts set in the ground, which were nearly rotted off. It was decided that the building was not worth repairing and a new building was ordered constructed and located in a more convenient place.

Accordingly, a combined tool shed, woodhouse and work shop was planned and located near the administration building. The old building was torn down and such material as could be used in the construction of the new one was utilized. The building was made forty feet long, twenty-four feet wide and twelve feet

high to the square and was placed on a solid concrete foundation. It was sided to match the barn and was covered with galvanized roofing.

The items of expense were as follows:

Lumber and sawing	$84 08
Cement and sand	17 50
Hardware	14 35
Roofing	62 98
Labor	105 00
Total	$283 91

Visitors.

The value of the experimental station as an object lesson in growing forest trees is becoming more apparent each year. A majority of the visitors come as students of their special forestry problems and spend as many as three days in studying the several forest tracts. Persons who visit the reserve through curiosity are becoming fewer each year.

During the year 410 visitors registered at the headquarters, and many visited the reserve who did not register. The number of the visitors by States is as follows: Indiana, 370; Kentucky, 20; Oklahoma, 5; Minnesota, 4; Kansas, 3; Michigan, 2; California, Iowa, Louisiana, Missouri, Pennsylvania and Washington, D. C., 1 each.

Receipts From Sales.

The receipts from sales for the fiscal year were as follows:

1910.		
Dec. 5.	M. H. Dunlevy, 1 bushel apples	$1 00
	Mr. Nevills, 1 cord 4-foot wood	1 75
	Dr. Prall, 1 cord 4-foot wood	1 75
1911.		
Jan. 5.	Alex. Neville, 2 cords 4-foot wood at $1.75	3 50
	Ed. Sauers, 1 cord 4-foot wood at $1.75	1 75
	H. Richardson, 10 shocks fodder at 10 cents	1 00
	Alex. Neville, 1 cord 4-foot wood at $1.75	1 75
	F. Metzger, 1 cord 4-foot wood at $1.75	1 75
Jan. 31.	Alex. Miller, 1 cord 4-foot wood at $1.75	1 75
	Ed. Sauers, 1 cord 4-foot wood	1 75
	L. A. Edwards, 2 cords 4-foot wood	3 50

Mar.	1.	Louis Rueff, 1 cord 4-foot wood	1 75
		Newt. Plumber, 1 cord 4-foot wood	1 75
		Alex. Neville, 3 cords 4-foot wood	5 25
		Cauble & Dunlevy, 1 cord 4-foot wood	1 75
Apr.	6.	Henry Richardson, 35 shocks fodder at 8 cents	2 80
		Chas. Guernsey, 15 shocks fodder at 8 cents	1 20
July	6.	Chas. Francke, 6 bales wire at $1.75	10 50
June	5.	Chas. Dean, 155 ties in log at 10 cents per tie	15 50
		Alex. Neville, 2 cords wood	3 50
		John Gibson, 10 shocks fodder at 8c	80
		W. D. McKain, 1 cord 4-foot wood	1 75
Sept.	6.	W. D. McKain, 1 cord 4-foot wood	1 75
		Jas. L. Boling, 1 cord 4-foot wood	1 75
		Total	$71 30

Office Work.

The work of the office, in the greater part, was as follows:

First: The answering of inquiries that came to the department through personal visits and correspondence.

Second: The work of topically cataloguing the library accessions.

Third: The administration of the Forest Experimental Station and recording data accruing from the experiments in progress.

Fourth: Field work.

Fifth: Creating an interest in forestry by issuing press bulletins, offering a prize for the best essay on forestry and in making a preliminary study of the woodworking industries of the State.

Correspondence.—The inquiries that came to the department were practically all in the nature of seeking information on forest planting. Landowners wish to know what kind of trees to plant; the distance apart the trees should be planted; where to buy the seedlings, etc. Only one inquiry was received asking where timber could be sold to the best advantage. This inquiry came from a non-resident who had an undivided interest in Indiana land. Owners of timber are never at a loss to find buyers.

During the year 1,289 first-class letters were received, and 1,427 first-class letters were mailed. There were also mailed 2,096 first-class circular letters and 5,374 second-class circular letters.

There are frequent requests for the annual reports and the supply previous to 1910 has been exhausted, except a few copies of 1903 and 1909. In September a janitor discovered about 300 copies of the 1903 reports that had been stored in the basement for years, which accounts for the remaining copies of this report. There were repeated requests for back reports, which can not be filled. The number of reports mailed during the year was as follows: One of 1901, thirty-nine of 1903, two of 1906, fifty-eight of 1907, twenty-seven of 1908, five hundred and sixty-six of 1909 and 838 of 1910, making a total of 1,532.

Library.—The total number of accessions is 1,068. During the year 302 accessions have been made. An effort is made to obtain for the library all the State and Federal publications bearing upon the subject of forestry.

Press Bulletins.—The number of press bulletins issued the past year was not as large as was desired. Neither time nor money permitted of the issue of more. The press bulletins are deemed to be of sufficient importance to be reproduced, and are as follows:

[Press Bulletin No. 11.]

PLANT A TREE.

Many years ago it was a custom when a child was born to commemorate the event by planting a tree. Today there are many trees sacredly guarded because they were planted by or for someone whose memory it was desired to perpetuate. Every reader of this article no doubt recalls one or more trees with which are associated pleasant recollections. It may be the one in the yard under which you were accustomed to play. It may be the one that sheltered you when overtaken by a storm on your way to and from school. It may be the one on the river bank under which you sat with fishing pole in hand. It may be the one under which you and your lover exchanged vows, or it may be made dear to you by any one of the many incidents of life. When your child is grown, give it an opportunity to possess a living tree which it can call its own. Mary's and John's trees will always be cared for with tender hands, and when their namesake has forsaken the old homestead, there will always be a yearning to see "my tree" again.

[Press Bulletin No. 12.]

TEN DOLLARS FOR ESSAY ON FORESTRY.

In order to encourage the study of forestry among the pupils of the public schools, the State Board of Forestry is offering four prizes of $10 each for the best essays on forestry. The contestants for the first prize are limited to the pupils of the seventh grade country schools. The second prize is for the pupils of the eighth grade country schools. The third prize is for the members of freshmen and sophomore classes of the high schools of the State. The fourth prize is for the members of the junior and senior classes of the high schools. The conditions are as follows:

The subject must be "To what extent should Indiana be reforested; give reasons." The essay must be a hand-written manuscript in ink, containing not more than one thousand words. The essay must be in the hands of the board on or before May 1, 1911. Former prize essay winners are not eligble. The essays are to be graded on the basis of 70 points for thought, 30 points for composition, manuscript, etc. The board wishes original thought and no credit will be given contestants who copy verbatim works on forestry. If direct quotations are used they should be indicated by quotation marks and their source given in a foot note. It is hoped that every boy and girl, eligible to compete, who reads this will send an essay.

Address your essay and inquiries to Chas. C. Deam, secretary, State Board of Forestry, Indianapolis, Indiana.

[Press Bulletin No. 13.]

GUN CLUBS TO BUY HUNTING RESERVES.

It has been suggested that gun clubs, or a number of sportsmen, form a company for the purpose of buying large tracts of hilly woodland of southern Indiana, and convert them into forest and hunting reserves.

There are thousands of acres in that part of the State which are too hilly and broken to be profitable for farming. It was ordained by nature to be a forest and the hunters' vacation ground. If you cannot go to the wilds of the Adirondacks, you can bring the wilds to you in Indiana. Interest a few of your friends in the plan of buying a 500-acre tract or more, and build a nice clubhouse on it. Maintain the best house you find on the tract for the residence of the custodian, who can farm a few of the best fields, guard the reserve and transport you to and from the reserve. All the remaining cleared land and open woods should be afforested. In a few years the tract will be well stocked with game.

Such an enterprise would not merely develop a hunters' paradise, but the timber products would yield a good per cent. on the investment.

[Press Bulletin No. 14.]

GREAT LOSS BY WATER.

Many farms are partly ruined by erosion. The farmers in the southern part of the State have suffered the greatest damage. There are many fields and parts of fields in southern Indiana that

have been abandoned because they are so badly eroded that at present they can not be profitably farmed. Even grass will not grow on them, because the top soil has all been washed off, and now briars and bushes are taking possession.

This article is to remind owners of such property that the only way to reclaim eroded land is to plant forest trees on it. Forest trees will stop the washing and soon grow into money. Remember that a guillied field on a farm depreciates the value of the remainder of the farm.

The kind of trees to plant would be black locust, ash or yellow poplar, and seedlings may be bought for $2 to $5 per thousand. The trees should be planted in the spring, before the rush of spring work begins. If you have a gullied field, decide now to save it. If you are not certain as to what kind of trees to plant, or where to buy the seedlings to the best advantage, write the State Forester, Indianapolis, Indiana, for information and printed literature, who will be glad to assist you.

Issued December 16, 1910.

[Press Bulletin No. 15.]

SAVE THE BANKS.

Save the banks of your ravines, creeks and rivers by encouraging grass, shrubs and trees to grow on them. Where you find the bank of a stream perpendicular you will usually find a tree on its top which protects it until the support beneath is washed away, when it tumbles to a watery grave. This reminds us that our streams are ever increasing in width, and many of us can recall when the fence stood a rod closer to the center of the stream.

The same may be said of the banks of deep cuts along highways and railroads. If there is a bluegrass sod on top the bank it will be perpendicular for six to twelve inches, and the nude roots form a miniature ledge, which is sufficient to show the value of bluegrass as a soil binder. If it is not desirable to plant shrubs and trees on the roadside banks, sow the slopes with bluegrass seed, and scatter cornstalks on it, which may be prevented from washing away by weighing them down with pieces of old rails, brush, etc. When the bluegrass is well set the wash will be stopped.

The banks of creeks and rivers may be best protected by planting willows at the base. At the top white ash, black walnut, oaks and hickories may be planted, choosing the species best adapted

to the soil conditions. If the bank is low and flat, sycamore and elm may be set back of the willows. If conditions will warrant trees of a higher commercial value than elm and sycamore should be planted. The slope of the banks should be sown with bluegrass, and if there is too much shade for bluegrass, they should be planted with vines and shrubs that will endure shade, such as American sarsaparilla, briars, cornels, bladder nut, wahoo, wafer ash, etc.

Neglect to fortify the banks of our streams means an annual loss of many acres of valuable land, whereas if they were planted with trees they would not only be protected, but would grow valuable timber.

Issued January 16, 1911.

[Press Bulletin No. 16.]

REPEAL THE LAW.

Our wide-open ditches were once small creeks which have been straightened and dug deeper and wider in order to facilitate drainage. These wide creek-beds, together with the two broad ridges of earth on each side of the ditch, usually occupy about two rods of space. This space is waste land and produces nothing but a crop of weeds.

Now it is proposed to reclaim such waste land by planting trees on each bank. If forest trees are planted, such species should be selected as grow a deep root system, produce little shade and have a high commercial value, such as black walnut, ash, hickory and poplar. Orchard trees would have the advantage over forest trees in that they would not grow so tall and would shade the adjacent land less. If the ditch and its banks are narrow, the banks could be planted with peach and plum trees.

By planting trees, not only would the waste land be made remunerative, but the trees would assist in holding the banks. When these ditches were dug the sides were left very steep, and subsequent rains, alternate freezing and thawing have loosened thousands of tons of earth from the sides of the ditches, which has in a greater part been washed away and the remainder deposited at the bottom of the ditch to increase the cost of cleaning it out. In the spring of the year it is not an unusual thing to see a stretch of bank a foot in width slip into the ditch and be lost forever. Wise landowners will see that ditch banks are protected by plant-

ing some kind of trees, shrubs or vines, whose roots will hold the banks and whose wood or fruit will be of value.

But the State law says "owners of land through which an open ditch runs shall remove all brush and weeds from the banks of that part of the ditch through the lands owned by them respectively, during the month of July of each year." The intent of this clause was to prevent the ditch filling up, but the contrary is true. The trees assist in preventing the banks from caving in, and stop lots of rubbish that would otherwise blow into the ditch. It is easier to clean a few leaves out of the ditch than to shovel out tons of mud, and to be deprived of the use of the ground along your ditches. If you think this law should be revised, write your legislator at once.

Issued January 23, 1911.

[Press Bulletin No. 17.]

INFORMATION ON FOREST PLANTING.

What kind of forest trees are best adapted to Indiana planting; how far apart the trees should be planted, to what extent the young trees should be cultivated and pruned; how fast they grow, and what per cent. on the investment the landowner may expect, are problems on which the State Board of Forestry is working. They now have twenty-nine tracts at the Forest Experimental Station planted to the most promising kind of forest trees. These tracts have been under observation now for several years, and each year they are regularly hoed, plowed and pruned. Every item of expense and every observation made is carefully itemized and recorded. Thus, by recording and tabulating data on forest plantings, general and correct principles of forest culture can be worked out.

The forest experimental tracts are located in the south part of the State, and what is true of trees in that part of the State might be different in the central or northern part of the State. So the forestry board expects to extend its investigations and observations to forest plantings in different parts of the State.

To do this it is proposed to coöperate with persons who expect to do forest planting. The board is not in a position to lend financial aid to planters, but it proposes to give suggestions as to the best kind of trees to plant, how to prepare the ground, how to care for the trees, etc., and to make visits of inspection. In return the owner of the planting is expected to keep a record of all items

PLATE 2. Successful contestants in forestry prize essay for 1911.

of expense, and make observations, which are to be forwarded to the office of the secretary, where a permanent record of the planting will be kept. If you expect to do any forest planting it will pay you to write to the State Forester at Indianapolis for his plan of coöperation.

In this work the planter is free to do as he pleases. He plants the kind of trees he chooses and manages the way he thinks best. He gets the advice of experts without cost. At present the board expects to limit the number of coöperative plantings to 100, so do not delay in taking advantage of this offer.

Issued January 30, 1911.

[Bulletin No. 18—Sheet One.]

TO WHAT EXTENT SHOULD INDIANA BE REFORESTED?

The uses of the forest are numerous. Besides yielding many useful and necessary articles, such as turpentine, resin, tar, timber for fuel and lumber for building purposes, the forest is a soil former, a sod improver, a soil fixer, a flood preventer, a conservator of moisture, a wind break, a beautifier of the earth, and a sanitary agent; as it is one of the greatest protectors of mankind, its presence is most necessary to our well-being.

In Indiana the protection which the forest gives is of far greater importance than the products which it yields. They can easily be brought into the State from some of the regions of the United States which are unfit for agricultural purposes but which are well-suited to the needs of the forest. But the protection which the forest renders cannot be thus transferred.

Unlike many States, Indiana has no mountains, and very few rivers which need the protection of the tree. In this State the chief aim of reforestation is to establish small forests throughout the State, the purpose of which is not to produce lumber, but to protect the people living about it by acting as a wind-break or flood preventer.

As has been said before, in many States the main purpose of reforestation in general is to provide future supply of timber, but in Indiana this is not the case. This State is well adapted to agricultural pursuits, as it lies in one of the most fertile farming districts in the world. It would seem almost wasteful to devote such land to forests when there are so many acres in the United States which are unfit for farming purposes but capable of producing

excellent trees. They might furnish timber and lumber to Indiana, while it raises wheat and corn for them.

So Indiana ought to be reforested only to such an extent that its people would receive all the forest protection that it needs.

Indiana now has a forest reserve of 2,000 acres, located in Clark County. It is maintained solely for experimental purposes to obtain data concerning the growth and need of the various trees and to demonstrate the value of the forest to the people.

At present reforestation must be carried on by the State. The growth of the tree is very slow, thus making the investment, which is increasing rapidly by compound interest, too long unavailable and too slow in producing returns for the farmer to undertake it again. Most of the land is divided into small farms, ninety-seven and four-tenths acres being an average-sized farm. The farmers are obliged to cultivate all their land in order to provide food for their families; therefore, they object to giving it up to reforestation, especially when they cannot see the value of the forest.

It has been suggested that the State compel each landowner to forest a certain per cent. of this land, but there are several objections to such a plan; first, it would throw the burden of reforestation upon the farmer; second, the land changes hands so often that it would be difficult to keep any one spot forested for a definite length of time. For instance, Mr. B. and Mr. S. each own 160 acres of land. According to the requirements of the law each should have a four-acre forest. Now Mr. B. sells eighty acres of his land to Mr. S. According to law Mr. B. is at liberty to cut down one-half of his trees, while Mr. S. must add two acres to his forest, consequently the people are without the protection of the forest for at least twenty years. Third, if this plan were followed a great deal of good farming land would be devoted to forest, while much of the waste land, which needs the forest more than the farming land, would stand idle. The State must own and develop and protect the forests, at least, until the people come to know their value.

Of course, all waste land should be reforested. By the term waste land we mean untillable land, such as hillsides, ravines, land too poor to raise the ordinary crops, such as wheat and corn, and fields which cannot be cultivated because of frequent overflow. In the southern part of the State and in the Wabash Valley there are many hillsides so steep and rocky that it would be impossible to till them. They are covered with large stumps, showing that they are adapted to the needs of trees and that a fine

forest grew there at one time. Such land should be forested. They can be utilized for no other purpose. Then a forest planted there will give the people living near it the same protection that it would planted on a level, fertile field capable of producing excellent crops of corn.

The forests have proven themselves soil formers, soil fixers and soil improvers. For this reason all the land too poor for farming purposes should be reforested.

Every year in this State a great amount of property is destroyed and much suffering is caused by floods. All this might be prevented by planting trees along the banks of the rivers, where floods are frequent. They would absorb the moisture and thus prevent the floods.

Now, if the purpose of reforestation is carried out woodlots must be established throughout the State. Every section of land should have its own forest. Most sections have land which cannot be well used for farming purposes, either because of its location or the character or quality of its soil. All such lands should be seized as an eminent domain and productive forests planted on it. If such lands are forested and properly cared for very little of our farming land need be devoted to the forests. But after the forests are established they must be taken care of, for a neglected forest is wore than no forest.

In reply to the question, "To what extent should Indiana be reforested?" I would say, briefly, so much that all the waste land be utilized and the necessary protection against the natural elements be given.

GLADYS JONES,
Attica, Ind.

Senior Class, Attica High School.

TO WHAT EXTENT SHOULD INDIANA BE REFORESTED?

The forests of Indiana are being cut down so rapidly that if some restraint is not put on this work of destruction the forests will, in a short time, be only a remembrance among the "Hoosiers." The people in early days can be pardoned for cutting down trees, for they had to do it to clear places for their homes and to prevent beasts and enemies from hiding around. Besides they were not taught the economical importance of the forests. There were many trees then, but wood for fuel and lumber is becoming so

scarce now that the preservation and restoration of our forests is a very important problem, hence the question, "To what extent should Indiana be reforested?" confronts us.

The places that should be reforested are the sections of land not adapted to agriculture. Hilly country is not suitable for farming, it cannot be easily tilled, and the soil has generally been washed off the rocks. There are many acres of such land in Brown County. If the lands that have always been poor or have been made so by improper usage should be properly reforested, the leaf-mould caused by the fallen leaves would enrich them and make them valuable. A great many tracts of land are located so as to be unprofitable for agriculture. They may be too far away from town or from the owner's home. Some plots are too small, being cut off from large fields by railroads, creeks or roads. Many streams wash banks and make them irregular. If the right kind of trees were set out, they would have a tendency to hold the banks in.

Public property and lands not used for anything else should be utilized for trees. If trees were neatly and tastefully arranged around churches, schoolhouses, jails, libraries, halls and courthouses they would be a protection, would beautify the surroundings, and around the schoolhouses would serve as a shade for the pupils during playtime. Trees should be set out on roadsides and public highways, to serve as windbreaks for the protection of the traveler and to beautify the roads. Of course, the old question would arise concerning the drying of the roads. It should be a supervisor's duty to keep the roads well graded, the trees well trimmed, and it would not be necessary for the roads to be muddy. There are large government reservations not being used at present which should be reforested.

Trees should be set out along the streets of our towns and cities between the sidewalk and the curbing. The street, indeed, looks beautiful that is well shaded by tastefully arranged trees. Every town or city should have a park to beautify them or to be a place of pleasure. What is a park without some trees?

Where or who is the farmer that does not like a beautiful country home, which cannot be made so unless some trees are used? How pretty is the small woodlot near the home of the farmer? Every farmer should have a woodlot. Ten acres would be the required amount on a farm of 160 acres in Boone County. The woodlot serves as a protection to the buildings and orchard, also a convenient place to put young animals in, if it is placed near

the home. The trees should be planted in straight rows and a certain number to the acre. The number depend on the kind of trees. The dead trees and the trimmings from the others would furnish enough wood for domestic use.

There are many things which lead us to believe Indiana should be reforested. The high price of lumber and firewood is due to the scarcity of trees. Some day there will not be any coal, for it takes decayed leaves and other plants to form it. The people then will have to depend entirely on wood for fuel. Trees retain moisture by their leaves and roots. The leaves form a thick carpet over the ground and prevent such rapid evaporation. Thus, by reforesting, the natural resources would be increased, the home would be more beautiful, and would serve as a check to floods. Hence, under all these conditions, why should not Indiana be reforested?

MABEL ADAIR,
Lebanon, Ind.

Sophomore A, Lebanon High School.

[Bulletin No. 18—Sheet Two. Released June 5, 1911.]

TO WHAT EXTENT SHOULD INDIANA BE REFORESTED?

There are so many reasons why we should use our best efforts to replace the forests of this State that they could not be easily be numbered.

Several years ago people were awakened to the fact that our trees were rapidly disappearing, because the cost of timber, and especially hardwood of Indiana, had, in a few years, so many times doubled its value of an age ago.

My father says that during his boyhood days lumber products were so lightly regarded that beautiful hardwood trees, such as one could scarcely find for a good example now, were cut down and cleared away with the waste wood, or burned in a huge fireplace, where it might as well have been substituted by soft wood, had they used any forethought in preserving their valuable timber.

When we note what a few years time has done it gives us a very vivid picture of a treeless State in the near future, unless all cooperate and work to make it otherwise.

For some time a great many people have been interested in this movement to reforest the State, and much good has been done, but there is still a large task for us to perform to convince and educate the people to the practical results of this work.

The slow growth of trees is discouraging at first thought, when our parents think of this work from the standpoint of money, but many of our farmers or landholders have land which is of no use unless it could be utilized in this manner, and former experiments by men of this State goes to prove that it will not be a losing investment to set apart a tract of land to plant to forest.

It has been found that the cost of your time and labor in raising seedlings, preparing the ground, then planting, pruning and cultivating the young tree is easily covered by their value in a short while as posts, which you will have when you thin out your growth, besides you may use ground which is only used for pasturage, and this might be continued to some extent, or if the soil is suitable potatoes or corn might be grown with the seedlings during the first two or three years. They are soon valuable also for shade, windbreaks or ornamentation.

The fellow with a young forest will find his land far more desirable to the prospective buyer, thus you may be sure that the trees you plant will be of worth should you not be the one to reap the benefit of their maturity.

Other evils which come from deforestation may be found among the hilly regions of the State.

As the trees disappear the soil of a hillside decreases in value, since the rich top soil is easily washed away, and after a few hard spring rains a hillside field may become almost worthless.

It is also to be noted that small streams disappear and floods from the larger streams are more frequent as the trees are cleared away.

It is also a fact that people all choose bottom land in preference to the hilly districts for the farm home, while not many years ago many almost worthless hilly regions of today were valuable.

Droughts are becoming more common as our forests go, because the loose leaf mulch then goes, leaving a soil so compact that the water is washed off and only a very small amount is held by absorption.

This leaf mulch also helps to prevent evaporation, and thus more ground water is preserved until taken by plant roots.

Trees take a great deal of water from the soil, and moisture is constantly thrown off by the leaves. This is a help during the hot months to prevent dangerous thunder storms.

These floods and droughts destroy much animal life. A flood may carry a great number of small fish out in larger streams, where they are consumed by larger ones, or during a flood fish may

enter a flooded area for the purpose of spawning, then the later droughts came, which resulted in the death of the young fish and other animal life upon which they feed, until it seems almost useless to try to replenish streams with fish until a preventative is used for droughts and floods.

Forestry is now part of our school work, and if we boys and girls band together and properly observe Arbor Day we will be amply repaid in the future with beautiful trees, their shade and a home for our birds.

CORA E. DOUGHERTY,
Bedford, Ind.

Eighth Grade. Country Schools.

TO WHAT EXTENT SHOULD INDIANA BE REFORESTED?

First of all, any spot on earth (therefore Indiana) should bear upon its surface all that nature, and by nature we mean the wisdom of God, endowed it.

Trees, flowers and grasses are a connecting link between heaven and earth, and where man has intentionally or otherwise robbed the earth of this charm what is more his duty than, so far as is in his power, to replace it.

Looking at the matter from a purely practical point of view, it is easily seen that the economic value of timber, even in a growing State, is sufficient reason for reforesting the land.

Men have learned too late that the leaves of the growing trees expire great quantities of water, which taken care of by the sun, winds and varieties of moisture, furnishes to the world the showers which are everything to the vegetation.

It is said that Indiana soil will grow as good or better timber in accordance as any other State in the Union.

We can readily perceive the protection which heavy forestry affords our crops from cold waves, droughts and such inconveniences which are often to be dealt with in this part of the country.

Where there is no timber, ground ceases to build and improve because of the lack of falling leaves and twigs which from year to year add to the richness of the coat of loam which is so valuable.

Timber is valuable for fuel as well as building purposes, as we know the coal will soon be gone, as there is but a small quantity at the present time, and fuel will have to be imported, which is a heavy expense to the State.

Ground denuded of trees becomes disfigured by the soil being washed away by heavy rainfall, because of the lack of roots which is between the bedrock and the soil proper.

This disfiguration of the surface of the land is noticeable in our own State, which has been denuded of its forests only a short while; and as the years pass the conditions will, of course, become worse.

Travelers in Spain and China notice this condition even in that far country, which is every day growing worse.

While men have learned to make buildings without so much timber as was formerly used, there are places, and, indeed, ever will be, where nothing will answer so well as the walnuts, oaks and pines for the beautiful architecture which is always wanted in a building.

Summing up, then, the reasons why Indiana should be reforested, we would say to replace, in a small measure, at least, nature's primitive adornment, which, like the trimming on the maiden's hat, is the portion that attracts; to preserve from greater disfiguration the land surface itself, the roots of the trees, and the foliage mass, preventing, in a way, the washing away of soil, the making of ditches, gutters, etc., on slopes and plains; the furnishing, in a purely economical way, if not ornamental, of material for furniture, casings and building furnishings. Now, like the division of labor among the people of a community, or the members of the body, so the trees that drew their sustenance from the earth should and will return a hundredfold that which it has taken, by laying their coverlets of leaves to be converted into loam, by adding their tons of water to be returned as rain to feed spring and river.

Added to all this, we have the shelter from storm and sun, the nuts, the home of birds, bees and beast; in short, it is impossible to enumerate the many uses which trees supply in the world. Bryant may well ask us the question, "What do we plant when we plant a tree?"

The nations of the old world are already at work replacing the groves that were ruthlessly destroyed, and are sparing neither expense nor labor in doing so.

No one who considers the matter in a fair light but will add their voice in commendation of the work, not only in the old world, but in that much loved section of the new which bears the name

of Indiana. Since "The groves were God's first temples" let us replace those temples which our own hands have so carelessly torn down.

MARY MASON,
Mecca, Ind.

Seventh Grade. District No. 8.

[Bulletin No. 19. Released July 7, 1911.]

HAVE WE MADE GOOD? COME AND SEE.

Is it possible to reforest Indiana? Can we make forest trees grow in Indiana? Are you interested in forest planting or keeping up your woodlot? If you are you should accept the invitation to visit the forest reservation on July 27th. Arrangements are being made to show the people what has been accomplished in the way of forest planting in the past seven years. There have been over thirty tracts planted on the reserve with the following species: Ash, catalpa, yellow poplar, black locust, oak, hickory, elm, chestnut, pecan, buckeye, coffeenut, sycamore.

There you can see which are the most promising trees to plant in Indiana; the distance apart you should plant the various kinds of trees; how you should cultivate and prune them. Remember that an object lesson is worth more than what you read or what tree agents tell you. If you are interested it will be a good investment for you to see the many fields and hillsides that have been successfully planted to forest trees.

The reserve can be reached by going over the Pennsylvania line to Henryville, or over the Indianapolis and Louisville traction line. Take limited cars to Henryville. Local cars will let you off at the reserve.

The reservation hack will meet all trains, and guides will be furnished who will show you around over the reserve, consisting of 2,000 acres.

Some prominent people have been invited and are expected to attend.

For additional information address the State Forester, Chas. C. Deam, Indianapolis, Ind.

The prize essay bulletin resulted in much good. Pupils from all parts of the State entered the contest. Great interest was taken in it by county school superintendents, city school superintendents and teachers. Some teachers became so enthusiastic on the sub-

ject that they gave their pupils three months' work on forestry, and as many as eight essays were received from one school. The plan of offering a prize for the best essay has met with such success that the board has decided to offer prizes in 1912. The subject will be: "Woodlot conditions in the county in which I reside and suggestions for their improvement."

Circular Letters.—Several inquiries asking the title of books on forestry and conservation suggested the idea of writing the librarians of the State. Accordingly, on January 17, 1911, a circular letter was mailed to the librarian of each library of the State calling his attention to the increased interest in the subjects of forestry and conservation and asking him to supply his readers with literature covering these subjects. The following list was sent as a suggestion:

CHOICE BOOKS ON FORESTRY.

Practical Forestry, by John Gifford. D. Appleton & Co., 1902.....$1 25
A First Book of Forestry, by Filibert Roth. Ginn & Co., 1902..... 1 25
A Primer of Forestry, by Gifford Pinchot, Parts 1 and 2, Bulletin 24, U. S. Division of Forestry.
North American Forests and Forestry, by Bruncken, Putnam & Sons, 1908 ..... 2 00
Handbook of the Trees of the Northern States and Canada, by Hough, 1907. Published by author, Lowville, N. Y..... 8 00
Economics of Forestry, by Fernow. Crowell & Co., fourth edition.. 1 50
History of Forestry, by Fernow. University Press, Toronto, 1907.... 2 75
Care of Trees, by Fernow. Holt & Co., 1910..... 2 00
Trees of the Northern United States, by Apgar. 1892. American Book Co. 1 00
Manual of the Trees of North America, by Sargent. Houghton, Mifflin Co. 6 00
Report of the National Conservation Commission, three vols., 1909, Senate Document 676. Obtained through your Senator.
The Conservation of Natural Resources in the United States, by Chas R. Van Hise. Macmillan Co., 1910..... 2 00
American Forestry, monthly magazine, published by American Forestry Association, Washington..... 1 00
Publications of the Department of Forestry of the U. S.
Publications of the Department of Forestry, Minnesota, New York, Michigan, Massachusetts, New Hampshire, Pennsylvania, Wisconsin, and others.
Plant Life of Maryland, Vol. 3, published by the Weather Service of Maryland.
The Forestry Reports of Indiana, Coulter's "The Forest Trees of Indiana," in the Trans. Ind. Horticultural Society for 1891, and Coulter's "Catalogue of Indiana Plants," published in Indiana Geological Report for 1899.

This year a preliminary study of the woodworking industries of the State was undertaken. Accordingly, in July a circular letter with a statistical blank and stamped reply envelope, to the number of 702, was sent to each of the woodworking industries of the State. About 260 replies were promptly received. The delinquents were again written to, and in all 375 replies were promptly received. The data received is made the subject of a special report and will be found on page 59.

Field Work.—The field work consisted in inspecting woodlots, in response to requests from owners who asked the secretary to examine their woodlots and to make suggestions as to how to improve and to manage them. Several plantations that were visited last year were revisited for the purpose of collecting additional data. The amount of field work was necessarily limited on account of lack of funds. The new plantations visited are deemed worthy of record and are as follows:

County.	Town.	Owner.	Species.	Trees.	Acres.
Floyd	Edwardsville	Beard, Maynard et al	Black walnut		1
Fulton	Rochester	Scott, E. H.	Catalpa	12,050	
Fulton	Rochester	Scott, E. H.	Ash	600	
Fulton	Rochester	Scott, E. H.	Wild cherry	4,300	
Gibson	Patoka	Hull, David	Catalpa	1,000	
Hamilton	Carmel	Johnson, W. S.	Catalpa	1,200	
Hamilton	Westfield	Barger, C. D.	Catalpa	300	
Henry	New Castle	Anderson, John	Catalpa	1,200	
Henry	New Castle	Hodson, Albert	Catalpa		1
Henry	New Castle	Hodson, Albert	Chestnut		1
Henry	New Castle	Painter, A. C.	Catalpa	1,000	
Henry	New Castle	Payne, J. M.	Locust	1,000	
Henry	New Castle	Stewart, Elton	Catalpa	600	
Henry	New Castle	Stewart, Elton	Catalpa	600	
Jefferson	Madison	Irwin, Chas. E.	Locust	35,000	
Laporte	Laporte	Bosserman, Chas.	Catalpa		13
Laporte	Laporte	Bosserman, Chas.	Locust		2
Washington	Salem	McCurrach, David	Black locust	35,000	15

Some Features of the Climate of Indiana.

BY VERNE H. CHURCH, SECTION DIRECTOR, U. S. WEATHER BUREAU.

The absence of mountain ranges and large bodies of water within, or contiguous to, the State of Indiana, together with the level character of its surface, gives it a comparatively uniform climate. While Lake Michigan forms a part of the northern boundary, it has very little influence upon the climate of the State at large, as their relative positions do not permit of interchange of air currents in the regular course of the prevailing southwesterly winds. There are local effects produced by the lake over a limited area in its immediate vicinity, however. Altitude, direction of slope, character of surface, and various other influences affect the climate of individual localities, but for the State as a whole, the climate varies quite uniformly with the latitude. Following the rule which obtains where ideal climatic conditions prevail, there is a gradual increase in both temperature and precipitation from north to south, or, as it is often expressed, with decrease in latitude.

The accompanying chart (Plate 3) shows that the annual mean temperature ranges from slightly less than 48 degrees in the extreme northern part of the State to slightly more than 56 degrees in the extreme southern and southwestern parts. The northern half being comparatively level, the isotherms are more regular and more nearly parallel there than in the southern half, where the surface is much more broken. The irregularities in the isotherms are attributed chiefly to local causes. The cold area in Henry, Wayne, Rush, Fayette, Randolph, Franklin and Decatur counties is explained by the fact that this section of the State has an altitude of more than 1,000 feet. The highest point in Indiana is 1,285 feet above sea level and is located in the southern part of Randolph County. A further examination of the chart discloses the fact that the Wabash Valley is practically as warm at Terre Haute as it is at the mouth of the Wabash River, a peculiarity attributed to the topography of that section.

However, a discussion of the mean temperature does not necessarily give a true conception of the climate of a State as affected

ANNUAL MEAN TEMPERATURE.

Data compiled from records of Meteorological stations established 10 years or more.

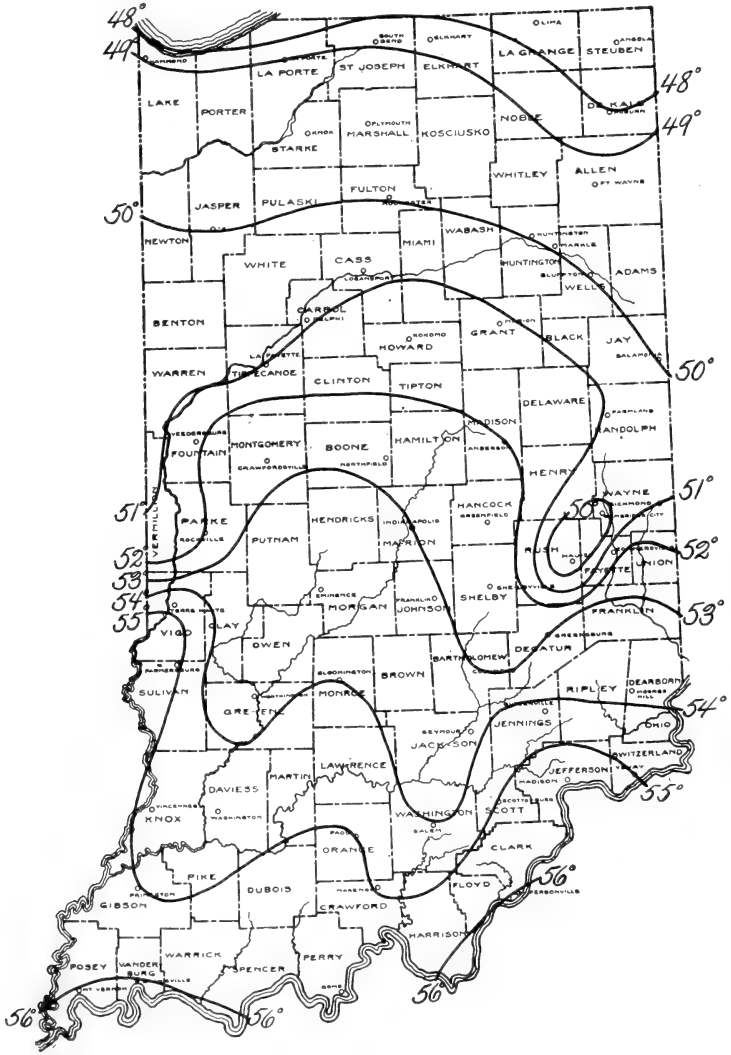


PLATE 3.

by the temperature element. Due consideration must be given to the highest and lowest temperatures reached in the locality under discussion. The temperature has a comparatively wide range, as the State of Indiana comes well within the influence of the pronounced cold waves which occasionally sweep down from the northwest over the central valleys. The distance from any large body of water is sufficient to prevent modifying influences from that source in either summer or winter, except over a small area in the extreme northwest corner bordering upon Lake Michigan. The temperature at all stations occasionally rises in summer to 95 degrees or more, but these instances are rare. The hot periods are generally of short duration and interspersed with those of moderate temperatures and cool breezes, which tend to greatly lessen the effect of the summer heat and produce a climate that is delightful rather than oppressive. It frequently occurs that the highest temperature of a season is recorded in the central or northern part, while the lowest is sometimes recorded at a station well toward the southern end of the State. This is due to the fact that the areas of high and low barometric pressure, which produce these extremes of temperature, cross the State with as great frequency over one portion as the other. It may so happen that, during a hot wave, the heat is more intense in the northern half of the State, while on the other hand, a cold wave may be more severely felt in the southern half. It is also true that the records of individual stations are more or less affected by local topographic features. The lowest temperatures reached during a season, or period of years, have a greater effect upon the character of vegetation than do the highest temperatures.

The length of the growing season has a more direct and decisive influence than is exerted by the minimum temperatures. A chart (Plate 4), showing the advance of spring is presented herewith. It will be noted that the average date of last killing frost at Evansville is April 7th. A week later the line has moved northward until it includes the greater part of what is termed "The Pocket" of Indiana. In another week about one-third of the State is included, and week by week the line moves northward until on May 5th there remain only small areas in the northern and eastern parts of the State where there is still a probability that a frost sufficient to kill the staple products of those localities will occur. It may also be observed that the distribution outlined on this chart bears a fairly close resemblance to that shown on the chart of an-

AVERAGE DATE OF LAST KILLING FROST IN SPRING.

Data compiled from all available records of Meteorological stations.

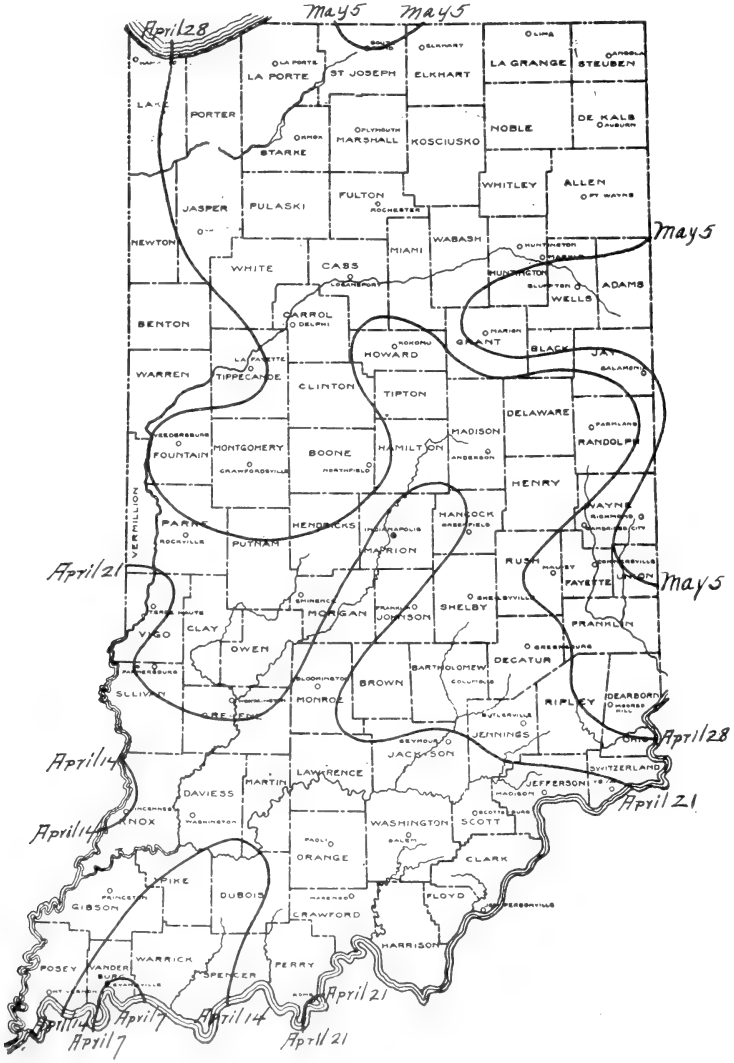


PLATE 4.

AVERAGE DATE OF FIRST KILLING FROST IN AUTUMN.

Data compiled from all available records of Meteorological stations.

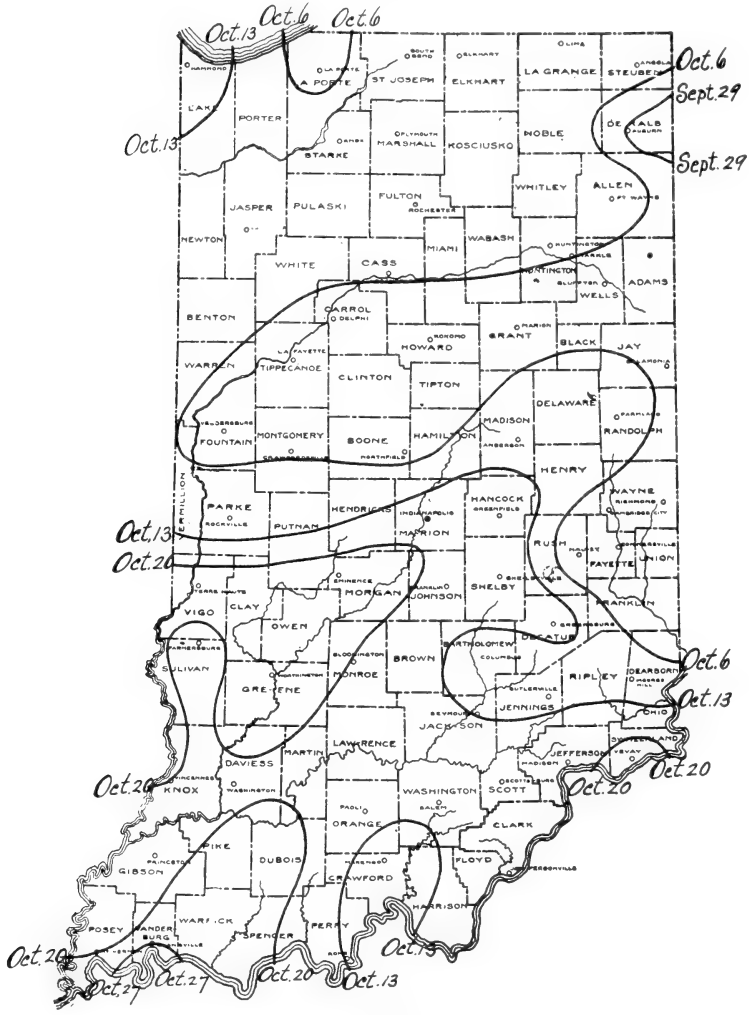


PLATE 5.

nual mean temperature. The cold area in the eastern part of the State, and the warm conditions in the lower half of the Wabash Valley are clearly defined and similarly outlined on both charts.

These areas are also found to be equally well preserved on the chart (Plate 5) of the average date of first killing frost in autumn. There is a striking resemblance between the two frost charts. This illustrates well the fact that the advance of the spring and autumn seasons is regular and, in the same locality, similar climatic influences prevail during both seasons. It will be noted that each chart shows a range of about twenty-eight days between the extreme ends of the State in the average time of occurrence of the first and last killing frost. It is thus shown that, while the district lying along the Ohio River in Indiana has a growing season of practically 200 days, the extreme northern and east-central portions have little more than 140 days. This difference of about eight weeks causes a great diversity in the nature of crops grown in the State.

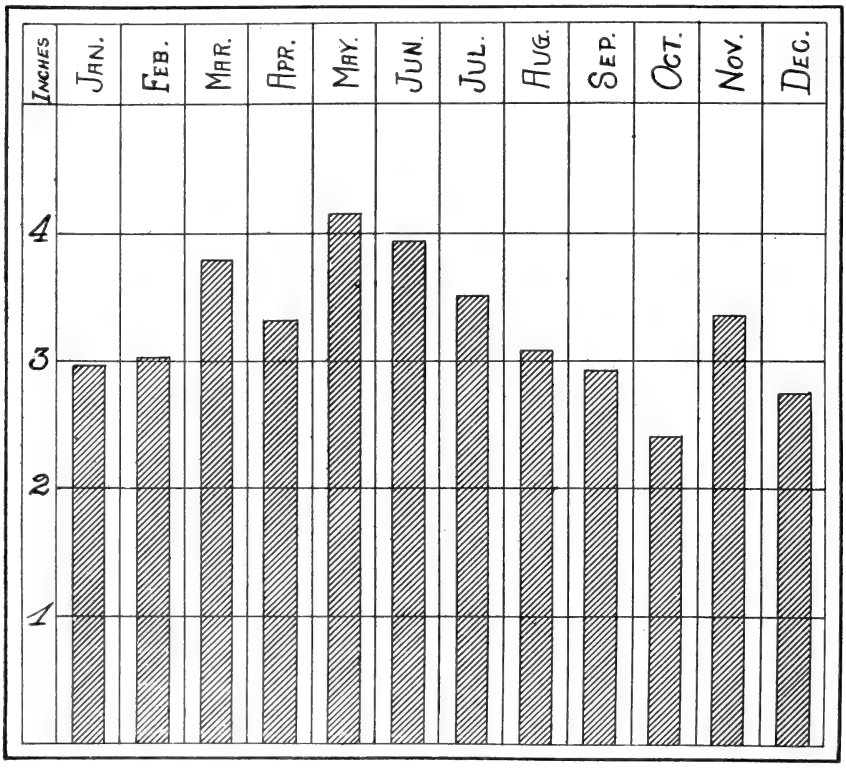


FIG. 1. Average monthly precipitation for Indiana.

The seasonal distribution of rainfall, while important in Indiana as well as elsewhere, is of less significance than in the semi-arid regions of the West, where the total amount for the year is only sufficient for the current needs of vegetation. In Indiana, the normal amount is ample for nature's requirements during all seasons of the year, as is shown by the chart (Fig. 1) on preceding page, which is introduced to illustrate graphically the monthly amounts of rainfall.

The precipitation has a comparatively uniform distribution throughout all months of the year, because the State of Indiana lies within the general storm track, and receives a portion of the moisture from the majority of storms which cross the Ohio Valley and lake region at irregular but frequent intervals. While droughts sometimes occur during the summer months, they are seldom severe enough to cause extensive damage to the staple crops of the locality.

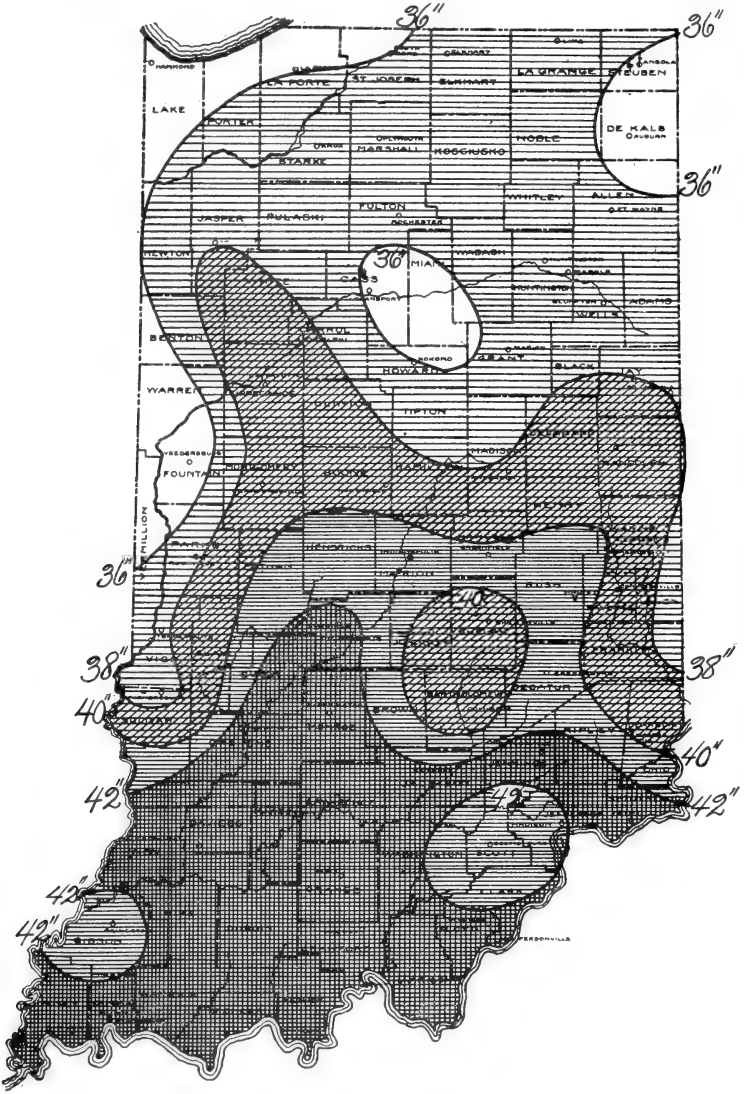
The geographical distribution of rainfall is somewhat variable, as an examination of the accompanying chart (Plate 6) will show. In general there is an increase in amount from north to south. Small areas in the northern half of the State have an average annual amount of less than 36 inches; the remainder of the northern half has from 36 to 40 inches, and the greater part of the southern half has more than 40 inches. About one-third of the State, extending from the Ohio River northward, receives more than 42 inches.

From this it is apparent that the precipitation in all parts of Indiana, during an average year, is ample for all kinds of plant life, and that, from the standpoint of both the temperature and precipitation elements, climatic conditions in Indiana permit an unusual variety in the character of its vegetation.

There is a popular belief that our climate is changing, but a study of all available statistics fails to bear out this opinion. There are short-period variations in temperature and precipitation, and it is possible that there are similar long-period oscillations. It is to be regretted that there are but few reliable records covering a long period of years. Those available show changes from year to year in the temperature and rainfall of the respective places, but there is nothing to indicate that a definite change in climate is actually taking place. They also show that, while the temperature and precipitation elements are above normal in certain years, there are other years when the same elements fall, in varying amounts,

AVERAGE ANNUAL PRECIPITATION.

Data compiled from records of Meteorological stations established 10 years or more.



SCALE OF SHADES—Inches.

Less than 36. 36 to 38. 38 to 40. 40 to 42. more than 42.

PLATE 6.

below normal. It is now conceded by scientists that if any long period changes are taking place they are of a secular nature, and, therefore, not to be considered in a discussion of this character.

The following graphic charts (Figs. 2 and 3) represent the mean temperature and annual precipitation, respectively, for the State of Indiana for the twenty-four-year period, 1887 to 1910, inclusive. These records are compiled from all of the observations made during that time at the regular and coöperative stations of the United States Weather Bureau, which are about sixty in number.

FIG. 2. Mean temperature for Indiana, 1887–1910.

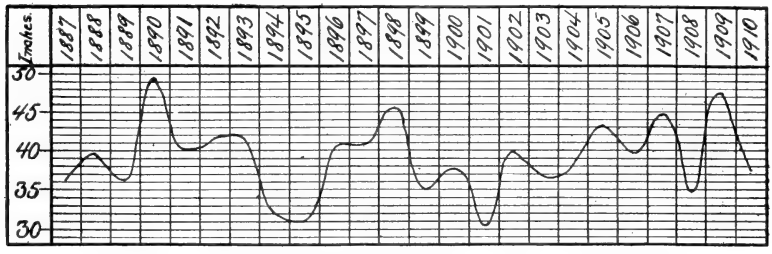


FIG. 3. Average precipitation for Indiana, 1887–1910.

In order to illustrate the regularity of the temperature and rainfall elements during successive periods of years, the following table has been prepared:

	1887–90	1891–95	1896–00	1901–05	1906–10
Mean temperature (° F.)	52.1	52.3	53.1	51.5	52.4
Av. precipitation (inches)	40.38	37.32	39.91	37.75	40.67

This grouping into periods shows that while slight fluctuations in temperature, and considerable ones in precipitation, have taken place during successive periods, there is no permanent increase or decrease indicated, and the variations are irregular as to the time of their occurrence.

The effects of forests upon climate is a subject that has been freely discussed, and various opinions prevail regarding the extent and nature of their influence. Authentic records of observations

made in different parts of the globe extending back for a period of several hundred years would be required to determine this point definitely; but, unfortunately, such records are lacking. The available data on the subject show that certain local effects are produced by forests, but the temperature and precipitation of a region are not materially influenced or controlled by them. A few records in the United States date back to a time when the country was largely forested, and comparison made between these and records made since the forests were removed, indicate that no important or distinctive changes in temperature or precipitation have taken place as a result of such removal.

Experiments along this line are being conducted jointly by the United States Bureau of Forestry and the United States Weather Bureau. A station has been established at Wagon Wheel Gap, Colorado, for this purpose. Observations are being made in and near certain forested slopes, where, after a number of years have elapsed the forests are to be removed and the observations continued for a similar period of time. Meteorological observations are also being made regularly in some of the other forested sections of the country. It is very probable that the data thus obtained will afford new and valuable information on this important subject.

The precipitation that falls in Indiana, as well as in the other central States, is brought chiefly from the Gulf of Mexico by the southerly winds that attend the passage of large cyclonic areas, which cross the country from west to east at frequent intervals. Very little moisture is brought to this section from the Pacific Ocean, as the moist winds from that body of water give up the greater part of their moisture content by the cooling process involved in crossing the mountain ranges of the western States. This explains the semi-arid condition of the Great Basin and the eastern slope of the Rockies. By similar reasoning, the heavy rainfall on the north Pacific slope during the winter months is produced by the cooling of the moisture-laden winds, which, as they ascend the slopes of that region, must give up a large portion of their moisture. It is evident that the rainfall of a locality may be brought to it over great or short distances, and that the moisture is precipitated by changing temperature conditions regardless of the nature of the surface covering of the earth. In view of this fact, it is only reasonable to believe that the heavy growth of forests in regions of heavy rainfall and their absence in semi-arid regions is the effect rather than the cause of such climatic conditions.

A Preliminary Report of the Wood-Using Industries of Indiana.

F. J. BREEZE, INSTRUCTOR IN FORESTRY, PURDUE UNIVERSITY.

This last year the State Board of Forestry sent out the following questionaire to the firms engaged in wood-using industries:

PLEASE FILL OUT AND RETURN TO DEPARTMENT OF FORESTRY, INDIANAPOLIS.

1. Name of firm.
2. Address.
3. Location of industry.
4. When established.
5. Number of persons regularly employed?
6. How many days did your plant run in 1910?
7. Are you able to sell your mill waste, such as sawdust, shavings and slabs?
8. If so, for what purpose?
9. Price received for mill waste?

For Industries that Use Timber from the Woods.

10. Estimate how long it will take before you will have to close or move for want of timber.
11. What per cent. of the timber you use comes from Indiana?
12. What per cent. are you able to get within a radius of 25 miles?
13. What kind of timber do you use?
14. Smallest size of each kind you can use?
15. Price you pay at the mill for the different kinds per thousand feet or per cord?
16. Compare present price with that of 10, 20 and 30 years ago?
17. Give the list of articles you manufacture?
18. State kind and amount of timber used for each?

For Industries that Use Raw Timber, Etc.

19. What products do you manufacture?
20. For the wood products that you manufacture are there substitutes of steel, concrete, paper, etc., offered for sale?
21. Probable effect on the value of your wood products by these substitutes?
22. Remarks on the future of the wood working industries and the timber supply of the State.
23. Shall we enter your name for a copy of our next annual report?

Three hundred and two copies were returned from plants in operation. In most cases, the questions were not all answered, or only partly answered. A large number of concerns, including some of the very largest manufacturing plants, sent in no reports at all. This report, based on these answers, is only preliminary and is of necessity incomplete.

A report based on complete and accurate returns from the wood-using concerns can be of great service to those manufacturers. A careful inventory of our timber resources, together with an accurate knowledge of the conditions existing in the wood-using industries, will enable the manufacturer to pretty accurately forecast future conditions and to plan his business accordingly. The owner of standing timber can learn from such a report the various species of trees which enter into the wood manufactures and thereby know the present market demands and also gain insight into the probable future demands.

This report covers the timber of our own State and that from outside the State which is sawed into lumber and dimension stock or remanufactured within the State into the various wood products. That is, the industries engaged in the sawing of timber from Indiana or of logs shipped from other States, and the industries engaged in the remanufacture of lumber which may come from this State or other States are considered. No account is taken of the large quantity of lumber coming from other States which goes into use directly without further remanufacture, such as lumber and heavy construction timbers. Nor is any account taken of the wood of the State which is used for fuel and posts or sawed into lumber by the hundreds of portable sawmills and used directly upon the farms.

The many wood-using industries may be divided into the following classes:

(1) Sawmills which produce lumber and dimension stock, the only change in the raw material being that of dissection.

(2) Industries which remanufacture the lumber in products made wholly of wood, such as planing mill products, furniture and cooperage.

(3) Industries which combine wood and iron in the manufactured product, the wood being a very important factor, such as vehicles and agricultural implements.

(4) Industries in which wood does not enter into the finished products, but is used for boxes and crates for the shipment of the products.

In 1900 Indiana reached its highest point in the value of timber and lumber products. According to the industrial reports of the Census Bureau, the decline in value of wood products from 1900 to 1905 was from twenty million dollars to fourteen and one-half million dollars. During that same time, the State fell from the seventh place to the sixteenth place in the production of lumber. In 1905, although the lumber industries were showing a decline, yet in value of products, lumber and its remanufactures were fourth in the list of Indiana industries, being exceeded by (1) food and kindred products, (2) iron and steel and their products and (3) vehicles. At present more than half of the lumber comes from outside of the State, mainly from Kentucky, Tennessee, West Virginia, Arkansas and the Gulf States.

Table showing uses of the different kinds of wood made by Indiana wood-using industries. Out of 302 reporting, 240 named articles manufactured:

ASH.

Agricultural implements,
Barrels,
Furniture,
Player-pianos,
Tool handles,
Wagon stock,
Vehicle bodies.

BASSWOOD.

Barrel headings,
Boxes,
Baskets,
Caskets, undertakers' supplies,
Excelsior,
Furniture,
Player-pianos,
Vehicle bodies,
Veneers.

BEECH.

Baskets,
Boxes,
Children's wagons and sleds,
Dimension stock,
Furniture,
Lumber,
Planing mill products,
Porch furniture,
Slack cooperage,
Wagon stock,
Wood plugs,
Washing machines.

BIRCH.

Closet seats,
Furniture,
Pianos,
Planing mill products.

CHESTNUT.

Caskets, coffins,
Furniture,
Pianos.

CHERRY.

Closet seats,
Furniture,
Planing mill products.

COTTONWOOD.

Baskets,
Building materials,
Caskets and shipping boxes,
Excelsior,
Furniture,
Shipping cases and crates,
Slack cooperage,
Vehicles,
Vehicle bodies,
Veneers,
Wagons.

CYPRESS.

Boats,
Lumber,
Planing mill products,
Tanks.

ELM.

Baskets,
Boxes,
Building materials,
Furniture,
Hoops,
Pianos and organs,
Planing mill products,
Railroad stock,
Saddle trees,
Vehicle bodies,
Veneers.

GUM.

Agricultural implements,
Caskets,
Children's wagons and sleds,
Furniture,
Headings and staves,
Lumber,
Planing mill products,
Player-pianos,
Saddle trees,
Vehicle bodies and seats,
Veneers,
Wagons.

HACKBERRY.

Baskets,
Fruit packages.

HEMLOCK.

Crating,
Railroad stock.

HICKORY.

Agricultural implements,
Baskets,
Car stock,
Grain cradles,
Porch furniture,
Scythe snaths,
Tool handles,
Toy vehicles,
Vehicles (spokes, poles, shafts),
Vehicle stock,
Wagons.

MAHOGANY.

Caskets,
Closet seats,
Furniture,
Pianos,
Planing mill products,
Veneers.

MAPLE.

Baskets,
Broom handles,
Flooring,
Furniture,
Interior finish,
Pianos,
Saddle trees,
Veneers.

OAK.

Agricultural implements.
Automobiles,
Barrel headings,
Baskets,
Beds,
Boats,
Car stock,
Caskets and shipping boxes,
Chairs and rockers,
Chiffoniers,
Closet seats,
Desks,
Dining room furniture,
Doors,
Dressers,
Interior trim,
Ladders,
Kitchen cabinets,
Pianos,
Plow beams and handles,
Pork barrels,
Office and bank furniture,
Novelty furniture,
Railroad stock,
Railroad ties,
Tables,
Telephone cabinets,
Vehicles,
Veneers,
Wagon stock,
Wardrobes,
Wheels for agricultural implements,
Whiskey barrels.

RED CEDAR.

Caskets,
Cedar chests,
Posts.

SPRUCE.

Pianos and organs.

SYCAMORE.

Baskets,
Dimension stock,
Furniture,
Lumber,
Planing mill products,
Slack cooperage.

TAMARACK.

Cigar boxes.

WALNUT.

Furniture,
Lumber,
Pianos and organs.
Planing mill products,
Veneers.

WHITE PINE.

Boxes,
Burial boxes,
Furniture,
Pianos.

YELLOW PINE.

Agricultural implements,
Boxes and crates,
Dimension stock,
Furniture,
Planing mill products.

YELLOW POPLAR.

Building material,
Caskets and shipping boxes,
Furniture,
Pianos,
Saddle trees,
Vehicle bodies,
Veneers.

PRICES.

Very few of the reports indicated the prices paid for the different kinds of wood, so that the following figures are not entirely reliable. However, the prices are suggestive:

Kind of Wood.	*Prices per 1,000 Bd. ft.*
Apple	$100 00
Basswood	20 00
Beech	12 00
Cedar	50 00
Cherry	27 50
Chestnut	19 00
Cottonwood	27 00
Elm	18 00
Gum	12 00
Hemlock	16 50
Hickory	30 00
Mahogany	107 00
Maple	16 00
Oak	30 00
Oak, quartered	62 00
Pine	23 00
Red gum	30 00
Sycamore	15 00
Walnut	36 00
Yellow poplar	27 00

TABLES SHOWING SOURCES OF LUMBER.

(232 Concerns Reporting.)

The list indicates the kinds of industries and the number of each.

Industries Using 75 Per Cent. or More From Indiana.

Baskets, 3; excelsior, 1; furniture, 12; hubs and rims, 1; novelties, 2; plow handles, crates, porch furniture, 1; saddle trees, 4; saw lumber and dimension stock, 61; slack cooperage, 6; sled runners, bows, boxes, 1; spokes and hubs, 1; store fixtures, 1; tight cooperage, 1; tool handles, 6; veneers, 3; wagons, 3; washing machines, 1. Total, 108.

Industries Using From 50 Per Cent. to 75 Per cent. From Indiana.

Furniture, 3; extension tables, 1; handles, 1; lumber, 1; lumber and planing mill products, 1; pianos, 1; spokes and scythe snaths, 1; vehicles, 1; veneers, 1; wagons, 2. Total, 13.

Industries Using From 25 Per Cent. to 50 Per Cent. From Indiana.

Agricultural implements, 1; bowling alleys, 1; chairs, 2; crates, 1; excelsior, 1; flooring, 2; furniture, 1; handles, 3; hoops, 1; light vehicles, 1; lumber and veneer, 2; pianos, 1; posts, 1; staves and heading, 1; store, office and bank fixtures, 1; toys, 1; veneer, 1; wagons and hubs, 1. Total, 23.

Industries Using From 1 Per Cent. to 25 Per Cent. From Indiana.

Baskets, 1; boats, 1; boxes and cooperage, 2; brooms and mops, 1; caskets and coffins, 3; cooperage and woodenware, 1; crating and boxes, 4; furniture, 22; lawn furniture, 1; lumber, 6; lumber and planing mill products, 1; pianos, 2; planing mill products, 1; porch furniture, 1; toys, 1; school desks, 1; veneers, 3; wagons, 1; wood turnings, etc., 1. Total, 56.

Industries Using No Lumber From Indiana.

Brooms, 1; butter packages, 1; caskets, 5; cedar chests and boxes, 1; children's wagons and sleds, 1; cigar boxes, 1; closet seats, 1; furniture, 3; interior trim, 1; lumber, 3; lumber and dimension stock, 1; office furniture, 1; packing boxes, 1; plows, 1; porch columns, 1; sash and frames, 1; shipping cases, 1; trunks, 1; vehicle stock, 3; veneer, 1; wheels, 1; whisky barrels, 2. Total, 33.

Although the great centers of lumbering are somewhat remote from Indiana, yet it is probable that a large number of wood-using industries will always remain in the State. Many kinds of wood industries will always keep closer to areas of dense population than to the great lumbering regions, for extensive forest regions cannot have a dense population. In the case of furniture-making it will doubtless be more profitable to keep the factories near the markets and transportation lines, and ship in the logs or dimension stock from the lumbering regions.

Indiana is a broad gateway between the East and West and through this wide opening between the Ohio River and Lake Michigan the great continental railroads must pass. With large forest areas to the north and south of us, this State will always have a large number of wood-using industries which must be near great population centers and transportation lines.

Indianapolis, with its railroad facilities and abundant labor and capital, is the leading Indiana center of wood-using industries. This city is one of the great veneering centers of the United States. Evansville is advantageously situated for wood-using industries.

Located on the Ohio River, it stands almost at the gateway of the hardwood region of Kentucky, Tennessee and West Virginia.

If a more complete study of the wood-using industries of Indiana is to be made by the State Board of Forestry for the use and benefit of the people of this State, and especially for the manufacturers of wood products, it certainly must be urged that more complete answers be given to the questions which are sent to the wood-using industries. Reports not complete nor accurate can be of only doubtful value. If each concern will make a full and correct statement, a study and report can be made by the State Board of Forestry which will be of great use to the wood-using industries and to the producers of wood.

The Rate of Growth of Certain Species of Native Trees of the State Reservation.

BY STANLEY COULTER, PH.D., DEAN OF SCHOOL OF SCIENCE, DIRECTOR OF LABORATORY, PURDUE UNIVERSITY.

A fairly accurate knowledge of the rate of growth of the different species of trees used in the industries is evidently a matter of extreme importance. "The very existence of a problem of forest conservation is dependent upon the question of timber production. If production falls below consumption at present or threatens to in the future the problem is very real. If the production exceeds consumption there is obviously no problem of conservation to solve."[1]

It is also clear that upon a knowledge of the growth-rate of trees must depend the correct answer to the oft-repeated question concerning the time necessary to bring certain species to marketable size. The whole question of the economic possibilities in the reforestation of denuded areas, of the returns to be expected in the shorter rotations for the production of post and tie stuff depends upon our knowledge of the growth rate of the forms with which we are dealing.

So many factors enter in the determination of the rate of tree growth that studies of this nature must be regional. The results are necessarily of fairly limited application. Some of the factors determining tree growth are composition and strength of soil, its porosity, the soil moisture, the exposure to light, the topography and the climate. It is evident that conclusions drawn from a study of tree growth in New York or Arkansas might not, indeed almost certainly would not, be correct for Indiana.

Before further intelligent progress could be hoped for in forestal enterprises in the State it was necessary that accurate data bearing upon this question should be collected. Studies in the rate of growth of various tree species had previously been made by Ziegler[2] and the approximate rate of growth given for the north-

[1] Ziegler, E. A. Rate of Forest Growth. Report of The National Conservation Commission. Vol. 2, p. 203, l. 909.

[2] Ziegler, E. A., loc. cit.

ern forests, the central hardwood forests, the southern forests, the Rocky Mountain forests and the Pacific Coast forests. A reference to the tables in that report will show that the results obtained in the studies set out in the present paper are in substantial agreement with his conclusions.

In undertaking this study it was assumed that only those portions of the State which are untillable could be profitably devoted to timber production. True conservation consists in using every natural resource in the line of its highest value. In Indiana agricultural areas should, therefore, be devoted to agriculture and only those regions unfit for this devoted to forestry. In the main these regions lie in the southern counties of the State and more especially in what is known as the "Knobs."

The material for the first series of studies was collected from the State Forest Reserve in Clark County. The reserve embraces 2,000 acres and may be taken as fairly representative of ecological conditions prevalent over wide areas in our southern counties.

The topography is broken, with elevations ranging from 500 feet above sea-level to 1,000 feet above sea-level. The soil of the tract varies from a loose to a compact clay. Though receiving the average amount of rainfall, the soil is usually hard and dry, not only because of the character of the soil, but also because of the quick run-off. The land is practically untillable, a statement verified by the fact that the tract was purchased for eight ($8) dollars an acre. The timber to meet the future demands in Indian must, in the main, be taken from this region, which is sufficient reason for beginning these studies upon material collected at the State Forest Reserve.

The sections were taken from trees whose diameters were as near 12 inches, breast high (4½ feet), as could be secured. This size was chosen because at that diameter a tree is not only fit for firewood, poles and posts, but will also furnish a fairly good grade of lumber. Lumbermen, indeed, almost invariably cut below this diameter. Under present conditions trees from 12 to 16 inches in diameter may be classed as "saw-timber." It is evident that the time required to produce posts, tie, pole and firewood material can be determined as well as the time to produce first-grade timber.

The species selected for the study were the following:
Scrub or Jersey pine (Pinus virginiana Miller).
Black walnut (Juglans nigra L.).
Black or pignut hickory (Hicoria glabra (Miller) Britton).

Shellback hickory (Hicoria ovata (Miller) Britton).
Birch (Betula nigra L.).
Beech (Fagus grandifolia Ehrhart).
Chestnut (Castanea dentata (Marshall) Borkh.).
White oak (Quercus alba L.).
Scarlet oak (Quercus coccinea Muench.).
Chestnut oak (Quercus Prinus L.).
Red oak (Quercus rubra L.).
Black oak (Quercus velutina Lamarck).
White elm (Ulmus americana L.).
Yellow poplar (Liriodendron Tulipifera L.).
Red or sweet gum (Liquidambar Styraciflua L.).
Sycamore (Platanus occidentalis L.).
Black or sour gum (Nyssa sylvatica Marshall).
White ash (Fraxinus americana L.).

Ten trees of each of the above species were cut and a disk four inches thick was taken from a point 4½ feet above the ground. Credit should be given to Mr. Ambrose Waltman, custodian of the State Forest Reserve, for his skillful selection of the individual trees for cutting and his careful preparation of the disks for the studies. The individual trees were selected from different exposures, different elevations and different soils where it was possible, in order to secure average conditions as nearly as might be.

The following record was made for each specimen, the sheet being taken at random:

TREE NUMBER 48.

Species.—Shellbark Hickory.

Character of Soil.—Sandy loam.

Depth of Soil.—About four feet deep with shale bottom.

Exposure.—In ravine.

Associate Trees Within a Radius of Fifty Feet, Arranged in Order of Abundance.—1 black oak, 3 white oaks, 1 ash, 3 shellbark hickories.

The Size of Associate Trees.—3/7 inches; 3/10 inches; 1/14 inches; 1/16 inches.

Total Height of Tree.—Seventy-nine feet.

Diameter at 4½ feet, 12.2 inches; 8½ feet, 12.2 inches; 12½ feet, 12.1 inches; 16½ feet, 12 inches; 20½ feet, 11.9 inches; 24½ feet, 10.9 inches.

Length to Main Branch.— 44 feet, 6 inches.

Length of Clear Bole.—20 feet, 6 inches.

Width of Crown.—25 feet.

It was impossible because of press of other duties to consider all of the data included with sufficient care to justify conclusions which would be at all suggestive. It is fairly certain that on such a limited tract soil differences are not sufficiently marked to seriously affect the rate of tree growth. The indications are that under such conditions soil moisture and exposure are factors securing the most evident response. The data, however, are too meager to warrant any definite statements as to their effect.

The determination of the age of the specimen was by the familiar annual ring method. Evidently by counting these rings and adding the time necessary for the tree to reach the height from which the section was taken, the age of the tree from which the specimen was cut can be obtained. Before counting the annual rings several (usually four or five) diameter measurements were taken. The results of these measurements were then averaged and the resultant taken as the true diameter of the section. A place on the disk was then found having the average diameter. The rings were then counted in groups of ten years, the limit of each group being marked on a line of the radius. The decades were then measured and tabulated in order of age with the growth for the decade. The measurements are accurate to one-tenth of an inch. Each of the ten specimens of the eighteen species was thus measured and tabulated under its species heading.

These measurements were made under my supervision at the Forestry Laboratory at Purdue University by Messrs. C. J. Taylor and W. P. Brodie of the class of 1911. They were made with extreme care and at my suggestion many of them were later repeated in order that no question might arise as to the accuracy of the measurements. Without the skillful and intelligent work of these young men this paper would not have been possible at the present time.

These tabulations were made the basis of a series of curves which showed graphically the rate of growth of the species studied. From this series of curves the conclusions drawn in this paper are derived.

The work of Messrs. Taylor and Brodie indicate the following results by species:

Birch.—The average rate of growth in the material examined was .1 inch per year, the period of most rapid and uniform growth being from the tenth to the seventieth year. The taper is 2.2 inches for every ten feet. In the specimens examined no absolute conclusion can be drawn as to the age at which profitable growth ceases, although a study of the curve would indicate it to be at about the one hundred twenty-fifth year.

Chestnut.—The average growth rate is .2 inch per year, the period of most rapid growth being from the tenth to the fiftieth year, although in some specimens the growth becomes less as early as the thirtieth year. The taper is 1.4 inches for each ten feet.

Beech.—The beech grows extremely slowly, showing an average in the specimens studied of only .07 of an inch per year. Its period of most rapid growth is from the first decade to the fourteenth and apparently profitable growth ceases at approximately one hundred eighty years. The taper is 1.2 inches for each ten feet.

White Ash.—The white ash shows an average growth rate of .1 of an inch per year, the period of rapid growth being from the tenth to the sixtieth year. At sixty years the annual growth rate decreases and profitable growth ceases at approximately ninety years. White ash has a taper of 1.6 inches for each ten feet.

Black or Pignut Hickory.—This species in the region under consideration is an extremely slow grower, showing an annual growth rate of only .08 of an inch. Its growth is very uniform, although in the specimens studied its most rapid growth seemed to take place between the one hundredth and one hundred thirtieth years. It is probable from an examination of the curve that profitable growth ceases at about one hundred fifty years. The taper is 1.2 inches for each ten feet.

Shellbark Hickory.—This species shows an annual growth of .05 of an inch. Its growth is quite uniform, being perhaps slightly more rapid between the seventieth and the one hundred twentieth years. Profitable growth ceases at about the close of this period of rapid growth. The taper is 1.2 inches for each ten feet.

Black Walnut.—This species shows an annual growth rate of .16 of an inch. The growth is uniform up to the fortieth year, the period of most rapid growth being from the tenth to the fortieth

years. After the eightieth year its growth rate decreases sharply and profitable growth would cease at approximately one hundred to one hundred and twenty-five years. The taper of walnut is 1.6 inch for each ten feet.

Red or Sweet Gum.—The annual growth rate of this species is .12 of an inch. The growth is uniform and rapid up to about the seventieth year. At about one hundred years the growth rate decreases so sharply as to make it fairly certain that under the conditions existing at the State Forest Reserve profitable growth would end at that age. The taper is 1.6 of an inch for each ten feet..

Yellow Poplar or Tulip Tree.—This species shows an annual growth rate of .22 of an inch. The rate of growth is uniform and rapid from the tenth to the fortieth year. Profitable growth does not cease until about the one hundredth year. The taper is 1.2 inches for each ten feet.

Black or Sour Gum.—This is another slow growing species, showing an average annual growth rate of .08 of an inch. Its growth is uniform from the tenth to the one hundred and twentieth year and its profitable growth apparently continues far beyond that time. The taper is 1.2 inches for each ten feet.

Scrub or Jersey Pine.—This species shows an average annual growth rate of .16 of an inch. The growth is uniform up to the fortieth year, at which time the annual increment decreases. The period of most rapid growth is from the tenth to the fortieth years. While these pines attain considerable size on the "Knobs" the large trees are almost invariably "doty" at the base, so that the species, in spite of its apparent promise, is not an especially desirable one to plant or encourage. The taper is .4 of an inch for each ten feet.

Sycamore.—The sycamore shows an average annual growth rate of .2 of an inch. The most rapid and uniform growth is from the tenth to the fortieth year. After the sixtieth year the annual growth rate decreases rapidly. The taper is 1.2 inches for each ten feet.

White Oak.—White oak shows an annual growth rate of .08 of an inch. The period of the most uniform and rapid growth is from the twentieth to the one hundredth years. The curves derived from the specimens studied do not indicate at what time profitable growth ceases. The taper is 1.6 inches for each ten feet.

Scarlet Oak.—The average annual growth rate of this species is .15 of an inch. The growth is uniform and rapid from the tenth to the eightieth years. Its profitable increase continues far beyond this period, although even its approximate limit cannot be given from the data in hand. The taper is 1.4 inches for each ten feet.

Chestnut Oak.—This species shows an average annual diameter increase of .14 of an inch. The most rapid growth is from the tenth to the seventieth years. Growth ceases to be profitable at approximately one hundred years. The taper is 1.6 inches for each ten feet.

Red Oak.—The average annual growth rate of red oak is .13 of an inch. The period of most rapid growth is from the tenth to the sixtieth years. The specimens examined showed a period of exceptionally rapid growth between the fiftieth and sixtieth years. Profitable growth ceases at approximately one hundred and twenty years. The taper is 1.8 inches for each ten feet.

Black Oak.—This species of oak shows an average annual growth rate of .16 of an inch, with the period of most rapid growth between the twentieth and seventieth years. Profitable increase apparently ceases at about one hundred years. The taper is 1.6 inches for each ten feet.

White Elm.—The white elm shows an average annual growth rate of .16 of an inch. The time of most rapid and uniform growth is from the tenth to the fiftieth years. After the fiftieth year growth is extremely slow. The taper is 2.4 inches for each ten feet.

It was assumed that to reach a height of four and one-half feet would require five years, so that in each case five was added to the number of rings counted. Great care was used to avoid including the so-called "false rings" in the count and as such rings are fairly easily recognized it is believed that this source of error has been eliminated. In cases where the rings were very narrow and not sharply distinct, they were brought out by using phloroglucin and sulphuric acid. Finally, as each disk had its number and datum sheet, it was a simple matter to check back in cases where the measurements seemed doubtful. The curves of growth are not included in this report, because few persons have had sufficient practice to interpret them correctly. Both the disks and these

curve-plats are on deposit at the Forest Laboratory of Purdue University and may be examined by any one interested in the question of tree-growth.

It is to be remembered that the results of these measurements hold only for the region studied or for regions having similar ecologic conditions. Doubtless in the southwestern counties, with their deep and rich alluvial soil, the growth would be found to be very much more rapid. It will be observed also that for several of the species the conditions obtaining at the reserve are distinctly unfavorable. The hard, compact, dry soil would without question greatly lessen the growth rate of such species as sweet gum, black walnut and sycamore, trees which find the conditions of maximum development in rich, deep, loose and moist alluvial soils.

Taking all of these matters into consideration, however, we are forced to the conclusion that the production of timber material takes not merely care and skill, but *time,* and that the time required is much longer than is usually thought and evidently very much longer than the average tree agent states. While the number of trees examined under each species is far too few to warrant definite conclusions, no doubt exists in my own mind that the results obtained are fairly indicative of forestal probabilities and possibilities in such regions as those under consideration. As it is from just such regions that the future timber supply must come, the significance of these conclusions becomes evident.

It is evident that some of the species indicated have a possible utilization before they reach a diameter of twelve inches. Every forest which gives the maximum returns requires "thinning" from time to time in order that the trees which are to remain until they reach "saw-timber" size may have room for growth. The utilization of these thinning cuttings is therefore a question of great importance in forest management. At a diameter of six inches certain species have a value as posts; at eight inches many species have a fair value for handles, pulp, spools, props, and fuel; at eleven inches, under present methods "tie" size is reached. It follows that many species which it would not be profitable to bring to saw-timber size, might be very promising as furnishing material for the products where a less diameter is required. Table I attempts to place these facts in such form as to be readily understood.

TABLE I.

SPECIES.	Average Diameter. Six Inches. (Posts.) Years.	Ave. Diameter Eight Inches. (Handle, Extract, Pulp, Spools, Props, Fuel Wood.) Years.	Ave. Diameter Twelve Inches. (Ties, Poles, Saw-timber). Years.
Birch	48	60	100
Chestnut	29	42	60
Beech	75	100	150
White ash	44	70	110
Black hickory	95	120	150
Shellbark hickory	100	150	210
Black walnut	32	45	70
Yellow poplar	28	38	60
Red or sweet gum	48	60	100
Black or sour gum	74	100	150
Scrub pine	25	35	80
Sycamore	60	70	94
White oak	60	80	120
Scarlet oak	42	54	80
Chestnut oak	41	52	80
Red oak	48	58	84
Black oak	44	57	73
White elm	27	35	56

These figures, it must be borne in mind, are based in each case upon an examination of only ten specimens and are to be regarded as indicative rather than as absolute statements as to the exact number of years required to reach the diameter mentioned. The figures represent the average growth rate of ten individual trees of each species under the conditions described earlier in the paper. For such regions there is little doubt that the shellbark and black or pignut hickories are the most slowly growing forms, while the scrub pine, chestnut, yellow poplar, black walnut and white ash are those which under the conditions named show the most rapid growth. It is probable also that the ratio existing between these growth rates is expressed with practical accuracy in the results given.

It is beyond question that under proper management the diameters named would be attained in a much shorter time. In a strong, loose, properly drained soil, with proper management the time required would be very greatly reduced. This conclusion is borne out by the results obtained in the experimental plats at the Forest Reserve. An examination of the reports of the Secretary upon these plats is sufficient justification for this conclusion. A study of Table 1 will indicate promising species for post stuff, for handles, pulp, props, fuel wood, and ties. These species may well be encouraged and given the care necessary to secure their most rapid growth.

Even taking into consideration all of the factors involved, the fact remains that individual peculiarities of growth, in the limited number of specimens examined under each species, may in some cases have modified the results to such an extent that the figures given do not express the true average annual growth rate. This variance in growth rate in different individuals of the same species under practically identical conditions is shown in Table II, modified from that prepared by Messrs. Taylor and Brodie.

TABLE II.

SHORTEST TIME IN WHICH INDIVIDUAL TREES REACHED A DIAMETER OF SIX INCHES AND OF TWELVE INCHES.

SPECIES.	Six Inch Diameter Shortest Time.	Six Inch Diameter Average From Table I.	Twelve Inch Diameter Shortest Time.	Twelve Inch Diameter Average From Table I.
	Years.	Years.	Years.	Years.
Birch	38	48	70	100
Chestnut	18	29	38	60
Beech	60	75	90	150
White ash	28	44	58	110
Black hickory	75	95	130	150
Shellbark hickory	80	100	150	210
Black walnut	22	32	40	70
Sweet gum	40	48	62	100
Yellow poplar	18	28	40	60
Black or sour gum	54	74	120	150
Scrub or Jersey pine	20	25	40	80
Sycamore	16	60	30	94
White oak	45	60	70	120
Scarlet oak	28	42	55	80
Chestnut oak	31	41	50	80
Black oak	34	44	50	73
White elm	19	27	32	56

These variations in growth rate show conclusively that the figures given are relative and not absolute and that they will probably require modification upon the examination of a larger number of specimens. There is also the suggestion to be drawn from this table that in the reinforcement of existing woodlots or in the reforestation of denuded areas only seed coming from rapidly growing trees should be utilized. This is especially important in the work of reinforcing existing wooded areas if satisfactory financial returns are secured. The solution of the problem of the timber supply in Indiana lies largely in the hands of woodlot owners. If the woodlots are made to carry their full load of such species as will come to marketable size within a reasonable time, the problem is practically solved. From tables one and two data can be secured which will make it possible to undertake this reinforcement in an intelligent way and with every assurance of success.

A further study of the data reveals the fact that the form of trees studied is not good. The clear bole is not as long as it should be and the taper is too great. In all probability the failure of the trees to develop a clean bole is largely due to the fact that the land is not carrying its full load of trees in consequence of which the branches have not been naturally pruned. It is possible, also, that in some limited areas this condition has arisen from the fact that the soil was not strong enough to carry a sufficient number of trees to insure good form.

This condition is shown by the following tables of species covering length of clear bole, height to main branch and total height.

BIRCH.

Tree No.	*Length of clear Bole.*	*Height to main branch.*	*Total height of tree.*
61	16 feet 6 inches	22 feet	60 feet
64	16 feet	24 feet	52 feet 6 inches
65	16 feet 6 inches	20 feet 9 inches	60 feet
70	12 feet 6 inches	20 feet	64 feet
71	20 feet 6 inches	32 feet	65 feet
75	24 feet	25 feet	60 feet 6 inches
74	12 feet	13 feet 6 inches	56 feet
91	17 feet 6 inches	17 feet 6 inches	61 feet
98	20 feet	21 feet	60 feet
99	12 feet	15 feet	56 feet 9 inches

CHESTNUT.

101	12 feet 6 inches	14 feet	52 feet
118	20 feet 6 inches	24 feet	68 feet
126	10 feet 6 inches	11 feet	68 feet
131	16 feet 6 inches	20 feet	56 feet
132	16 feet	17 feet	60 feet
133	16 feet 6 inches	20 feet	58 feet
137	18 feet	20 feet	56 feet
157	24 feet	32 feet	68 feet
158	16 feet	20 feet	58 feet
159	10 feet	14 feet 6 inches	52 feet

BEECH.

7	16 feet 6 inches	18 feet	60 feet 4 inches
117	8 feet 6 inches	12 feet	68 feet
122	24 feet	40 feet	92 feet
125	12 feet	20 feet	60 feet
130	12 feet 6 inches	16 feet	66 feet
136	12 feet	14 feet	72 feet
138	8 feet	16 feet	68 feet
139	10 feet	20 feet	56 feet
140	9 feet	20 feet	58 feet
141	12 feet 6 inches	24 feet	60 feet

WHITE ASH.

Tree No.	*Length of clear Bole.*	*Height to main branch.*	*Total height of tree.*
22	22 feet	22 feet 9 inches	69 feet
47	20 feet 9 inches	28 feet 6 inches	58 feet 6 inches
62	20 feet 6 inches	34 feet	62 feet
83	16 feet	22 feet	54 feet
87	13 feet	24 feet	59 feet
109	20 feet	20 feet	68 feet 6 inches
119	32 feet	45 feet	72 feet 6 inches
121	28 feet 6 inches	32 feet	80 feet
127	24 feet	26 feet	68 feet 6 inches
161	13 feet	14 feet	58 feet

BLACK OR PIGNUT HICKORY.

10	16 feet 10 inches	27 feet 9 inches	52 feet 6 inches
17	19 feet	23 feet	72 feet
41	16 feet 6 inches	20 feet 6 inches	72 feet
44	16 feet 6 inches	22 feet	58 feet 9 inches
55	16 feet 9 inches	32 feet	78 feet 6 inches
81	20 feet	32 feet	80 feet
107	28 feet	44 feet 6 inches	80 feet
146	28 feet	45 feet	64 feet
147	16 feet 6 inches	24 feet	72 feet
148	20 feet	32 feet	68 feet

SHELLBARK HICKORY.

15	17 feet	29 feet	69 feet
57	12 feet 9 inches	30 feet	80 feet 6 inches
58	20 feet 6 inches	23 feet	76 feet 9 inches
63	20 feet 6 inches	36 feet	69 feet
66	12 feet 6 inches	32 feet	62 feet 6 inches
142	12 feet	28 feet	72 feet
143	20 feet	28 feet	64 feet
144	20 feet	28 feet	72 feet
145	20 feet 6 inches	32 feet	62 feet

BLACK WALNUT.

115	32 feet 6 inches	32 feet 6 inches	72 feet
123	20 feet 6 inches	34 feet	80 feet
124	24 feet	34 feet	72 feet
135	20 feet	22 feet	68 feet
163	42 feet	44 feet	86 feet
162	30 feet	32 feet	80 feet
176	12 feet	32 feet	48 feet
178	12 feet 6 inches	13 feet	44 feet 6 inches
179	8 feet	8 feet	40 feet
180	10 feet	10 feet	48 feet

RED OR SWEET GUM.

Tree No.	*Length of clear Bole.*	*Height to main branch.*	*Total height of tree.*
13	31 feet	34 feet 8 inches	68 feet
14	22 feet	24 feet	66 feet
19	27 feet 6 inches	46 feet	82 feet
84	12 feet 6 inches	15 feet	57 feet
89	13 feet 6 inches	18 feet	65 feet
102	8 feet	9 feet	60 feet
148	28 feet 6 inches	32 feet	60 feet
149	32 feet	44 feet	72 feet
150	20 feet	45 feet	80 feet
153	16 feet	24 feet	64 feet

YELLOW POPLAR OR TULIP TREE.

32	12 feet 6 inches	21 feet	62 feet
82	8 feet	20 feet	64 feet
108	28 feet	42 feet	76 feet
113	20 feet	24 feet	70 feet
115	45 feet	47 feet	89 feet
116	28 feet	45 feet	84 feet
120	32 feet 6 inches	49 feet	88 feet
128	20 feet	30 feet	69 feet
129	24 feet 6 inches	36 feet	78 feet
154	28 feet	32 feet	72 feet

BLACK OR SOUR GUM.

4	30 feet 6 inches	30 feet 6 inches	67 feet 4 inches
5	38 feet	38 feet	68 feet 8 inches
23	25 feet 6 inches	35 feet	61 feet
56	24 feet	30 feet	67 feet 6 inches
68	20 feet 6 inches	28 feet	60 feet
77	27 feet	27 feet	68 feet
88	24 feet 6 inches	36 feet	62 feet
105	24 feet	25 feet 6 inches	68 feet
134	24 feet	25 feet	76 feet
152	28 feet 6 inches	32 feet	62 feet

SCRUB OR JERSEY PINE.

25	17 feet 9 inches	28 feet	62 feet
26	20 feet 9 inches	36 feet	63 feet 6 inches
27	17 feet 6 inches	28 feet	62 feet
28	22 feet	38 feet	65 feet
51	8 feet 9 inches	9 feet	53 feet 6 inches
52	9 feet	10 feet	54 feet 9 inches
53	12 feet 9 inches	16 feet	51 feet 6 inches
60	16 feet 9 inches	20 feet	52 feet 6 inches
90	12 feet	13 feet	54 feet 6 inches
92	9 feet	10 feet	48 feet 6 inches

SYCAMORE.

Tree No.	*Length of clear Bole.*	*Height to main branch.*	*Total height of tree.*
31	15 feet 8 inches	22 feet	65 feet
73	20 feet	30 feet	61 feet 6 inches
74	20 feet	45 feet	68 feet 6 inches
78	17 feet 9 inches	30 feet	64 feet
94	12 feet	16 feet	64 feet
164	28 feet	40 feet	76 feet
166	12 feet	16 feet	64 feet
167	20 feet	24 feet	64 feet
171	12 feet	14 feet	60 feet
172	8 feet	8 feet	60 feet

WHITE OAK.

6	12 feet 6 inches	14 feet	62 feet 6 inches
8	25 feet 6 inches	27 feet 6 inches	69 feet 6 inches
9	12 feet 6 inches	15 feet	57 feet
24	20 feet 6 inches	31 feet 6 inches	65 feet
36	8 feet 6 inches	22 feet	64 feet 9 inches
49	16 feet 9 inches	23 feet	60 feet 6 inches
69	16 feet 6 inches	24 feet	63 feet
85	14 feet	16 feet 6 inches	54 feet 6 inches
106	20 feet	20 feet	68 feet 6 inches
111	24 feet 6 inches	27 feet	62 feet

SCARLET OAK.

1	27 feet 6 inches	30 feet	64 feet 5 inches
29	16 feet 8 inches	22 feet	72 feet
30	25 feet	35 feet	72 feet
34	8 feet 9 inches	30 feet	64 feet 9 inches
39	20 feet 6 inches	28 feet 6 inches	66 feet
54	16 feet 9 inches	24 feet	64 feet 6 inches
67	16 feet 6 inches	26 feet	61 feet
103	20 feet 6 inches	22 feet	70 feet
110	28 feet	40 feet	76 feet
112	16 feet 6 inches	30 feet	68 feet

CHESTNUT OAK.

11	18 feet 9 inches	20 feet	69 feet 9 inches
12	22 feet	23 feet 6 inches	64 feet
16	21 feet 3 inches	28 feet	66 feet
33	16 feet 6 inches	18 feet	60 feet 6 inches
38	18 feet 6 inches	18 feet 6 inches	61 feet 6 inches
45	12 feet 6 inches	18 feet	51 feet 6 inches
46	12 feet 6 inches	13 feet	66 feet 9 inches
151	16 feet 6 inches	19 feet	58 feet
155	20 feet	24 feet	68 feet
156	20 feet	32 feet	68 feet

RED OAK.

Tree No.	*Length of clear Bole.*	*Height to main branch.*	*Total height of tree.*
18	26 feet	26 feet	65 feet
20	21 feet	41 feet	75 feet
42	12 feet 6 inches	30 feet	58 feet
43	16 feet 6 inches	24 feet 9 inches	58 feet 6 inches
59	16 feet 9 inches	18 feet	56 feet 6 inches
72	8 feet 6 inches	12 feet	56 feet
76	18 feet	22 feet	60 feet
86	20 feet 6 inches	24 feet	62 feet 9 inches
93	12 feet 6 inches	14 feet	60 feet
95	12 feet 6 inches	14 feet	57 feet

BLACK OAK.

2	16 feet 10 inches	18 feet	64 feet 9 inches
3	27 feet 6 inches	27 feet 6 inches	80 feet 7 inches
21	25 feet	41 feet	73 feet 6 inches
35	16 feet 6 inches	28 feet 6 inches	64 feet 9 inches
37	13 feet	19 feet 6 inches	62 feet 8 inches
40	16 feet 6 inches	36 feet	68 feet 6 inches
50	16 feet 8 inches	24 feet 6 inches	56 feet 9 inches
80	20 feet 6 inches	23 feet	68 feet
100	16 feet 6 inches	24 feet	60 feet
104	24 feet 6 inches	29 feet	69 feet

WHITE ELM.

96	12 feet	12 feet	56 feet
97	6 feet	6 feet	53 feet
165	16 feet	18 feet	69 feet
168	12 feet	12 feet	56 feet
169	20 feet	24 feet	60 feet
170	16 feet	16 feet	56 feet
173	8 feet	9 feet	52 feet
174	28 feet	29 feet	64 feet
175	28 feet	32 feet	64 feet
177	20 feet	25 feet	56 feet

When it is remembered that the trees considered were cut to a given diameter, being between twelve and fourteen inches outside measure four and one-half feet from the ground, the above tables prove extremely suggestive. It is evident that no relation exists between diameter and height capable of expression in the form of a ratio. In the region considered, trees twelve to fourteen inches in diameter show following height measurements:

Species.	*Average for 10 trees.*	*Least height.*	*Greatest height.*
Birch	59 feet 7 inches	52 feet 6 inches	65 feet
Chestnut	59 feet 6 inches	52 feet	68 feet
Beech	66 feet	56 feet	92 feet
White Ash	65 feet	54 feet	80 feet
Pignut Hickory	71 feet 8 inches	58 feet 9 inches	80 feet
Shellbark Hickory	67 feet 6 inches	60 feet 6 inches	76 feet 9 inches
Black Walnut	64 feet 4 inches	40 feet	86 feet
Red or Sweet Gum	67 feet 4 inches	57 feet	82 feet
Yellow Poplar	75 feet 1 inch	61 feet	89 feet
Black or Sour Gum	66 feet	60 feet	76 feet
Scrub or Jersey Pine	56 feet 9 inches	48 feet 6 inches	65 feet
Sycamore	64 feet 9 inches	60 feet	76 feet
White Oak	64 feet 8 inches	54 feet 6 inches	69 feet 6 inches
Scarlet Oak	67 feet 10 inches	61 feet	76 feet
Chestnut Oak	63 feet 5 inches	51 feet 6 inches	69 feet 9 inches
Red Oak	60 feet 10 inches	56 feet	75 feet
Black Oak	66 feet 10 inches	56 feet 9 inches	80 feet 7 inches
White Elm	58 feet 6 inches	52 feet	68 feet

It is interesting to note that the results obtained from the small number of trees considered under each species, are borne out by an inspection of the forests of the region studied. The relative height of the species is, without doubt, practically correct, and while the average height of each species might require some modification, it is approximately correct. Within each species, however, the tables show that in trees of the same diameter the height may vary widely. In the case of the black walnut, for example, tree No. 179, with a diameter of fourteen inches, is forty feet high, while tree No. 163, with a diameter of thirteen inches is eighty-six feet high. It is, however, safe to say that any considerable number of Black Walnut trees of a diameter of thirteen to fourteen inches will average about sixty-five feet in height. This wide variation in height is, in the region under consideration, due in some measure to the unevenness in density of the second growth stand. In some cases the conditions are practically those of the open, while in others they are forestal.

Another feature brought out by the tables is the scant amount of clear bole, which in some cases is as low as six feet and in many does not exceed eight or ten feet. An examination of the datum sheets shows that this is directly related to the density of the stand. In case of a short clear bole there are no other trees within a radius of fifty feet, or if any are present they are so small as to show that they have sprung up after the tree in question had acquired its permanent form.

Associated with this is the slight height at which the main branching occurs. An examination of the tables will show that relatively few trees are included which would furnish a clear sixteen-foot log and only one or two which would furnish two such logs. The economic significance of these characters is so evident as to need no discussion.

Some important deductions can be drawn from the facts set out in this paper.

1. The growing of "saw-timber" requires not merely care and skill, it also requires time. If the one hundred and eighty trees examined are considered it is found that the average time required to reach a diameter of twelve inches was ninety-four years. Saw-timber twelve inches in diameter of the species is not high class material. As a rule (excepting perhaps the hickories) the growth rate begins to decrease after sixty or seventy years, so that any diameter increase above the limits indicated would be extremely slow. Investment in land for the purpose of producing high grade saw timber is not a promising one for the individual. Such investments are suitable for the State or for great corporations.

2. These studies indicate that the reforestation of our denuded areas is not a task for the individual land owner or investor, but is one which properly belongs to the State or in exceptional cases to great industrial corporations dependent upon the forest for raw material. The value of such investments is indicated by the large acreage of such land acquired within the last few years by the States of New York, Pennsylvania, Michigan, Minnesota, Wisconsin and others.

3. The data emphasize the fact of the necessity of properly managing the existing woodlots. In practically every instance reenforcement is necessary in order to secure a tree form which will have a market value. It is necessary, also, in the interests of true conservation that the woodlot should carry its full load of trees. Under present conditions this increase in the number of trees per acre, especially if of high grade species, cannot be looked for from natural seed regeneration. Suitable seed trees of desirable species do not exist in any area in sufficient numbers to insure their production as against that of less desirable forms. Fortunately this artificial reënforcement is neither difficult nor expensive. It requires chiefly time and persistence. It should be recognized that a woodlot carrying only one-half of the trees of which it is capable is as great a mistake economically as to permit a corn-

field to stand without replanting when every other hill is vacant. If the land owners of the State should compel the woodlot to carry its full load of trees the future of our wood working industries would be secure. The area within the State, now considered timber land, would be sufficient, if properly managed and made to carry its full load of trees, to meet all of the prospective demands of the State for many years.

4. Other facts obtained in these studies, but not set out in this paper, show that our present stand is not merely unsatisfactory as to quantity, but also as to quality. The proportion of the species is wrong. In almost every case the species of high value occur in scant numbers, the bulk of the stand being made up of species of relatively inferior value. There are to be found ordinarily more black oak than white oak, more black hickory than shellbark hickory. This condition is the result of long continued selective cutting and is one which can only be remedied by artificial reënforcement. The woodlots of the State must not only carry more trees, they must also carry trees of higher grade. Such a change of condition cannot be brought about in a year or in two years, but persistent, intelligent effort will ensure success in a relatively short time.

In the region studied, which is fairly typical of large areas in the southern counties, a stand in which the trees average from twelve to thirteen inches in diameter, is approximately one hundred years old. None of these stands will cut to exceed 2,500 to 3,000 feet B. M. per acre; they should cut from 5,000 to 7,000 feet. The proportion of species is unsatisfactory. The species which dominate in numbers are not of high value, and valuable species are sparingly represented. These are the conditions which are to be corrected if our citizens do their part in the work of forest conservation.

While the annual growth rate of the species discussed might be much more rapid in other parts of the State, none of the other statements of this paper would require modification. In no part of the State do the timbered areas show a full stand, a profitable proportion of species or any evidence of intelligent management. Until these facts are recognized and their significance appreciated the agitation for forest conservation is practically useless.

Taking all of the facts into consideration the maintenance and improvement of existing wooded areas is the most practical and most promising line of effort in the conservation of our forest re-

sources. This work is wholly the function of the individual owner. It is hoped that this paper will give something of intelligent direction to his efforts.

The reforestation of the thousands upon thousands of acres of stripped and wasting land, is not the function of the individual, it belongs in all good reason, in economy, in a wise prevision of the welfare of the commonwealth, to the State. In case the State fails to see and seize the opportunity it will be taken up by the great corporations controlling our wood-working industries.

Trees of Indiana.

BY CHAS. C. DEAM.

The number of trees included in this list is wholly arbitrary, the scientific definition of a tree being ignored. All the woody plants of the State that usually attain a diameter of 10–15 cm. (4–6 inches) have been included and also a few that rarely attain this size in our area. *Alnus rugosa* (Alder), which in our area is usually a shrub, is included because it so closely resembles *Alnus incana* (Tag Alder) that it might be mistaken for it. Forms in our area that rarely attain tree size and are generally regarded as shrubs, such as *Euonymus atropurpureus* (Wahoo), Rhus species (Sumacs) and Hamamelis (Witch Hazel) have been excluded. Trees introduced that have freely escaped and have successfully maintained themselves for many years are considered members of our flora, but horticultural trees which have escaped, such as the apple, pear and plum have been excluded.

Each tree is considered under the following heads: botanical description, distribution, economic uses and horticultural value.

Botanic description.—Great care has been taken to avoid technical terms, but occasionally for the sake of precision and brevity, it has proven necessary to introduce them. It is believed, however, that none have been used of which the common school dictionary will not give a satisfactory definition.

Botanical names are usually pronounced according to the English method of pronouncing Latin. The accented syllables have been marked as follows: the grave (ˋ) to indicate the long English sound of the vowel and the acute (ˊ) to show the short or otherwise modified sound.

Some of our trees are easily identified and short descriptions are sufficient, while others, such as the oaks and hickories, are not easily identified and more detailed descriptions are desirable. The descriptions have been based upon characters which are conspicuous in order that the aid of a microscope or lens would not be necessary. The color, size and measurements are based upon fresh material from mature trees. The measurements are given in the metric system, followed by the English equivalent in parentheses. The last page is a plate on which the systems of measurements are compared. The etymology of such generic names as

are of special interest has been given. The nomenclature conforms to that of the United States Forest Service, and when it differs from Gray's Manual, 7th edition, the synonym is given after the common name. The common names are those commonly or locally used in this State, and when text-book common names are given they are so indicated. The names are arranged in the order of the frequency in which they are used, the most common being first. In naming the associate trees, they have been arranged in the order of their frequency, the first being the most numerous.

The Malaceae (Apple Family) has been contributed by W. W. Eggleston of the Bureau of Plant Industry, Washington, D. C., who is a specialist in this group.

Distribution.—The general distribution is given first, which is followed by the distribution in Indiana. The number of individuals occurring on a given area is defined by using the terms common, frequent, rare, etc., which have no definite meaning, so the following arbitrary meanings have been attached to the following words and carefully followed throughout: very common, more than 25 trees to the acre; common, 5-25 trees to the acre; frequent, 1-5 trees to the acre; infrequent, 1 tree to 2-10 acres; rare, 1 tree to every 11-100 acres; very rare, 1 tree to more than 100 acres; local, when the distribution is circumscribed or in spots.

The published records of the distribution of each species include only those where the name and county or locality are definitely given. When an author mentions one or more trees and the location incidentally, or when an author is not discussing the trees of the State, such publications are not credited. In considering some of the older publications it should be borne in mind that scientific accuracy was not as rigorously demanded as at present, and that some of the authors were not trained botanists. When errors in such publications are beyond dispute, attention has been called to them. There are other records that are questionable, and attention will be drawn to them when it is noted that they are beyond the known range of the species in the State.

Additional records are those based on existing specimens deposited in the following herbaria: Deam, Bluffton; Depauw University, Greencastle; Grimes, Russellville; Lilly, Indianapolis; Purdue University, Lafayette; Wabash College, Crawfordsville.

The fact that a tree is not given as occurring in certain counties, does not imply that it is not found there, but that it has not been reported. It is believed that about one-half of our trees are found in nearly every county of the State.

A county map has been inserted on page 2 to assist in locating the records of the distribution of the species.

Economic uses.—Under this head the physical appearance and qualities of the wood of each species and its principal uses are given. Other commercial products which may be obtained from our trees are also mentioned. It will be noted that no mention is made of the dry distillation of wood, because at present it is not used for that purpose in this State. All species of trees are used more or less for fuel in this State, but only the principal ones are named.

Horticultural value.—The silvicultural qualities of only such species as are adapted to ornamental, shade tree or forest planting are discussed. The planting, spacing and management of such trees as are adapted to forest planting are discussed in detail.

Drawings.—The drawings have been made by Miss Minnie Ellsworth Bartlett of Indianapolis. All were made from herbarium specimens taken from Indiana trees, which are deposited in the Deam herbarium, except the fruit of the genera, Juglans, Hicoria, Malus and Crataegus, which were drawn from fresh mature fruit. The drawings are all natural size unless otherwise indicated.

Acknowledgments.—Material for the preparation of this work has been gathered from field work in sixty-two out of the ninety-two counties of the State at different times during the past fifteen years. All publications bearing on the distribution of Indiana trees have been freely used, and credit is here acknowledged. The general range of the species and the character and qualities of the wood have in the greater part been taken from the works of Britton, Hough and Sargent, to whom indebtedness is acknowledged.

My thanks are tendered to the Board of Forestry for the privilege of undertaking this work and for services rendered. The most grateful acknowledgment is accredited Prof. Stanley Coulter, who read the manuscript, for inspiration, many valuable suggestions and criticisms. The favor of having the genera Malus and Crateagus written by the well known specialist, W. W. Eggleston, is appreciated not only by the author but will be by the readers of this book. The author wishes to acknowledge the assistance of Dr. N. L. Britton in examining critical specimens; of E. B. Williamson in reading manuscript; of E. J. Grimes and W. B. VanGorder in furnishing material. Last, but not least, I wish to acknowledge the assistance of Stella M. Deam, my wife, in field and clerical work.

TREES OMITTED FROM THE PRESENT LIST WHICH HAVE BEEN REPORTED AS NATIVE TO THE STATE.

It should be borne in mind that the forests of Indiana have undergone many changes since the first list of Indiana plants was published in 1819. Many birds and mammals have vanished from our area, and it is not unreasonable to believe that many of the plant forms also have disappeared after the advent of the ax and plow.

In the preparation of the present list of trees of the State, a critical examination has been made of the records of all the trees that have been reported as being native to the State. This seemed advisable in order that the present work might not be burdened with the discussion of unnecessary species and to correct errors if any existed.

Pìnus rígida Miller. PITCH PINE. This species was given by Baird and Taylor as occurring in Clark County in a flora of the county published in the manual of the schools of Clark County, Indiana, 1878-1879. The range of *Pinus rigida* is east of our area, and since the authors did not include in their list *Pinus virginiana* (Scrub Pine), which is frequent on the knobs, it is believed the reference to *Pinus rigida* should be referred to *Pinus virginiana.* It is to be noted that Prof. Stanley Coulter, who knew the authors of this flora and who is well acquainted with the trees of that vicinity, ignored the reference in his catalogue of the plants of Indiana.

Chamæcyparis thyoìdes (Linnæus) Britton, Sterns and Poggenberg. WHITE CEDAR. This tree was given a place in our flora upon the authority of Dr. C. R. Dryer of Ft. Wayne, who reported it from Allen County. All efforts to verify this record have failed. Dr. Drake in his picture of Cincinnati, published 1815, page 83, says,—"The White Cedar and Cypress are found on the banks of the Wabash." Since the range of this species is given by Sargent as along the Atlantic coast from Maine to Florida, it is improbable that it occurs within our area.

Pópulus balsamífera Linnæus. BALSAM POPLAR. This species is reported by Bradner from Steuben County, where it may occur. The writer has a leaf specimen collected near Gage Lake in Steuben County, which if taken from a mature tree is unquestionably from *balsamifera;* if from a young tree, it may be *grandidentata.* In a reply to a letter addressed to Mr. Bradner asking if he had specimens from the tree on which his record was made, or if he knew where the tree was to be found, or if the record he made was from a cultivated or an escaped tree, he says he had no specimens and

had no recollection of the location of the tree. Since the record could not be verified it is thought best to drop it for the present. J. M. Coulter reports it from Jefferson County, and A. H. Young, who also reported on the flora of Jefferson County, fails to mention it. The preceding record may have been made from a cultivated tree, or it may have been mistaken for *Populus grandidentata,* which is not reported and is within range of the county. Baird and Taylor also reported it from Clark County in a flora of Clark County but failed to report *Populus grandidentata,* which is locally frequent.

Hicòria aquática (Michaux) Britton. WATER HICKORY. (*Carya aquatica* (Michaux) Nuttall.) This is listed as one of the principal trees occurring along the Wabash in the Coblenz edition of Prince Maximilian's travels in North America. It is recorded as "Water Bitternut (*Juglans aquatica*)." If it occurs in our area it most likely would be found in the extreme southwestern counties. It has been reported from Gallatin County, Illinois, bordering Posey County on the west.

There are two other records of its occurrence in the State, which are doubtful. Ryland T. Brown reported it in a list of the principal trees of Fountain County in a report of the geology of Fountain County. *Hicoria laciniosa,* which is sometimes called swamp hickory and which is more or less frequent in the county, he failed to report. It is believed this reference to *Hicoria aquatica* should be referred to *laciniosa.* B. C. Hobbs also reported it as common in Parke County in a short list of the principal trees. He named only four of the five or more species of hickory that occur in the county, and it is believed, since he was no botanist, that he confused the names. Elliott in his Trees of Indiana gives "*Carya aquatica*" as common, but no doubt this reference should be transferred to some other species.

Hicòria myrísticæfórmis (Michaux) Britton. NUTMEG HICKORY. This tree also was reported by Prince Maximilian as occurring along the Wabash River. The known range of the species is from North Carolina to Arkansas, and for this reason the species is not included in this list.

Castànea pumila (Linnæus) Miller. CHINQUAPIN. This species was given a place in our flora in Coulter's catalogue upon the authority of Sargent, Ridgway and Schneck. Ridgway, in giving an additional list of the trees of the lower Wabash Valley (Proc. U. S. Nat. Mus. 17:415), says: "There is some doubt as to No. 16, *Castanea pumila,* which is given on Prof. Sargent's authority; but there is a possibility of an error having been made from the cir-

cumstance that the name 'chinquapin' is in that region almost universally applied to the fruit of *Quercus Muhlenbergii.*" The Posey County record was based on a specimen in Dr. Schneck's herbarium, which proves to have been taken from a cultivated tree near Poseyville.

Quércus ilicifòlia Wagenheim. BEAR OAK. This species is credited to our flora by Will Scott in his ecological study of "The Leesburg Swamp" in Kosciusko County, published in the Indiana Academy of Science, 1905, page 225. In a reply to an inquiry addressed to him he says no herbarium material was preserved. This ecological work was done during the summer months while working at the biological station at Winona Lake. In a footnote in this paper we are informed that for the identification of the trees listed, Apgar's Trees of the Northern United States was used. In this key to the trees, *Quercus velutina* (Black Oak) is given only as a variety of *Quercus coccinea* (Scarlet Oak), and the distinction between *Quercus velutina* with its many formed leaves, and *Quercus ilicifolia* is not made apparent. In view of the fact that the natural habitat of *Quercus ilicifolia* is sandy barrens and rocky hillsides and its western range is eastern Ohio, it is believed what Mr. Scott had in hand was a variable form of *Quercus velutina,* which is frequent in that vicinity. The evidence is not encouraging enough to include it.

Quércus nígra Linnæus. WATER OAK. This species has been reported by several authors for Indiana. It is believed that a majority of the records should be transferred to *velutina* and *imbricaria* or *marylandica.* Gorby and Schneck call *Quercus nigra* black jack oak, which is generally the common name for *Quercus marylandica.* Ridgway in his writings of the flora of the lower Wabash Valley, likewise speaks of *Quercus nigra* as jack oak and says it is found in poor soil. Coulter in his catalogue of Indiana plants regarded these references to *nigra* as errors and did not include it in his list. The report for Crawford County by Deam should be transferred to *marylandica.* Since the range of the species is not north of Kentucky, the reference to the species in the State should be dropped.

The published records are as follows: Carroll (Thompson); Crawford (Deam); Delaware, Jay, Randolph and Wayne (Phinney); Jay (M'Caslin); Fountain (Brown); Miami (Gorby); Parke (Hobbs).

Quércus Phéllos Linnæus. WILLOW OAK. This species has been reported from various counties of the State. The tree is said to grow in swamps and on sandy uplands, ranging from Staten Island,

New York, south to Florida and west to Texas, and north to southern Kentucky. If it occurs within our area it no doubt would have been found by Dr. Schneck, who was an enthusiastic student of the oaks. He reported it as occurring in the lower Wabash in his early writings, but his herbarium contained no specimens. The writer while in search for this species in Posey County met three men in widely separated parts of the county who were acquainted with the species in the South and they said they had never seen it in Indiana. One of the men was an old man who had spent his boyhood in Arkansas and was well acquainted with the willow oak before he came to Indiana. It is believed what has been reported for *Phellos* has been narrow-leaved forms of *imbricaria* (Shingle Oak), and that the records should be transferred to that species.

The published records are as follows: Gibson, Knox and Posey (Schneck); Knox (Thomas); Miami (Gorby).

Planèra aquática (Walter) J. F. Gmelin. PLANER-TREE. WATER ELM. This tree was included in Coulter's catalogue upon the authority of Sargent, who includes Indiana in the range of the species in his "Forest Trees of North America", Vol. 9, U. S. Census Report, 1880, page 124. Dr. Schneck spent a lifetime along the lower Wabash bottoms and very carefully preserved specimens of all the flora of the region where this species is reported to occur. In his report of the flora of this region in 1875 he does not include this tree. An examination of his herbarium material showed no specimens of this tree either from Indiana or Illinois. It is fair to presume if he had been acquainted with the tree he would have had it represented in his herbarium. Since the white elm is frequently called water elm, as well as the planer-tree, it is easy to understand how confusion might arise in separating these trees by non-professional people.

Ìlex opàca Aiton. Holly. This tree was included in Coulter's catalogue on the authority of Robert Ridgway, who said it "had been listed for southern Indiana." It has not been possible to establish a reliable State record for the species, so it is dropped from the present list.

Àcer pennsylvánica Linnæus. MOOSEWOOD. The only record of this tree occurring in Indiana is in a report of the trees occurring along the Wabash River by Prince Maximilian. While Indiana is within the possible range of the species, it has not been discovered since. If not extinct in our area it is most likely to be found along the hills of the southern counties. Robert Ridgway says that he and Dr. Schneck saw it growing in a wooded cove near a cavern called Flory's Cave in Johnson County, Illinois.

Nyssa aquática Linnæus. TUPELO GUM. This species is included in Coulter's catalogue of Indiana plants and has been reported from many widely separated counties. But few specimens were preserved upon which county records were made. Two of these have been examined which showed that they were variable leaf specimens of *Nyssa sylvatica* (Sour Gum), no doubt taken from a vigorous branch or a thrifty young tree. It is believed that all the locations of this species occurring in the State should be referred to *Nyssa sylvatica*. This species has been a puzzle to the systemist who is not acquainted with both species, and so far as is known no one of those who reported *aquatica* for the State was acquainted with it at the time the report was made. The tree is said to grow in cypress swamps from southern Virginia west to Missouri and up the Mississippi Valley to southern Illinois. If it occurs in our area it would be found in the cypress swamps along the lower Wabash. Dr. Schneck reported it for this region in the early years of his botanical work, but on May 20, 1902, on a specimen of *Nyssa* he makes the following note: "I now believe all the forms of *Nyssa* are *sylvatica*." This note is made to cover the forms of the Wabash Valley. Robert Ridgway also reported it for Knox County in his earlier publications, but in a letter from him dated November 11, 1911, he says, "You will observe that *Nyssa aquatica* is not given in my two catalogues, and I think the species may safely be omitted."

The published records of its distribution are as follows: Dearborn (Collins); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Coulter); Lake (Barnes); Marion (Wilson); Monroe (Blatchley); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Vigo (Blatchley).

Halèsia díptera Ellis. SNOWDROP TREE. (*Halesia carolina* Linnæus). This tree has been admitted to our flora upon the authority of Robert Ridgway who reported it as occurring near Evansville. Mr. Ridgway says he quoted from some standard authority but can not recall where he saw it. Since the range of the species is much to the south of our area it is not included in this list.

Fráxinus caroliniàna Miller. WATER ASH. This species was included in Coulter's catalogue of Indiana plants upon the authority of Dr. Schneck. It is asserted that specimens were verified at the Shaw Botanic Gardens, but an examination of the material there showed that no specimens from Indiana were deposited there.

There were no specimens in Dr. Schneck's herbarium, so it is to be inferred that an error in determination has been made. Since the range of the species is given as swamps from Virginia west to Arkansas, it is proposed to drop this species from our flora. The published record of Brown for Fountain County is considered an error.

Key to the Families.

PINÀCEÆ. THE PINE FAMILY.

Trees with a resinous juice; mostly evergreen; leaves linear or scale-like, clustered or alternate; flowers naked, appearing in early spring; fruit a cone or sometimes berry-like. A family of trees of great economic importance and widely distributed, although in our area the trees are usually small and few in number.

Leaves all linear.
  Leaves in bundles or fascicles.
    Leaves in bundles of 2-5, with a sheathing base..... 1 Pinus.
    Leaves in bundles of more than 5, without a sheathing base..... 2 Larix.
  Leaves apparently 2-ranked.
    Leaves bluish-white beneath..... 3 Tsuga.
    Leaves green on both sides, deciduous..... 4 Taxodium.
Leaves scale-like, or some of them short and awl-like.
  Fruit a small cone of 8-12 imbricated scales..... 5 Thuja.
  Fruit berry-like..... 6 Juniperus.

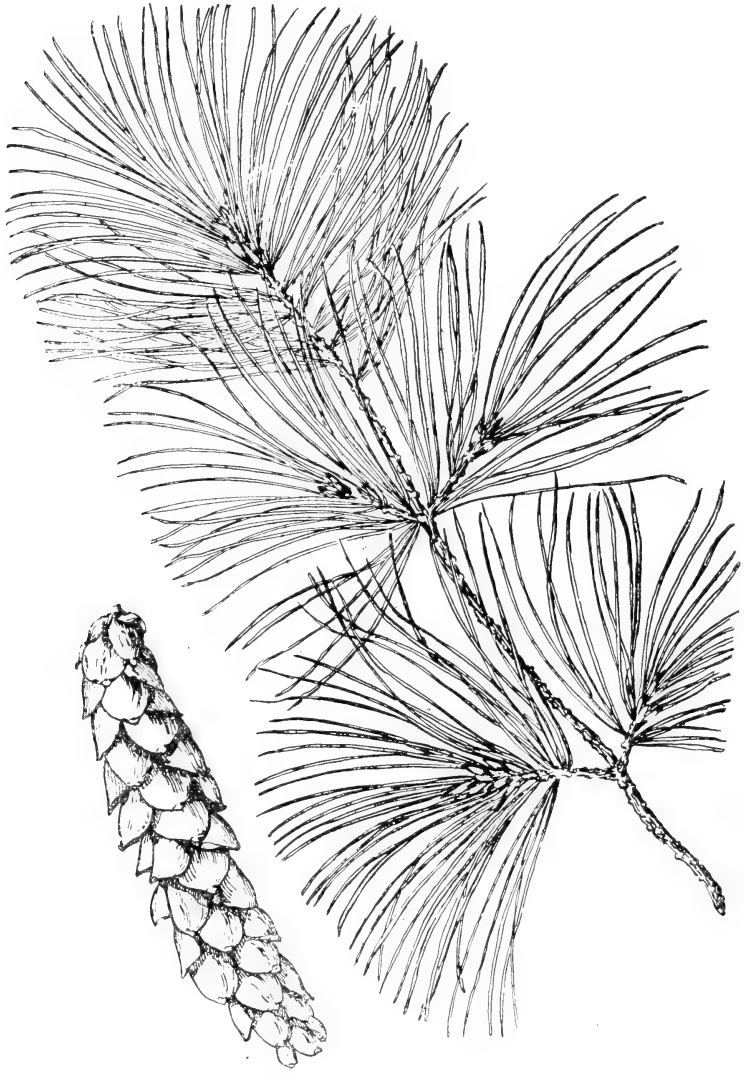
1. PÌNUS. THE PINES.

Evergreen trees with needle-shaped leaves in bundles of 2-5 with a sheath at the base; flowers appearing in the spring, the staminate clustered at the base of the season's shoots, the pistillate on the side or near the end of the shoots; fruit a woody cone which matures at the end of the second season, or more rarely at the end of the third season; scales of the cone variously thickened; seeds in pairs at the base of the scales. Some trees of this genus are tapped for their resinous juice from which turpentine and rosin are obtained. Repeated tappings of the trees soon kill them and the supply of trees is fast decreasing. The price of turpentine and rosin has advanced more than one hundred per cent. during the past twenty years.

Leaves 5 in a bundle, 7-10 cm. (3-5 inches) long..... 1 P. Strobus.
Leaves 2-3 in a bundle.
  Scales of cones unarmed, leaves about 2.5 cm. (1 inch) long..... 2 P. Banksiana.
  Scales of cones tipped with a short spine, leaves about 5 cm. (2 inches) long..... 3 P. virginiana.

1. Pinus Stròbus Linnæus. WHITE PINE. Plate 7. Bark on old trees thick, dark reddish-brown, furrowed, on young trees greenish, smooth or nearly so; young twigs scurvy-pubescent, soon smooth and brown; leaves normally 5 in a bundle, sometimes more, 7-10 cm. (3-5 inches) long, 3-sided, soft bluish-green, sharp pointed;

PLATE 7.



PINUS STROBUS Linnæus. WHITE PINE. (x ½.)

cones drooping, pointed, 10-15 cm. (5-7 inches) long, about 2.5 cm (1 inch) in diameter when closed, about 4 cm. (2 inches) when opened, falling during the winter.

Distribution. Newfoundland to Manitoba, south to Iowa, Ohio and along the Alleghany Mountains to northern Georgia. In Indiana it is found on the dry sand dunes bordering Lake Michigan, and in lower ground in sparing numbers for about 15 miles inland. In a few places along the lake it was formerly common, but on account of its commercial value was cut, and it has been succeeded by a mixed forest. In this part of the State where it grows in low ground it is associated with the white elm, black ash and soft maple. It again appears on the sandstone bluffs of several creeks in Warren County. In this locality it is found near the edge of the bluffs which range from 20 to 100 feet in height. It is next found on a sandstone bluff of Sugar Creek in Montgomery County. At this point a few trees are found, associated with the hemlock. Upon good authority it is said a few trees occur in Clark County on the tops of the hills near Borden, associated with *Pinus virginiana* and a few in a similar location near St. Joe in Floyd County. In our area it is usually a medium sized tree in the dry soil conditions and a moderately large tree in the low ground.

The published records of the distribution are as follows: Clark (Baird and Taylor); "a few counties in the southern, and a few in the northern part of the State." (Coulter's Catalogue, Rept. Ind. Geol. Surv., Vol. 24, p. 615.)

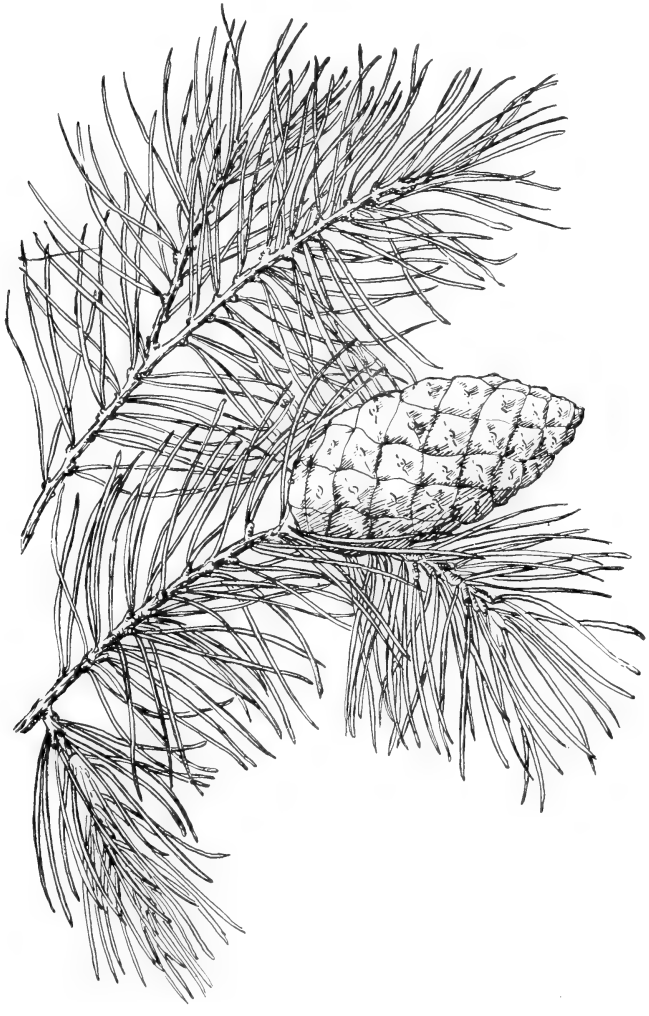
Additional records are: Laporte (J. M. Coulter); Lake, Laporte, Montgomery, Porter and Warren (Deam).

Economic uses. Wood light, not strong, straight grained, works easily, nails without splitting, seasons well, shrinks less than any other pine, sap wood nearly white, heart wood a light brown. The supply in this State is so limited as to be of no economic importance. The white pine has been the most preferred of all American woods for building material on account of its compact grain, working qualities, etc., until at present the supply is well nigh exhausted. Once it was one of the cheapest, now it is equal in price to the more rare and valuable timbers.

Horticultural value. Frequently planted as an ornamental tree; grows faster than any other American pine and is adapted to almost any kind of soil, although its preference is for a silicious soil. It should be propagated by planting seedlings. It has not been tried for the purpose of reforesting in this State on a scale large enough to predict results, however it appears that it would be one of the best species to use in the sand dune region bordering Lake Michigan.

2. Pinus Banksiàna Lambert. JACK PINE. SCRUB PINE. Plate 8. Bark reddish-brown, quite scaly, flakes small; shoots of the season yellowish-green, turning reddish-brown; leaves in twos, about

PLATE 8.



PINUS BANKSIANA Lambert. GRAY OR JACK PINE. (x 1.)

2.5 cm. (1 inch) long, divergent, curved or twisting, stout and stiff, sharp-pointed, outer surface convex, inner concave or flat, scattered along the branch and persisting for two or three years, dark green; cones light yellow when young, dull brown when mature,

sessile, sharp-pointed, oblique at the base, oblong-conical, 1.5-3 cm. (¾-1½ inches) long, erect, incurved or pointing in the direction of the branch.

Distribution. Nova Scotia to the northwest territory, south to Maine, northern New York, southern shores of the Great Lakes to central Minnesota. In Indiana it is frequent to common on the sand dunes bordering Lake Michigan.

The published records of the distribution are as follows: Lake (Hill) and (Blatchley); Porter (Blatchley); Putnam (MacDougal)*.

Additional records are: Lake and Porter (Deam).

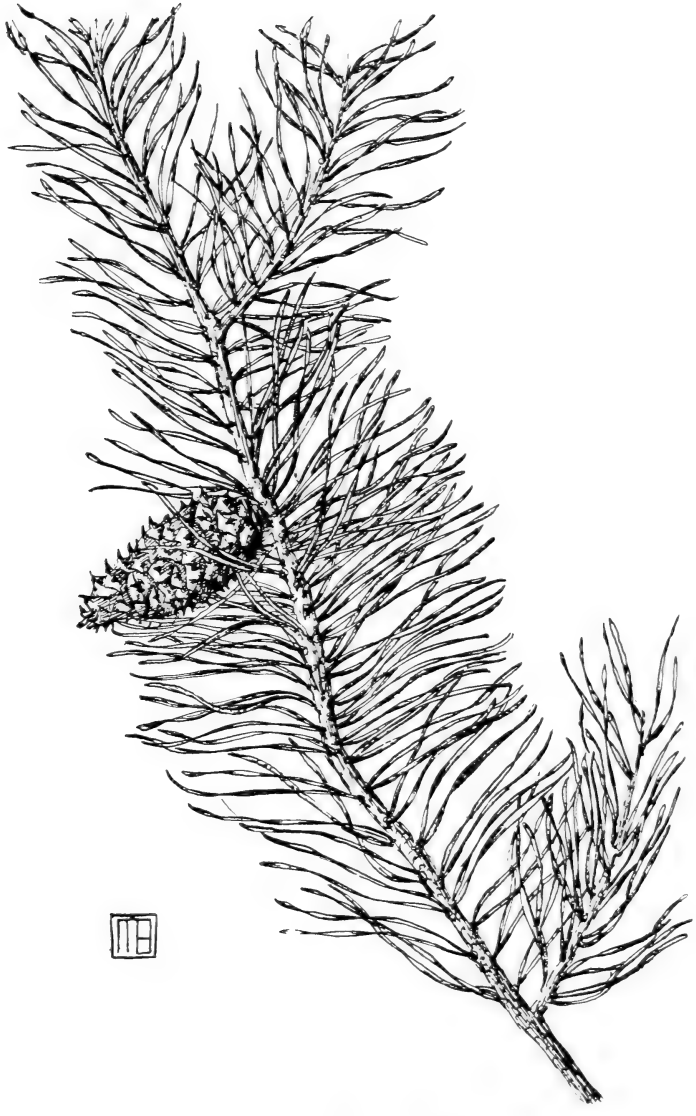
Economic uses. In our area it is only a scrubby or medium sized tree and occurs so sparingly as to be of little economic importance.

3. Pinus virginiàna Miller. SCRUB PINE. SPRUCE PINE. Plate 9. Bark dark brown, with rather shallow fissures, the ridges broken, somewhat scaly; branches spreading, at first green, light brown or purplish with a bloom, becoming a gray brown; leaves in bundles of 2, rarely 3, twisted, deciduous during the third or fourth year, about 5 cm. (2 inches) long; cones sessile or nearly so, narrowly conic when closed, 4-7 cm. (1½-2¾ inches) long, opening in the autumn of the second year, frequently remaining on the branches 3 or 4 years; scales armed with a curved spine 2-4 mm. (about 1–8 inch) long.

Distribution. From Long Island, New York, south along the coast to northern Georgia and Alabama, west to eastern Kentucky and southern Indiana. In Indiana it is confined to the "knob" region of a few counties near the Ohio River. As nearly as could be ascertained the limits of its distribution are as follows: North as far as Scottsburg in Scott County, west in Washington and Floyd counties to Blue River and east to the Pennsylvania railroad which passes through Clark County. In Clark County near Henryville it is found a few miles east of the railroad. This location is not contained in the "knobs" and it is believed that the few trees found obtained a foothold after the original forest had been cut. Investigation showed that it never occurred in any of the southeastern counties. References to *Pinus echinata* should be referred to this species. Baird and Taylor reported *Pinus rigida* for Clark County but did not report *virginiana* which is common on some of the hills. Doubtless the preceding record of *rigida* should be referred to *virginiana*.

*The specimen on which this record is made is in the Depauw herbarium, and is *Tsuga canadensis*.

PLATE 9.



PINUS VIRGINIANA Miller. SCRUB PINE. (X ½.)

It is usually a small tree, although under favorable conditions it reaches a diameter of 4-7 cm. (16-28 inches) and a height of 25 m. (80 feet). In cutting quite a number of mature trees on the Forest Reserve it was found that many of the larger trees were doty at the base.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith).

Additional records are: Clark (Deam).

Economic uses. Wood light, soft, not strong, brittle and light brown. Used in construction and for fuel. Supply so limited as to be of little economic importance. It grows rapidly, and since it is adapted to the sterile hillsides it might be successfully used in reforesting eroded hillsides.

2. LÀRIX. THE LARCHES.

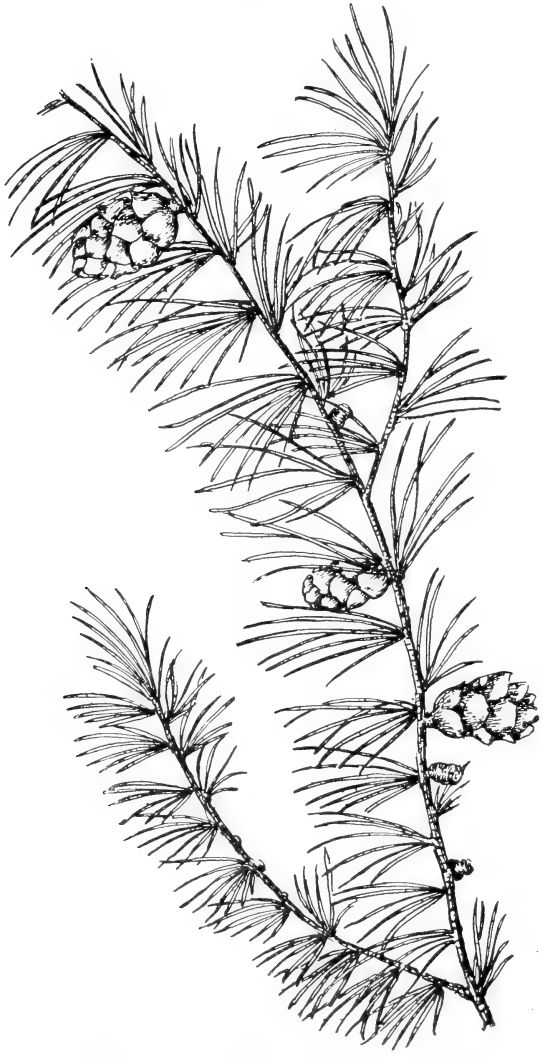
Làrix laricìna (Du Roi) Koch. TAMARACK. LARCH. Plate 10. Trees very tall; bark gray or reddish brown, furrowed and scaly; branches remote, usually horizontal; leaves pale green, triangular in cross section, 1-2.5 cm. (⅜-1 inch) long, obtuse at the apex, in clusters on the branches, or scattered along the season's shoots, falling off in the autumn; staminate flowers borne on the short and leafless lateral branches, the pistillate appear with the leaves on the branches of a previous season; cones borne on the short and stout dwarf branchlets, erect or nearly so, 12-20 mm. (⅜-⅞ inch) long, reddish-brown while growing, turning to a light brown at maturity, persisting on the tree for at least a year.

Distribution. From Labrador south to northern Pennsylvania and Indiana, west to the Rocky Mountains and north to Alaska. In Indiana it is confined to the northern part of the State where it is found in cold swamps or in peat bogs where it frequently forms dense stands. It flourishes in situations too low for other species of trees. It is frequently associated with the birches (*Betula lutea* and *pumila*), poison sumac (*Rhus Vernix*), black alder (*Ilex verticillata*) and swamp blueberry (*Vaccinium corymbosum*). It extends south in the state to 41° of latitude. In our area it seldom acquires a diameter over 5 dm. (20 inches). Locally it is classed as white and yellow tamarack. The yellow is considered the better of the two.

The published records of the distribution are as follows: Kosciusko (Chipman), (Clark), (Scott) and (Youse); Marshall (Hessler); Noble (J. M. Coulter) and (Van Gorder); Steuben (Bradner).

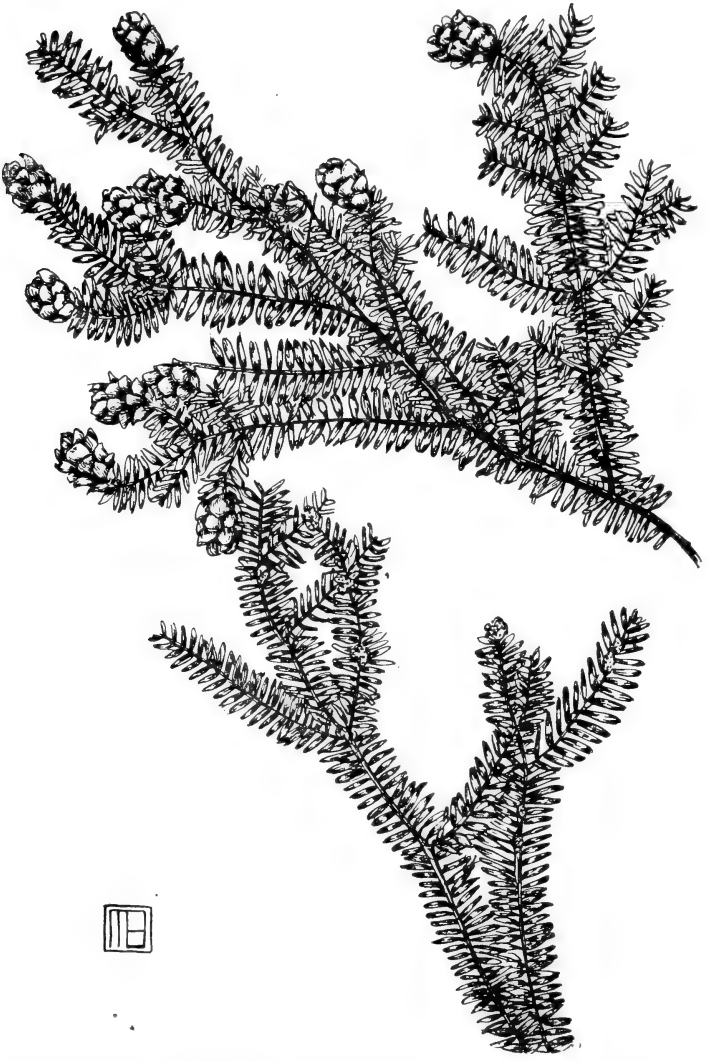
Additional records are: Dekalb, Porter and Steuben (Deam).

PLATE 10.



LARIX LARICINA (Du Roi) Koch. TAMARACK. (x 1.)

PLATE 11.



TSUGA CANADENSIS (Linnæus) Carr. HEMLOCK. (× ½.)

Economic uses. Wood heavy, hard, strong, light brown. Used in construction, fence posts and for fuel. Since the swamps have been drained the supply of this species has rapidly decreased until now it is of little economic importance.

3. TSÙGA. THE HEMLOCKS.

Tsuga canadénsis (Linnæus) Carrière. HEMLOCK. Plate 11. Tall trees with reddish-brown or grayish and deeply furrowed bark; leaves short petioled, 1-1.5 cm. (3/8-7/8 inch) long, flat or angular, obtuse or notched, apparently 2-ranked, bright green, shiny above, bluish-white beneath, persisting for about three years; staminate flowers appear early in the spring from buds in the axils of the leaves of the previous year, the pistillate terminal, erect, oblong; fruit a pendulous cone borne on the end of last year's branch, maturing the first season, short stalked, ovoid, 1.5-2.5 cm. (1/2-1 inch) long; seeds 2 in the axil of each scale.

Distribution. Nova Scotia west to eastern Minnesota, south to Delaware and along the mountains to Alabama. In Indiana it is found in limited numbers on the bluffs of Bean Blossom Creek in Brown County, of Walnut and Raccoon creeks in Putnam, of Sugar Creek in Montgomery and Parke, of Clear Creek between Clark and Floyd counties, of Raccoon Creek in Owen and on the north branch of the Muscatatuck River near Vernon in Jennings County. In our area it sometimes reaches a height of 30 m. (95 feet) and a diameter of 5-7 dm. (20-28 inches).

The published records of the distribution are as follows: Clark (Baird and Taylor); vicinity of New Albany (Clapp); Parke and Putnam (Ragan).

Additional records are: Parke (Wright); Putnam (Grimes) and (MacDougal); Brown, Crawford, Jennings, Montgomery, Parke, Putnam and Owen (Deam).

Economic uses. Wood light, soft, brittle, light brown, not durable, difficult to work, splintery but holds a nail well. Used for construction purposes. Where the tree is common the bark is used for tanning purposes. The powdered bark is used in medicine.

4. TAXÒDIUM. THE BALD CYPRESS.

Taxodium dístichum (Linnæus) L. C. Richard. CYPRESS. Plate 12. Straight tall trees usually with a buttressed base, frequently hollow at the base. When grown in very wet situations it develops steeple-like projections from the roots to above the water level

known as "knees"; bark gray or reddish-brown, long fibrous strips separating from the trunk; branches horizontal or drooping; leaves spirally arranged, appearing as if 2-ranked, 1-2 cm. (3/8-3/4 inch)

PLATE 12.

TAXODIUM DISTICHUM (Linnæus) Richard. CYPRESS. (x 1.)

long, acute, yellowish-green, turning brown in the fall and dropping off; staminate flowers numerous, borne on long terminal drooping panicles, pistillate in small terminal clusters near the ends of the twigs of the previous season; fruit a woody cone, usually in pairs,

at the end of the branches, maturing the first year, globose, about 2 cm. (¾ inch) in diameter, wrinkled; seeds in pairs under each scale.

Distribution. Along the Atlantic coast from Delaware south to Florida and along the Mississippi Valley south from southern Indiana and Illinois to the Gulf. In Indiana it is found only in the southwestern part of the State, along the wet banks of streams or in river swamps and sloughs. In Posey County it is found in a few sloughs along the Ohio River about 3 miles east of Mt. Vernon, on the low border of Hovey Lake and in a few swamps along the Wabash River south of Bone Bank which is 6 miles south of a line running due west from Mt. Vernon. It is not found between Bone Bank and White River. Just north of White River in Knox County it formerly filled extensive sloughs. These have been drained, cleared and are now cultivated. It is usually a large tree, sometimes reaching a height of 45 m. (145 feet) and a diameter of 18 dm. (72 inches).

The published records of the distribution are as follows: Clark* (Baird and Taylor); Gibson, Knox and Posey (Schneck); Knox and Posey (Wright).

Additional records are: Knox and Posey (Deam).

Economic uses. Wood light, soft, not strong, straight-grained, does not warp or shrink much, variable in color from a light to a dark brown, easily worked, frequently pitted by disease, and lumber which shows this disease is commercially known as "pecky cypress". Used principally for construction purposes. The tree has practically disappeared from our area because the wood is easy to work and the swamps in which it grew have been drained and are now cultivated.

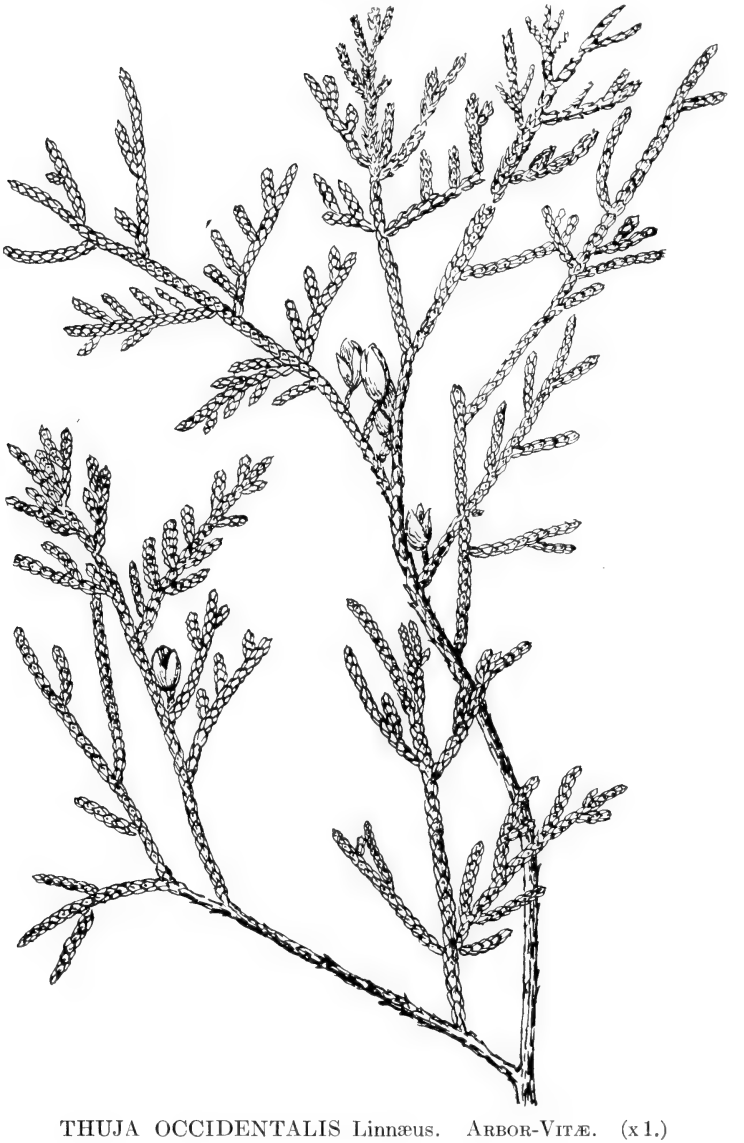
Horticultural value. Strongly recommended by some nurserymen for ornamental planting. In some localities in the eastern states it is a fair success. The tree is adapted to a wet soil and no doubt in such situations would prove hardy and a moderately fast growing tree.

5. THÙJA. ARBOR–VITÆ.

Thuja occidentàlis Linnæus. ARBOR–VITÆ. Plate 13. Small evergreen trees or shrubs with bark on old trees reddish-brown or dark gray, shreddy; branchlets compressed, reddish-brown; leaves of two kinds, sharp-pointed and awl-shaped on the older branches,

*Doubtless from a cultivated tree, because information solicited from the oldest residents of the county failed to verify this record.

PLATE 13.



THUJA OCCIDENTALIS Linnæus. ARBOR-VITÆ. (x 1.)

blunt and scale-like on the younger branches, and 4-ranked, yellowish-green, about 6 mm. (1/8 inch) long; flowers appear early in the spring from buds of the previous season at the ends of the branches; cones maturing the first season, 1 cm. (3/8 inch) or less in length and about 0.5 cm. (1/8 inch) in diameter, scales of cone 6-12.

Distribution. New Brunswick south to North Carolina, west to Minnesota and Manitoba. In Indiana it has been noted in only a few of the northern counties, where it is found in swamps.

The published records of the distribution are as follows: Hamilton* (Wilson); Lake (Hill).

Additional records are: Lake (Deam).

Economic uses. Wood soft, brittle, rather coarse-grained, pale yellow brown, durable, fragrant. In Canada where it is abundant it is used for fence posts, telegraph poles, shingles and on account of its lightness has been a favorite wood for making canoes. A tincture and a fluid extract of the leaves are used in medicine.

Horticultural value. It is frequently planted for ornamental purposes and several horticultural forms have been developed. It is adapted to all kinds of soils and exposures. Transplants readily but grows slowly. It retains its lower limbs which makes it a desirable tree to plant for a wind-break. The dwarf forms are commonly planted for hedges.

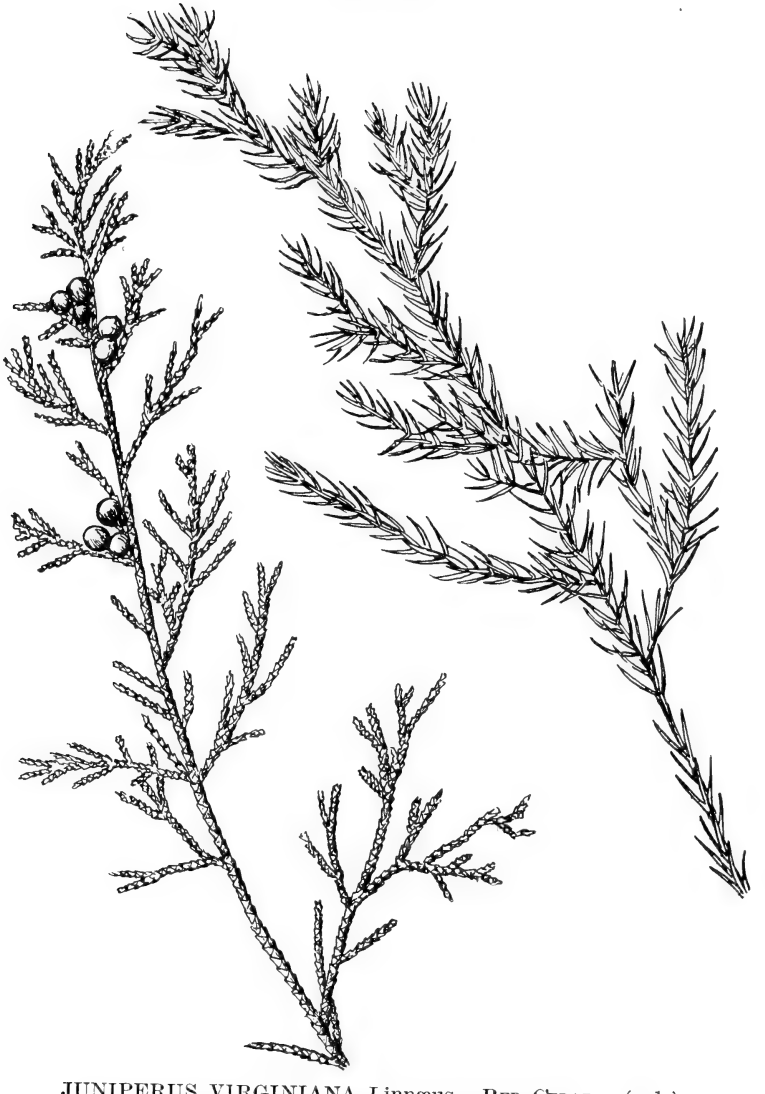
6. JUNÍPERUS. THE JUNIPERS.

Juniperus virginiàna Linnæus. RED CEDAR. CEDAR. Plate 14. Bark reddish-brown, shreddy; leaves sessile, opposite or ternate, usually of two kinds, scale-like or awl-shaped, 4-ranked, appearing as opposite, closely appressed, scale-like, bluish-green, 1.5-2 mm. (about 1–16 inch) long, except on some of the vigorous branches or seedlings where they are loose and about 1 cm. (3/8 inch) long; flowers small, terminal or axillary; fruit berry-like covered with a bloom, maturing the first season, bluish, 5-8 mm. (1/4 inch) in diameter, sweet, resinous; seeds usually 1-2.

Distribution. Nova Scotia south to Georgia, west to Texas and North Dakota. Found throughout Indiana although it has not been reported from a few counties in the east central part. It is found sparingly in the northern part usually on the bluffs of streams, becoming frequent in the southern part of the State, especially on sterile hillsides and in deserted fields. It is a very slow growing tree and in our area rarely acquires a diameter of 5 dm. (20 inches).

*Doubtless from a cultivated tree.

PLATE 14.



JUNIPERUS VIRGINIANA Linnæus. RED CEDAR. (x ½.)

[8—28415]

The published records of the distribution are as follows: Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Kosciusko (Chipman) and (Clark); Lake (Higley and Radden); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Steuben (Bradner); Vigo (Blatchley)*.

Additional records are: Monroe (Blatchley); Montgomery (Evans); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Crawford, Fountain, Grant, Harrison, Jefferson, Jennings, Johnson, Kosciusko, Morgan, Parke, Porter, Putnam, Steuben, Warren, Washington and Wells (Deam).

Economic uses. Wood light, brittle, close-grained, works easily, durable, sap wood thin and white, heart wood dull red, fragrant. Representative uses are posts, crossties, lead pencils, cigar boxes and chests. In this State when the trees become large enough they are generally used for fence posts. This species furnishes a large number of the commercial fence posts of the State, although they are shipped in, usually from Tennessee.

Horticultural value. It has been used for a long time as an ornamental tree and nurserymen now offer several horticultural varieties. It is adapted to almost all kinds of soils, although its preference is for a thin gravelly soil. It transplants with fair success, grows slowly and is long lived. The tree grows rather compact and since the leaves do not fall for several years it makes a desirable tree to plant for a windbreak. A rust which affects the leaves of apples and pears passes its winter stage on this tree and causes the malformations on the twigs known as "cedar apples." Since the tree is a harbor for this fungus, it should not be permitted to grow near an orchard.

SALICÀCEÆ. THE WILLOW FAMILY.

Trees or shrubs with simple, alternate leaves; flowers in catkins appearing before or with the leaves, the staminate and pistillate on different trees; fruit a dehiscent capsule, which contains numerous seeds with a tuft of long silky hairs at the apex.

Buds with one outer scale, leaf blades more than twice as long as wide, stamens 2-10, scales of the flower entire or merely toothed ..... 1 Salix.

Buds with numerous scales, leaf blades less than twice as long as wide, stamens more than 10, scales of flower incised ..... 2 Populus.

*No doubt many of the references to *Juniperus communis* should be referred to this species.

1. SÀLIX. THE WILLOWS.

(Derived from the Celtic words, *sal*, near and *lis*, water; in allusion to their place of growth).

Trees or shrubs with slender branches, leaves mostly long and pointed, entire or glandular-toothed. There are thirteen species native to the State and a few European species have become well established. The genus has members adapted to the most varied conditions of life, ranging from the forest, low banks of streams and shores of lakes to the exposed and dry sand dunes of Lake Michigan. The species sometimes hybridize and the relationships of such hybrids are difficult of determination. This genus of trees yields salicin, a substitute for quinine. The bark of some species is used in medicine as a tonic and febrifuge. The wood is used to some extent in the manufacture of charcoal and wood pulp.

Twigs not yellow-green or yellow, stamens more than 2.
- Leaves green below, petioles without glands..... 1 S. nigra.
- Leaves glaucous or whitish beneath at least to near maturity, petioles with or without glands.
  - Buds about 3 mm. (⅛ inch) long, petioles usually without glands..... 2 S. amygdaloides.
  - Buds about 5-10 mm. (about ¼ inch) long, petioles always with glands..... 3 S. lucida.

Twigs yellow-green or yellow, stamens 2..... 4 S. alba.

1. Salix nìgra Marshall. WILLOW. BLACK WILLOW. Plate 15. Bark of trunk rough, thick, flaky, dark brown or nearly black; twigs very brittle at the base, shoots pubescent at first and green or greenish-brown, becoming smooth and darker; buds ovate, 2-3 mm. (⅛ inch)long, acute; leaves narrowly-lanceolate, commonly about 10 cm. (4 inches) long, 1 cm. (⅜ inch) wide, long taper pointed, acute or rounded at the base, finely serrate, bright green and smooth above, paler and smooth beneath or pubescent along the primary and secondary veins; petioles 4-8 mm. (⅛-⅜ inch) long; flowers appear in April or May. Variety **falcata** (Pursh) Torrey is a form with narrower and more curved leaves.

Distribution. New Brunswick west to North Dakota, south to Florida and west to Texas. More or less frequent throughout Indiana on the banks of streams and on the borders of lakes and swamps. On the low borders of some lakes and rivers it forms the principal stand on considerable areas. In this State it is usually a small crooked tree, except in the southwestern counties, where it frequently becomes a medium or large sized tree.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Delaware, Jay, Randolph and

PLATE 15.

SALIX NIGRA Linnæus. BLACK WILLOW. (x ½.)

PLATE 16.

SALIX AMYGDALOIDES Andersson. PEACH-LEAVED WILLOW. (x $\frac{1}{2}$.)

Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Scott) and (Youse); Miami (Gorby); vicinity of New Albany (Clapp); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Lake (Hill); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Noble, Posey, Shelby, Vermillion and Wells (Deam).

Economic uses. Wood light, soft, weak, light reddish-brown, the thin sap wood white, checks badly in drying. Used principally for heading in this State.

2. Salix amygdaloïdes Andersson. WILLOW. Plate 16. Bark of trunk fissured, dark brown tinged with red; twigs somewhat brittle, smooth, orange or reddish-brown; winter buds ovoid, about 3 mm. (⅛ inch) long, pointed, smooth; leaves ovate-lanceolate, 5-10 cm. (2-4 inches) long, 1-2.5 cm. (⅜-1 inch) wide, finely serrate, long attenuate at the apex, narrowed at the base, pubescent when very young, soon becoming glabrous, smooth and bright green above, paler or a bluish glaucous and smooth beneath; petioles 1-3 cm. (⅜-1¼ inches) long; flowers appear in April or May, generally about two weeks after the preceding species.

Distribution. Quebec west to Manitoba, south to central Ohio and west to Illinois, and southward and westward through the Rocky Mountains. In Indiana it is known only from the northern part of the State. The specimens at hand are one taken by Umbach in Lake County and one taken by Deam in Lake County. It is a small tree and is difficult to separate from the preceding species. It has a more upright habit of growth and is usually found on the borders of stagnant water such as ponds, swamps and lakes. In text books it is called the peach-leaved willow.

The published records are as follows: Kosciusko (Scott).

Economic uses. Too rare to be of any economic importance.

3. Salix lucida Muhlenberg. WILLOW. Plate 17. Bark smooth or nearly so, reddish-brown, tinged with red, twigs smooth, dark orange the first year, becoming darker the second year; winter buds narrow ovate, 5-10 mm. (¼-⅜ inch) long, reddish-brown, shiny; leaves ovate to lanceolate, 7-15 cm. (3-6 inches) long, long-pointed, narrowed or rounded at the base, conspicuously glandular serrate, with a few hairs when they unfold, soon becoming glabrous, dark green above and paler beneath; petioles 6-12 mm. (¼-½ inch) long, usually glandular near the base of the leaf; flowers appear in April or May.

PLATE 17.

SALIX LUCIDA Muhlenberg. SHINY WILLOW. (x $\frac{1}{2}$.)

Distribution. Newfoundland to Manitoba, south to Pennsylvania, northern Ohio and Illinois and west to Nebraska. Schneck reports it as "common along streams" in the lower Wabash Valley.

If the reports are correct the range of the species is extended from the northern part of Ohio southward to southern Indiana. It is found in swamps and on the borders of lakes and streams. In our area it is a small tree, usually less than 1 dm. (4 inches) in diameter. In text books it is called shiny willow.

The published records of the distribution are: Clark (Baird and Taylor); Clay (Wilson); Delaware, Jay, Randolph and Wayne (Phinney); Gibson (Schneck); Hamilton (Wilson); Knox (Ridgway); Lake (Hill); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Posey (Schneck); Putnam (Wilson); Steuben (Bradner).

Additional records are: Laporte, Noble, Steuben and Wells (Deam).

Economic uses. Too rare and small to be of economic use.

4. Salix álba Linnæus. WILLOW. Plate 18. Bark on old trunks rough, thick, coarsely ridged, gray to brown; twigs smooth; winter buds 5-6 mm. ($\frac{1}{4}$ inch) long; narrowly ovoid, smooth and blunt; leaves lanceolate to oblong-lanceolate, 5-13 cm. (2-5 inches) long, long-pointed, narrowed at the base, hairy on both surfaces when young, becoming smooth or nearly so above at maturity, bright green above, paler or glaucous and persistently hairy beneath; petioles 4–8 mm. ($\frac{1}{6}$–$\frac{1}{3}$ inch) long usually without glands, sometimes bearing a few near the base; flowers appear in April or May.

Variety **vitellìna** (Linnæus) Koch, with yellow twigs, mature leaves glabrous above and whitish beneath, is the common form in our area.

Distribution. Introduced from Europe and now naturalized in many parts of the State. It is one of the largest of the genus and it is not uncommon to see trees in cultivation that are a meter (39 inches) in diameter.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Kosciusko (Scott); Marion (Wilson); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Posey and Wells (Deam).

Plate 18.

SALIX ALBA Linnæus. White Willow. (x ½.)

Economic uses. Too rare to be of any economic use.

Horticultural value. Adapted to a moist soil, in which it grows very rapidly. Propagated either by cuttings or seedlings. It is used as a windbreak and is frequently planted for ornamental purposes.

2. PÒPULUS. THE POPLARS.

(From the Latin, *populus* the people; the trees used by the ancients along the highways.)

Rapidly growing trees; buds large, scaly and more or less resinous; leaves alternate, broad, toothed or sometimes lobed; flowers on pendulous catkins; anthers purple-red.

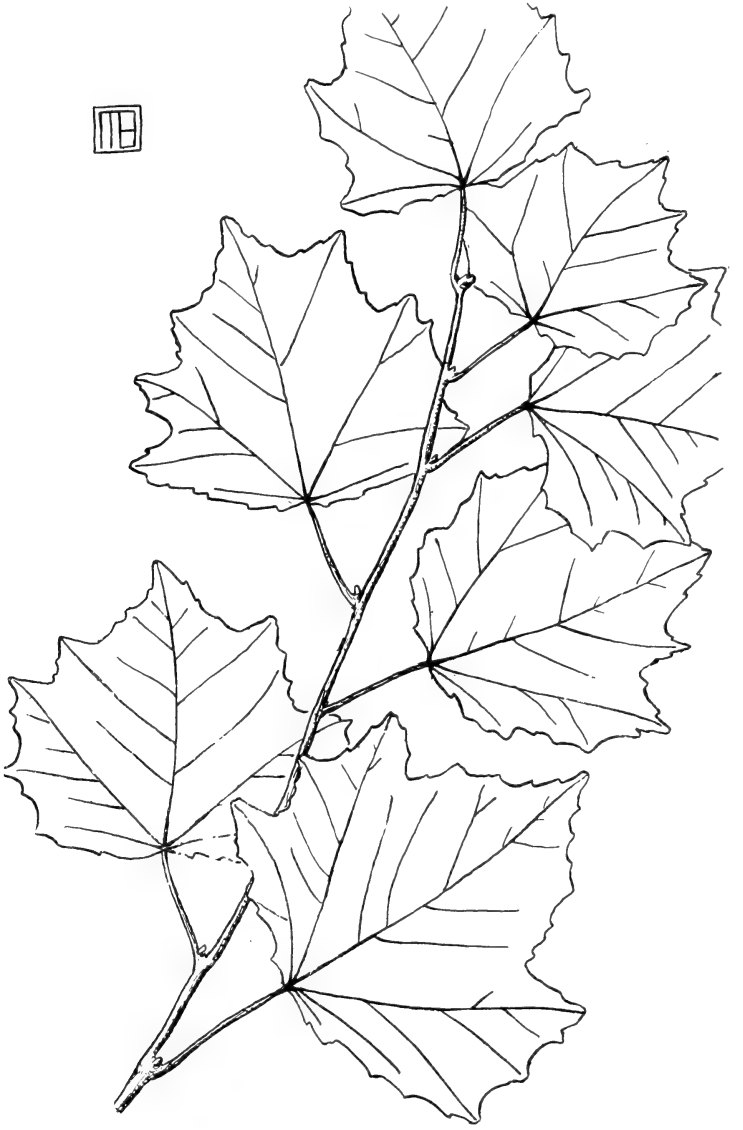
In the following key mature leaves from trees are considered:

Winter buds cottony, leaves more or less lobed..... 1 P. alba.
Winter buds not cottony, leaves with margins more or less regularly toothed.
  Winter buds pubescent, appearing dusty; margins of leaves with 5 or less teeth per 25 mm. (1 inch).... 2 P. grandidentata.
  Winter buds glabrous or nearly so; margins of leaves with 6 or more teeth per 25 mm. (1 inch).
    Leaf blades blunt or rounded at the apex; shoots at first hoary becoming glabrous and brown..... 3 P. heterophylla.
    Leaf blades sharp pointed at the apex; shoots smooth or with only a few hairs, becoming gray.
      Apex of most of the leaves without teeth for about 5 mm. (¼ inch); winter buds resinous and sticky, about 8 mm. (¼ inch) long; stamens less than 15..... 4 P. tremuloides.
      Apex of most of the leaves without teeth for about 10 mm. (½ inch); winter buds resinous but dry, about 12 mm. (½ inch) long; stamens more than 15..... 5 P. deltoides.

1. Populus álba Linnæus. SILVER-LEAF POPLAR. Plate 19. Bark on young trees smooth, greenish-white or gray, on old trees furrowed, gray or dark brown; young twigs hairy, becoming smooth in age; leaves ovate or triangular, 3-5 lobed or occasionally irregularly toothed, hairy on both surfaces while expanding, becoming dark green and glabrous above and remaining white-hairy beneath; stamens usually less than 15, flowering season, March, April or May.

Distribution. Introduced from Europe, now frequent in all parts of the State.

PLATE 19.



POPULUS ALBA Linnæus. SILVER-LEAF POPLAR. (x ½.)

The published records of the distribution are as follows: Delaware (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Posey (Schneck); Steuben (Bradner).

Additional records are: Putnam (Grimes); Franklin and Wells (Deam).

Horticultural value. Grows rapidly, adapted to all kinds of soil, though its preference is for a moist rich soil, propagated either by cuttings or seedlings, transplants easily, stands pruning well, commonly develops a broad and open crown, leaf period long and has few insect or fungous enemies. It is valued as a shade and ornamental tree. An objectionable character of this tree is its habit of sending up shoots from the roots.

2. Populus grandidentàta Michaux. QUAKING ASP. COTTONWOOD. POPPLE. Plate 20. Bark smooth, grayish-green, becoming furrowed and dark brown on the trunks of old trees that grow in the northern part of the State, especially when found growing in swampy conditions. In the southern part of the State where the tree grows on the top of hills the bark does not darken so much and frequently remains a light gray to maturity or becomes only a dark gray color; shoots at first hairy, becoming smooth at the end of the season; leaves broadly ovate with large and irregular teeth, short pointed, truncate or slightly heart shaped at the base, hairy when expanding, smooth at maturity; petioles strongly flattened at right angles to the plane of the blade; staminate catkins 2-8 cm. (1-3 inches) long, the pistillate catkins at maturity reaching 6-12 cm. (2¼-5 inches) in length; stamens less than 15; flowering season March, April or May. Trees usually about 10-20 m. (30-65 feet) high and less than 4 dm. (16 inches) in diameter.

Distribution. Nova Scotia, Ontario and northern Minnesota, southward to the Ohio River and along the Alleghany Mountains south to North Carolina. Locally distributed in all parts of Indiana. It is frequent or common in swamps, along the border of streams or in drier situations. In the northern part of the State it is generally found in moist conditions and exceptionally found in dry situations, while in the southern part of the State it is found either in moist conditions along streams or in dry situations such as the tops of hills. In Montgomery County along Sugar Creek it was noted on a high ridge associated with the hemlock. In moist conditions along streams it is usually found growing in colonies. When

PLATE 20.

POPULUS GRANDIDENTATA Michaux. LARGE-TOOTHED ASPEN. (x ½.)
Leaf in upper part of plate is a form often found on seedlings or shoots.

found on hillsides and hill tops there are usually only a few individuals, which indicates that the preference of the species is for moist soil conditions.

The published records of the distribution are as follows: Clark (Smith); Clay (Wilson); Delaware (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Knox (Ridgway); Kosciusko (Clark) and (Scott); Putnam (Wilson); Steuben (Bradner).

Additional records are: Crawford (Schneck); vicinity of New Albany (Clapp); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Clark, Decatur, Fulton, Jennings, Marshall, Monroe, Montgomery, Noble, Owen, Porter, Posey, Steuben, Vermillion, Warren and Wells (Deam).

Economic uses. Wood soft, light and not strong. Used principally for pulp and excelsior. The supply in Indiana is so limited as to be of no economic importance. The pioneers were accustomed to cut small quaking aspens into convenient sizes for tying in the stalls of their stables in order that their horses might gnaw off the bark which contains a bitter tonic principle.

3. Populus heterophylla Linnæus. LARGE-LEAVED COTTONWOOD. Plate 21. Bark deeply furrowed, the furrows as wide as the ridges, reddish-brown; winter buds glabrous or with a few hairs, slightly resinous, about 6 mm. (¼ inch) long; leaves ovate, 7-15 cm. (3-6 inches) long, cordate or truncate at the base, velvety when young gradually becoming glabrous above and paler beneath and remaining somewhat pubescent, especially along the conspicuous veins, petioles round or but little flattened; flowering season March or April.

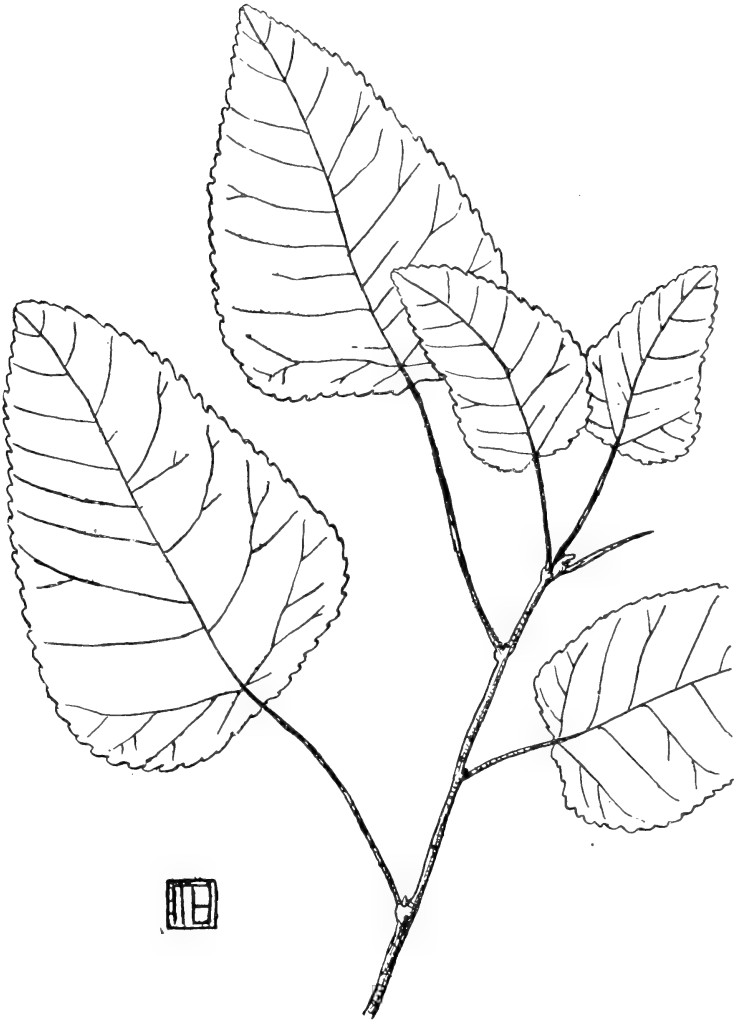
Distribution. Connecticut south to Georgia and west to Louisiana and Missouri. In Indiana it is rare and local, except in the lower Wabash bottoms, where it is frequent or common around ponds and in sloughs. It grows in low woods and swamps. A medium sized tree, usually about 15-25 m. (48-80 feet) high and less than 5 dm. (20 inches) in diameter.

The published records of the distribution are as follows: Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Doane); Jay (M'Caslin); Knox (Ridgway); Miami (Gorby); Posey (Schneck); Vigo (Blatchley).

Additional records are: Blackford, Laporte, Posey and Wells (Deam).

Economic uses. Too rare to be of any economic importance.

PLATE 21.



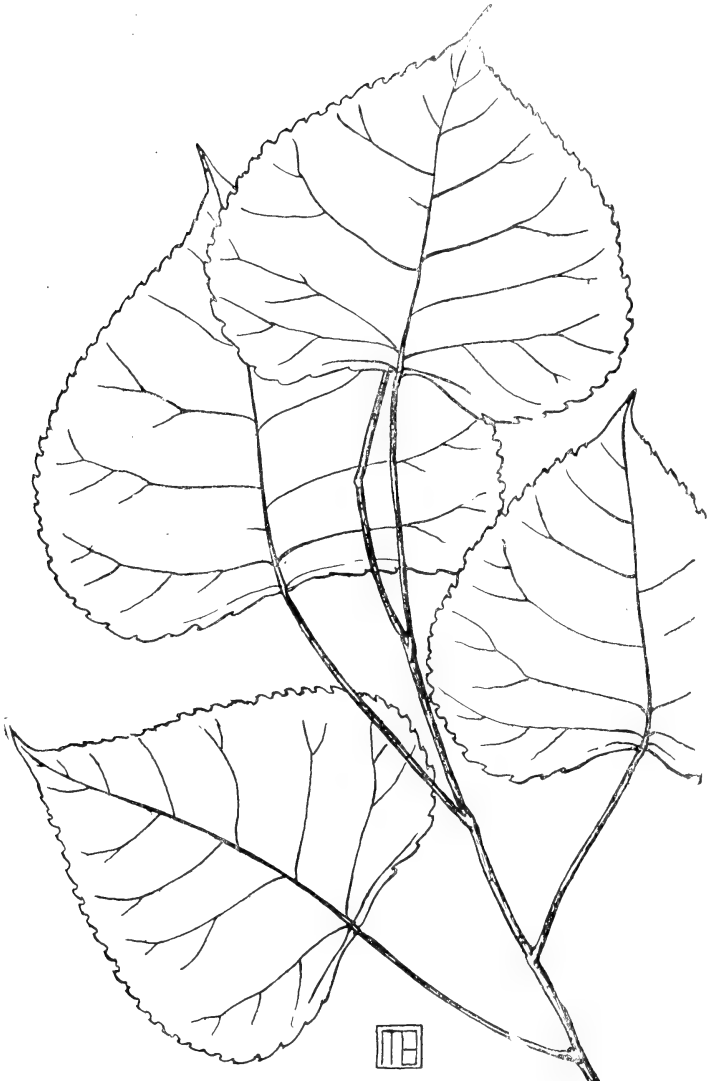
POPULUS HETEROPHYLLA Linnæus. LARGE-LEAVED COTTONWOOD. (× ½.)

PLATE 22.

POPULUS TREMULOIDES Michaux. QUAKING ASP. (x ½.)

Leaves in upper part of plate show forms on seedlings, root or coppice shoots.

PLATE 23.



POPULUS DELTOIDES Marshall. COTTONWOOD. (X $\frac{1}{2}$.)

4. **Populus tremuloìdes** Michaux. COTTONWOOD. QUAKING ASP. Plate 22. Bark usually smooth, greenish-white or gray, turning an ash color on age and on old trees becoming rougher or fissured and much darker; twigs smooth or with a few hairs, reddish-brown, shiny the first season, gradually turning gray; leaves 3-9 cm. (1½-4 inches) long; usually wider than long, dark green above, lighter beneath, more or less pubescent when young, soon becoming glabrous, petioles flattened; catkins at first 3-7 cm. (1-3 inches) long, the fertile gradually increasing in length to about 10 cm. (3 inches). Usually a small tree, 30-45 feet high, and less than 3 dm. (12 inches) in diameter.

Distribution. Alaska and Hudson Bay south to the Ohio River and along the mountains of Mexico. Found in all parts of Indiana, becoming rare or infrequent towards the Ohio River. It is found usually in colonies in open places about swamps, lakes and along streams.

The published records of the distribution are as follows: Clark (Baird and Taylor); Dearborn (Collins); Decatur (Ballard); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Clark), (Scott) and (Youse); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Allen, Lake, Laporte, Marshall, Porter, Steuben, Warren and Wells (Deam).

Economic uses. Not of sufficient size and abundance to be of much economic importance.

5. **Populus deltoìdes** Marshall. COTTONWOOD. Plate 23. Bark on old trees ash colored, deeply furrowed; branchlets round or those on vigorous trees angled, glabrous, yellowish-green becoming gray; leaf blades 4-12 cm. (1½-5 inches) long, usually about as wide, coarsely toothed, teeth glandular, incurved, lateral veins prominent on both sides, petioles flattened; flowering season March, April or May.

Distribution. Quebec to Florida and west to the Rocky Mountains. Frequent in low woods and along streams in all parts of Indiana. The largest tree of the genus, usually 1-1.6 m. (3-5 feet) in diameter. In the original forests it was one of the largest of Indiana trees.

The published records of the distribution are as follows: Clark (Baird and Taylor); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Young); Knox (Thomas); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); vicinity of New Albany (Clapp); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Hancock, Knox, Laporte, Marshall, Owen, Posey and Wells (Deam).

Economic uses. Heart wood thin, dark brown, sap wood thick, nearly white, light, soft, weak, and warps badly in drying. Used principally for siding, sheeting, heading, wagon boxes, shelving, excelsior and pulp. The lumber has been such a favorite on account of its lightness that the supply has been nearly exhausted.

Horticultural value. A stately tree, adapted to a moist soil, propagated either from cuttings or seedlings, grows very rapidly, developing a full wide and rounded top with a few large ascending branches. Frequently planted for a quick shade producing tree and for wind breaks, and well adapted to the planting of areas that frequently overflow.

A horticultural form of this species is sold as Carolina poplar. No greater mistake can be made in tree culture than in planting the Carolina poplar. While in its first years it grows rapidly and has a handsome foliage, it very soon acquires practically every undesirable tree habit. It should never be used unless as a temporary shelter for more valuable forms which are intended to be permanent.

JUGLANDÀCEÆ. THE WALNUT FAMILY.

Trees with leaves alternate, odd pinnate, large and aromatic; flowers appearing after the leaves unfold, the staminate in catkins, the pistillate solitary or in clusters; fruit a nut in a fleshy or hard fibrous shell; kernel edible or astringent.

Pith medium brown, interrupted by transverse sections; sterile catkins thick, sessile, or short stalked; stamens 8-40; nuts with a network of rough projections.. 1 Juglans.

Pith light brown, not interrupted by transverse partitions; sterile catkins slender, long stalked; stamens 3-10; nuts more or less angled but smooth..... 2 Hicoria.

1. JÙGLANS. THE WALNUTS.

Trees with furrowed bark; terminal buds with two pairs of opposite, more or less open scales.

Bark gray, the ridges smooth; upper part of leaf scar of the last year's twigs with a mat of hairs; fruit oblong, husk clammy	1 J. cinerea.
Bark dark brown or black, rough; upper part of leaf scar of the last year's twigs without a mat of hairs; fruit orbicular, husk not clammy	2 J. nigra.

2. Juglans nìgra Linnæus. WALNUT. BLACK WALNUT. Plate 24. Leaves 3-7 dm. (12-28 inches) long, mature leaves glabrous above, pubescent below, leaflets 11-23, 4-10 cm. (1½-4 inches) long, half as wide; flowers appear in May or June; fruit ripens in September and October; nut nearly round, somewhat flattened, 3-4 cm. (1¼-1½ inches) through the widest diameter, kernel edible and by some regarded as the best of Indiana's nuts.

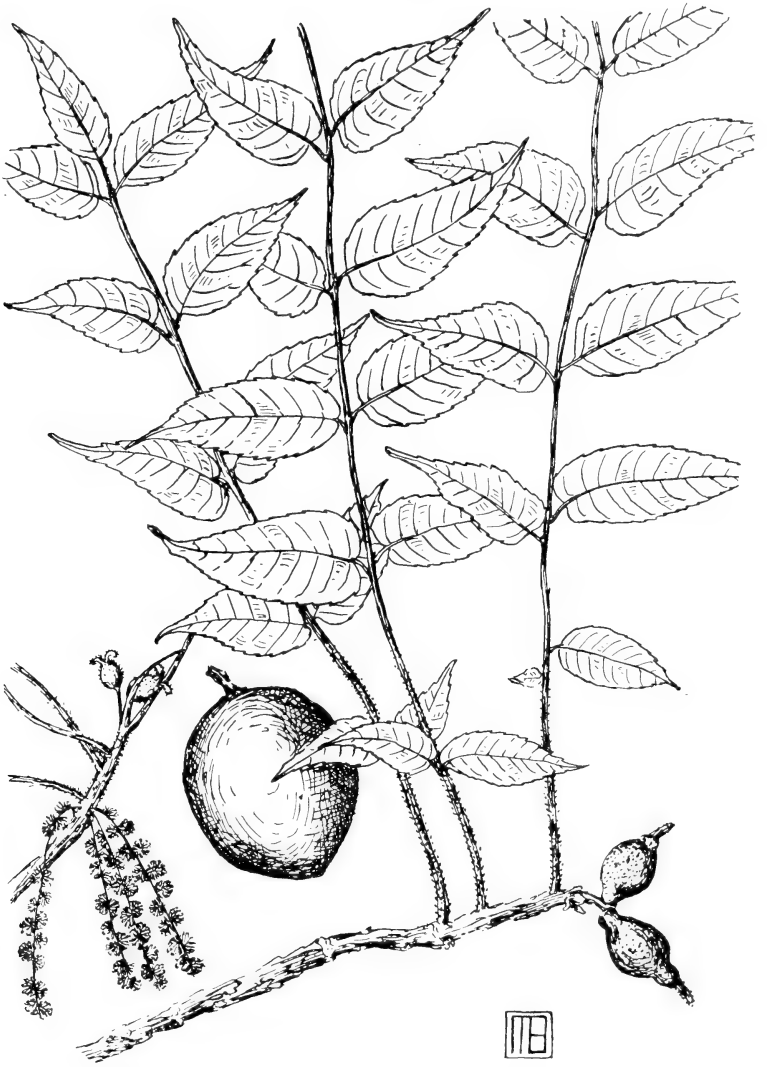
Distribution. Ontario south to the Gulf States and west to Nebraska and Texas. It was more or less frequent to common in all all parts of Indiana in well drained alluvial soil. On account of the value of the nuts and wood the landowner usually permits the walnut to grow, so small trees are yet found in considerable numbers along streams, in open woods and along fences where the nuts have been carried by rodents. In the forest it develops into a tall straight tree with a few large branches for a top, while in the open it develops a wide-spreading crown.

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Youse); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Grimes); Tippecanoe (Coulter); Blackford, Decatur, Delaware, Hamilton, Hancock, Johnson, Owen, Posey, Wells (Deam).

Economic uses. Wood heavy, hard, strong, rather coarse, heart wood a rich dark brown, works easily, takes a high polish, care

PLATE 24.



JUGLANS NIGRA Linnæus. BLACK WALNUT. (X $\frac{1}{3}$.)

must be taken in seasoning to prevent checking, durable in contact with the ground. The wood of this tree is the most valuable of any of the Indiana forest trees and for this reason the supply has been almost exhausted. There are yet isolated trees and small areas which contain a few valuable trees which the owners are holding for advanced prices. It is used principally for furniture, office fixtures and gun stocks.

Horticultural value. Adapted to a moist rich soil, grows rapidly, has a long tap root, which makes it difficult to transplant, best propagated by planting the nuts or germinated nuts. It is not well adapted to shade tree purposes because the leaves do not make a thick shade, appear late and fall early, although it could be planted to good advantage along roadsides. This species gives promise of being one of the most valuable for the purpose of reforestation in this State.

1. Juglans cinèrea Linnæus. BUTTERNUT. WHITE WALNUT. Plate 25. Leaves 3-6 dm. (12-24 inches) long, leaflets 7-17, 6-12 cm. (2½-5 inches) long, lanceolate to oblong, short stalked, clammy pubescent when young; flowers appear in May or June; fruit ripens in October, 4-8 cm. (1½-3 inches) long, with four prominent longitudinal ridges; kernel sweet and very oily.

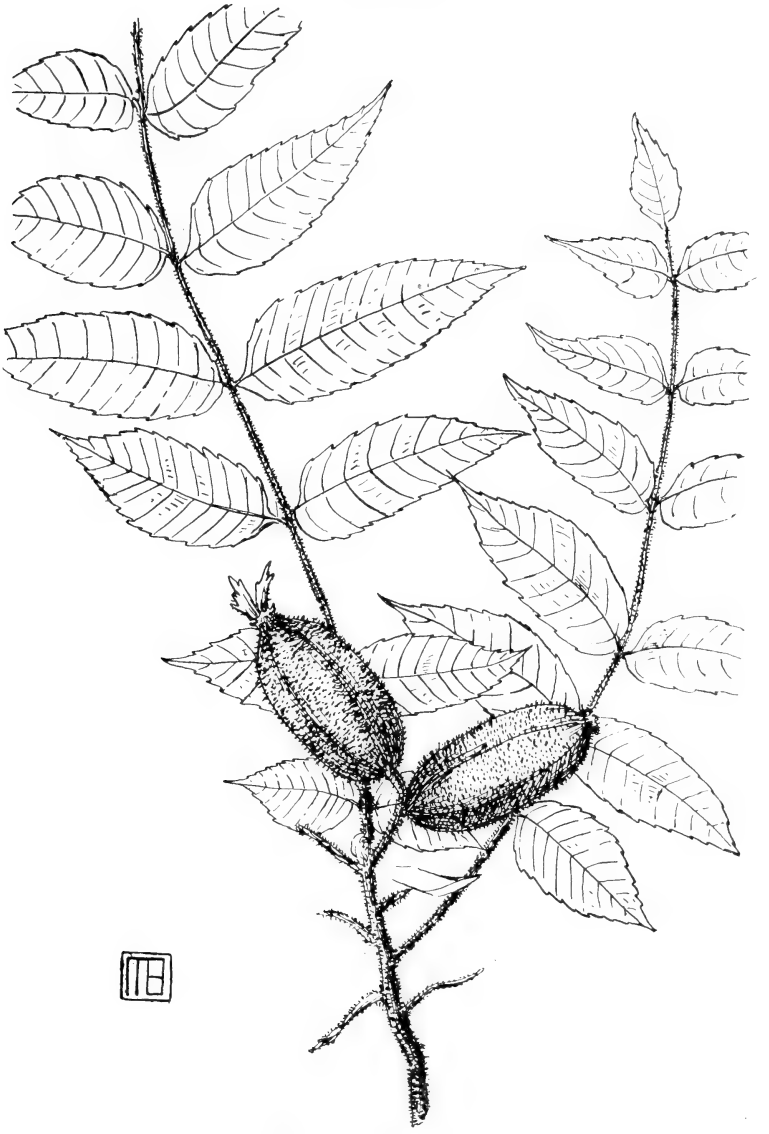
When grown in the forest it is a tall straight tree, attaining a height of 20-30 m. (65-95 feet) and 6-9 dm. (2-3 feet) in diameter.

Distribution. Valley of the St. Lawrence River south to the Gulf States and west to Nebraska. Found in all parts of Indiana, though very sparingly in some counties. In its distribution it is usually found along streams, in ravines, and in two instances it has been noted in old tamarack marshes. It is usually found in well drained, gravelly soil. It must be regarded as infrequent and only in a few localities has it been noted as frequent or common.

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod); Clark (Baird and Taylor), (Barnes) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Knox (Thomas); Kosciusko (Clark); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Putnam (Grimes), (Lewis and Bridges) and (MacDougal); Tippecanoe (Coulter); Brown, Delaware, Fulton, Hamilton, Hancock, Johnson, Madison, Morgan, Montgomery, Porter, Wells (Deam).

PLATE 25.



JUGLANS CINEREA Linnæus. BUTTERNUT. (x ½.)

Economic uses. Wood light, soft, not strong, coarse-grained, sap wood nearly white, heart wood light brown and takes a good polish. Uses similar to that of a black walnut. The bark of the root is used in medicine as a hepatic stimulant.

Horticultural value. Adapted to a moist rich soil. When grown in the open it usually develops a short trunk with a wide-spreading top. It is frequently planted along roadsides and on the borders of orchards for its nuts.

2. HICÒRIA. THE HICKORIES.

The range of the hickories is eastern North America from the valley of the St. Lawrence south to Mexico. Trees with strong, elastic and compact wood; bark on old trunks very hard, fissured, tight or scaly; branches flexible, difficult to break off; leaves glandular dotted; leaflets serrate and usually unequal at the base, lowest pair the smallest, upper pair and terminal the largest; fruit sessile or nearly so, a bony nut surrounded by a woody husk which separates more or less completely into 4 parts. The individuals of the several species vary much in respect to their bark, pubescence of the twigs, number and size of the leaflets and size and shape of the nuts.

Bud scales 4-6, valvate (in pairs).
- Leaflets 9-17, generally about 13; nut elongated, circular in cross-section, kernel sweet ..... 1 H. Pecan.
- Leaflets 5-9, generally 5-7; nut about as broad as long, elliptic in cross-section, kernel bitter ..... 2 H. cordiformis.

Bud scales more than 6, imbricated (not in pairs).
- Bark of trees shaggy, separating in long flat plates, at least from about 4 m. (13 feet) above the ground upward.
  - Husk of fruit thick, more than 2.5 mm. (about 1/8 inch) thick.
    - Leaflets 3-5, generally 5; shell of nut thin, nut generally less than 3 cm. (1 inch) long, usually about 2.5 cm. (7/8 inch) long ..... 3 H. ovata.
    - Leaflets 5-9, generally 7; shell of nut thick, nut generally more than 3 cm. (about 1 inch) long, usually about 4 cm. (1½ inches) long ..... 4 H. laciniosa.
  - Husk of fruit thin, less than 2.5 mm. (1/8 inch) thick .. 5 H. microcarpa.
- Bark of trunk fissured, not separating in long flat plates.
  - Bark generally light gray, husk thick and freely splitting to the base or nearly so, shell of nut thick ..... 6 H. alba.
  - Bark generally dark gray, brown or nearly black; husk not very thick, not splitting freely to the base, shell of nut rather thick ..... 7 H. glabra.

The species of this genus are very variable, and it is acknowledged that the present treatment of the genus is not satisfactory. A full understanding of the genus in Indiana would require much field study and more herbarium material than is available at the present time.

1. Hicoria Pecán (Marshall) Britton. PECAN. (*Carya illinoensis* (Wangenheim) K. Koch.) Plate 26. Bark tight, rather deeply fissured, ridges narrow, high up on old trees becoming somewhat scaly, light brown tinged with red; twigs at first hairy, becoming smooth or nearly so and reddish-brown by the end of the season; the terminal winter buds compressed, about 12 mm. (½ inch) long, covered with yellowish scales, the lateral buds much smaller; leaves 3-5 dm. (12-20 inches) long; leaflets 9-17, ovate to oblong lanceolate, somewhat curved backward, 7-15 cm. (2¾-6 inches) long, rounded or wedge-shaped at the unequal base, long taper-pointed at the apex, short stalked, hairy when they unfold, becoming at maturity smooth or nearly so, a dark green above and a yellow green beneath; staminate catkins sessile or nearly so; fruit in clusters of 3-11, oblong, 3.5-6 cm. (1⅜-2⅜ inches) long, the sutures of the husk splitting to below the middle; nut ovoid to ovoid oblong, reddish-brown.

Distribution. In the Mississippi Valley from Iowa south to Alabama and Texas. In Indiana it is found only in the southwestern part of the State. In our area it is generally confined to the low lands of the water courses, following the Wabash River up as far as four miles south of Covington in Fountain County*, the Ohio River up as far as Jefferson County, the south fork of White River up as far as Seymour in Jackson County and the north fork up as far as Greene County. It is frequent to very common in the lower Wabash bottoms, diminishing in numbers as the water courses are ascended.

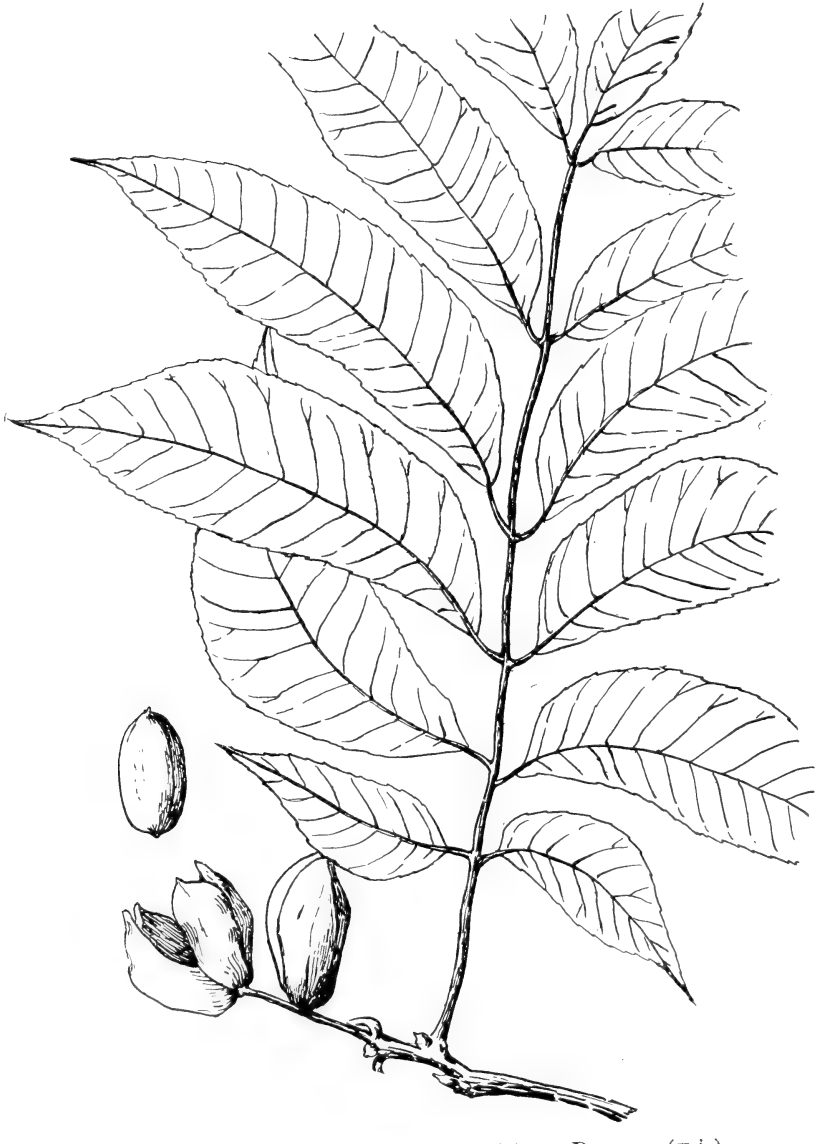
The published records of the distribution are as follows: Delaware, Jay, Randolph and Wayne (Phinney)**; Franklin (Meyncke) ***; Gibson (Schneck); Jefferson (Young); Knox (Thomas); Posey (Schneck); Vigo (Blatchley).

Additional records are: Posey (Deam) and (Wright).

Economic uses. Wood heavy, hard, not strong and light reddish-brown. The wood is the least valuable of all the hickories, although commercially it is frequently classed with the other hickories. Uses same as that of the other hickories. The nuts are an important article of commerce.

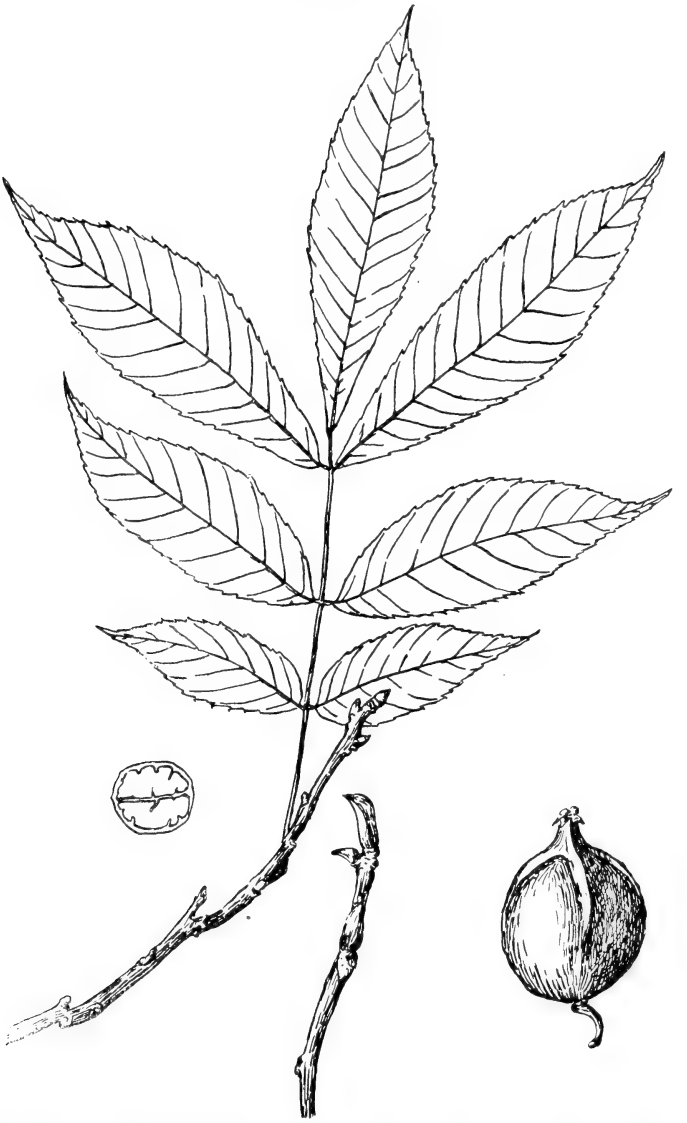
*Ind. Geol. Rept. 11:122, pub. 1882.
**Mr. Phinney says this was an error.
***No doubt from a cultivated tree.

PLATE 26.



HICORIA PECAN (Marshall) Britton. PECAN. (x ½.)

PLATE 27.



HICORIA CORDIFORMIS (Wagenheim) Britton. PIGNUT HICKORY.
(x ½.) (Fruit, x 1.) (Cross section of nut, (x ½.)

Horticultural value. The pecan like the other hickories develops a large tap root, which makes it difficult to transplant. It should be propagated if possible by planting germinated nuts. It is the most rapid in growth of any of the hickories. The cultivation of the pecan for the nut crop has received considerable attention in the Gulf States for many years and improved varieties have been secured by selection. Pecan culture has proven profitable in the southern States, especially when the improved varieties have been grown.

It is doubtful if pecan culture would prove profitable in Indiana, since when the cost of production in Indiana is compared with that of the Gulf States it will be found that our land is much higher in price, labor, which is an important item, is also much higher priced and that the crop is more liable to fail on account of climatic conditions.

Information from reliable people who reside in Posey County and who are familiar with the fruiting of the pecan in that part of the country, shows that only about one-fourth of the native trees ever bear fruit, and only about one out of every ten trees is a profitable nut bearing tree. While a few trees bear nuts every year, it is, however, the exception. They say, also, that the winters in Indiana are too severe to make pecan culture profitable.

2. Hicoria cordifórmis (Wangenheim) Britton. PIGNUT. PIG HICKORY. TIGHT BARK HICKORY. (*Carya cordiformis* (Wangenheim) K. Koch.) Plate 27. Bark on the trunk thin, tight, usually a light gray, sometimes darker, with shallow fissures, rarely separating into thin, short plates; twigs at first greenish, somewhat hairy, soon becoming smooth or nearly so and a yellowish-brown, often a reddish-brown by the end of the season, becoming before the leaves appear usually a light gray brown or the same tinged with red; winter buds oblong-ovoid, flattened, taper-pointed and oblique at the apex, scales 4-6, in pairs, valvate, covered with yellow glandular scales, somewhat pubescent; leaves 1.5-2.5 dm. (6-10 inches) long, petioles and main axis more or less pubescent; leaflets 5-9, lanceolate to oblong or obovate, 4-15 cm. (2-6 inches) long, more or less curved, sessile or the terminal one sometimes stalked, narrowed to the oblique base, taper-pointed, yellow green and smooth above at maturity, paler and more or less pubescent beneath especially along the prominent veins, generally covered with glands; fruit globose or slightly obovoid, 2-3.5 cm. (¼-1¼ inches) long, generally 4-winged from the apex to about the middle, sometimes the wings extend nearly to the base, more or less thickly covered

with a yellow scurfy pubescence; husk about 1.5 mm. (1/16 inch) thick, tardily separating to about the middle; nut ovoid, oblong or obovoid, slightly flattened, often as wide or wider than long, depressed or obcordate with a short or long point at the apex, ovoid at the base, smooth; shell very thin and brittle; kernel very bitter. This hickory can easily be distinguished from all the other species either in winter or summer by its yellow bud scales.

Distribution. Quebec to Minnesota, south to the Gulf States and west to Texas. Found throughout Indiana, but nowhere abundant. It is more or less frequent in rich soil along streams and in moist rich woods. Usually associated with the shellbark hickory, burr oak and ash.

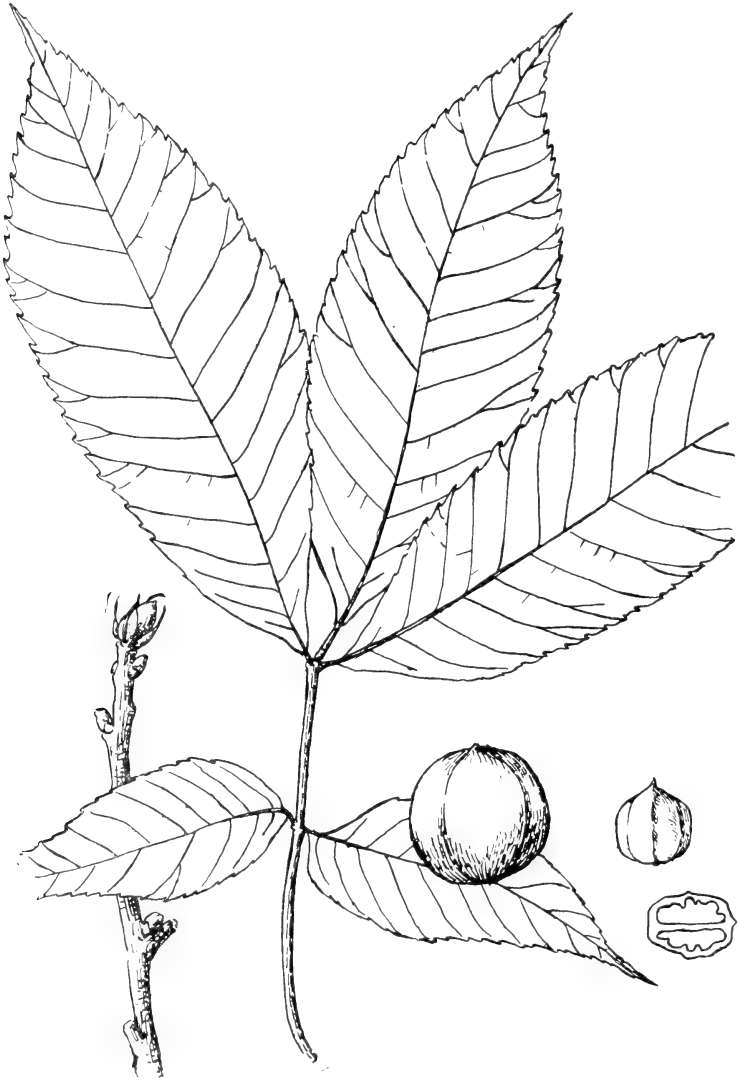
The published records of the distribution are as follows: Carroll (Thompson); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Knox (Ridgway); Marion (Wilson); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Monroe (Blatchley); Montgomery (Thompson); Posey (MacDougal and Wright); Putnam (Grimes); Tippecanoe (Coulter); Adams, Delaware, Hamilton, Jennings, Knox, Montgomery, Owen, Vermillion, Warren and Wells (Deam).

Economic uses. Wood heavy, very hard, strong, tough, close-grained and dark brown, the sap wood white, about 1½ inches thick at 25 years of age. It is used principally in the manufacture of vehicles, furnishing the spokes, rims, poles, shafts, single and double trees. It is also used for fuel.

3. Hicoria ovata (Miller) Britton. SHELLBARK HICKORY. SCALYBARK HICKORY. RED HICKORY. (*Carya ovata* (Miller) K. Koch.) Plate 28. Bark of trunk separating in thin, long, flat plates, light gray, sometimes rather dark; twigs at first covered with hairs, becoming smooth at the end of the season or remaining hairy, a reddish-brown; winter buds hairy, the terminal one ovoid, blunt, about 16 mm. (⅝ inch) long, the outer scales sharp-pointed, dark brown, deciduous before spring, when the inner scales are exposed they are a yellow green, hairy and blunt; leaves 2-3.5 dm. (8-14 inches) long, main axis hairy or sometimes smooth; leaflets generally 5, rarely 7, ovate to ovate-lanceolate or obovate, 10-18 cm. (4-7 inches) long, the lateral sessile, the terminal one obovate and short stalked, wedge-shaped at the base, generally long taper-pointed at the apex, margins finely serrated, when they unfold covered above with yellow scales, hairy on the margins and beneath

PLATE 28.



HICORIA OVATA (Miller) Britton. SHELLBARK HICKORY. (x ½.)

at least on the veins, becoming at maturity firm, smooth and a yellow green above, paler and smooth or somewhat pubescent beneath; fruit subglobose or obovate, depressed at the apex, furrowed along the sutures, especially above the middle, usually 3-4 cm. (1-1½ inches) in diameter from the apex to the base; husk freely splitting to the base, rarely not splitting freely, generally about 8 mm. (¼ inch) thick; nut exceedingly variable in size and shape, varying from oblong, subglobose, ovate, to obovate, sometimes wider than long, rounded or pointed at the base, generally pointed at the apex, sometimes rounded or obcordate, smooth or angular; shell generally thin, sometimes rather thick, or very thin; kernel uniformly sweet.

Distribution. Valley of the St. Lawrence west to Minnesota, south to Florida and west to Texas and Kansas. In Indiana it is frequent to common in all parts of the State in moist rich soil along streams, in the bottom lands or in dryer soil on hillsides. It is generally associated with the other hickories, sugar maple, white ash, red oak, linn and slippery elm. In the forest it is a tall, straight tree with a few main branches for the crown. In the open the side branches do not shade off and it is medium in height with a long and wide-spreading crown.

The published records of the distribution are as follows: Cass (Coulter); Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Scott); Marion (Wilson); Posey (Schneck); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Jefferson (Young); Monroe (Blatchley); Montgomery (Evans); Posey (MacDougal and Wright); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Clark, Delaware, Hamilton, Jennings, Owen, Posey Steuben and Wells (Deam.)

Economic uses. Wood heavy, very hard and strong, close-grained, flexible, light brown, sap wood white and thin. Used principally for carriage and wagon stock, agricultural implements, ax-handles and fuel. The nuts are delicious and command a good price.

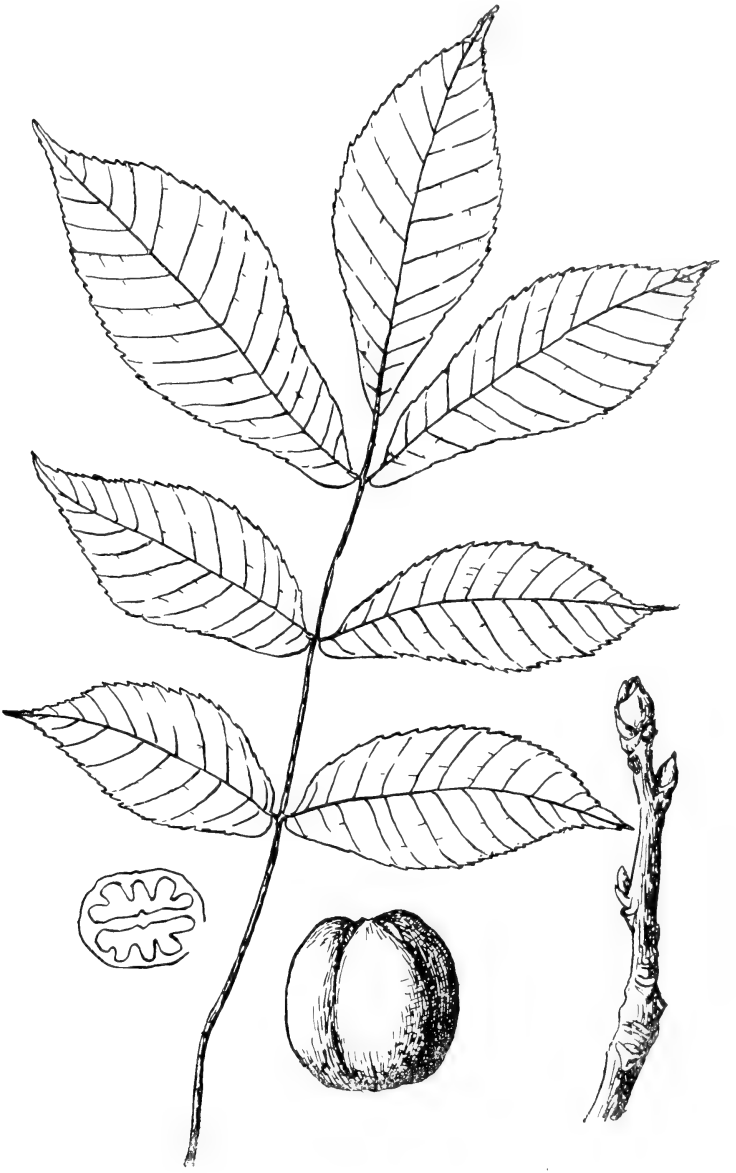
The pioneers were accustoned to bind the long plates of bark together for use as torches. It is recorded that many eminent men of the past gained their education by the light of the hickory torch. It was a favorite way of the fishermen to light up the surface of the water so that they could spear fish.

4. Hicoria laciniòsa (Michaux) Sargent. BIG SHELLBARK HICKORY. BIG SCALY-BARK HICKORY. HARD-HEAD HICKORY. (*Carya laciniosa* (Michaux fils) Loudon). Plate 29. Bark on the trunk gray, separating into long plates, twigs stout, at first hairy, yellowish, becoming smooth or nearly so, buff or nearly orange color, which is peculiar to this tree, frequently retaining the leaf stalks of the leaves of the previous year; terminal bud large, ovoid, blunt, about 2 cm. (¾ inch) long, outer scales brown, usually a dark brown, pubescent, generally keeled especially toward the apex, the lower pointed and nearly triangular in shape, outer scales persisting throughout the winter; leaves 2.5-5 dm. (10-20 inches) long, petioles and main axis more or less pubescent, leaflets 5-9, usually 7, ovate to oblong-lanceolate or obovate, the largest 1-2 dm. (4-8 inches) long, the lateral ones rounded and oblique at the base, the terminal one wedge-shaped at the base, all long taper-pointed at the apex, finely serrate, the lateral ones sessile, the terminal sessile or on a short stalk, hairy beneath when they unfold, becoming thick and a deep green above and remaining densely velvety hairy beneath, especially along the principal veins; fruit ovate, subglobose, oblong, or obovate, depressed at the apex, 5-8 cm. (2-3 inches) long, somewhat grooved along the sutures, especially towards the apex; nut broadly oblong or often obovate, usually longer than broad, sometimes broader than long, flattened, blunt or sharp-pointed at either end, the obovate type usually rounded or notched at the apex, and smoother than the oblong type, which generally has 4-6 sharp ridges; shell generally 2-3 mm. (about ⅛ inch) thick at the thinnest points; kernel very sweet.

Distribution. New York west to Iowa, south to Tennessee and west to Arkansas and Kansas. No study of the distribution of this species in the extreme northwestern part of the State has been made, but in the other parts it is more or less frequent in bottom lands and in moist rich woods. It is generally associated with the preceding species, preferring somewhat moister situations. It so much resembles the preceding species in general appearance that it is not commonly separated from it.

The published records of the distribution are as follows: Carroll (Thompson); Clark (Smith); Dearborn (Collins); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Jefferson (Coulter) and (Young); Knox (Ridgway); Kosciusko (Clark); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley).

PLATE 29.



HICORIA LACINIOSA (Michaux) Sargent. BIG SHELLBARK HICKORY. (x ½.)

[10—28415]

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Harrison, Marion, Posey, Vermillion and Wells (Deam).

Economic uses. Wood and uses the same as the preceding.

5. Hicoria microcárpa (Nuttall) Britton. (*Carya microcarpa* Nuttall.) Plate 30. Bark fissured and rather tight on the trunk near the base, becoming more or less shaggy a short distance above the ground, the lower part of the trunk resembling that of Hicoria glabra (Black Hickory), the upper part that of Hicoria ovata (Shellbark Hickory); twigs slender, becoming at the end of the season smooth, reddish-brown; winter buds ovoid, the terminal one at fruiting time 6–10 mm. (about ¼ inch) long; scales densely covered with small yellow scales, more or less pubescent especially along the margins, the outer usually almost glabrous, blunt or the outer somewhat sharp-pointed; leaves 2-3 dm. (8-12 inches) long, main axis at maturity smooth or nearly so; leaflets 3-7, usually 5, oval to oblong-elliptic, the lateral ones sessile, the terminal one short-stalked, long taper-pointed, at maturity light green and smooth above, paler and smooth beneath or with some pubescence in the axils of the veins and on the veins; fruit subglobose or obovoid, densely covered with yellow scales, sutures elevated; husk thin, about 1.5 mm. (1/16 inch) thick, somewhat tardily splitting to nearly the base; nut oval, somewhat angular, sharp-pointed at each end, about 1.5 cm. (½ inch) long, about as wide through the widest diameter, compressed; shell thin; kernel sweet. In the northern part of the State a form is found with a nut about one-fourth longer in diameter, obovoid, nearly smooth, rounded at both ends or obcordate at the apex. Another form was noted associated with the two forms above, with bud scales and twigs very pubescent, husk of fruit about one-third thicker, and shell of nut as thick as *Hicoria ovata.*

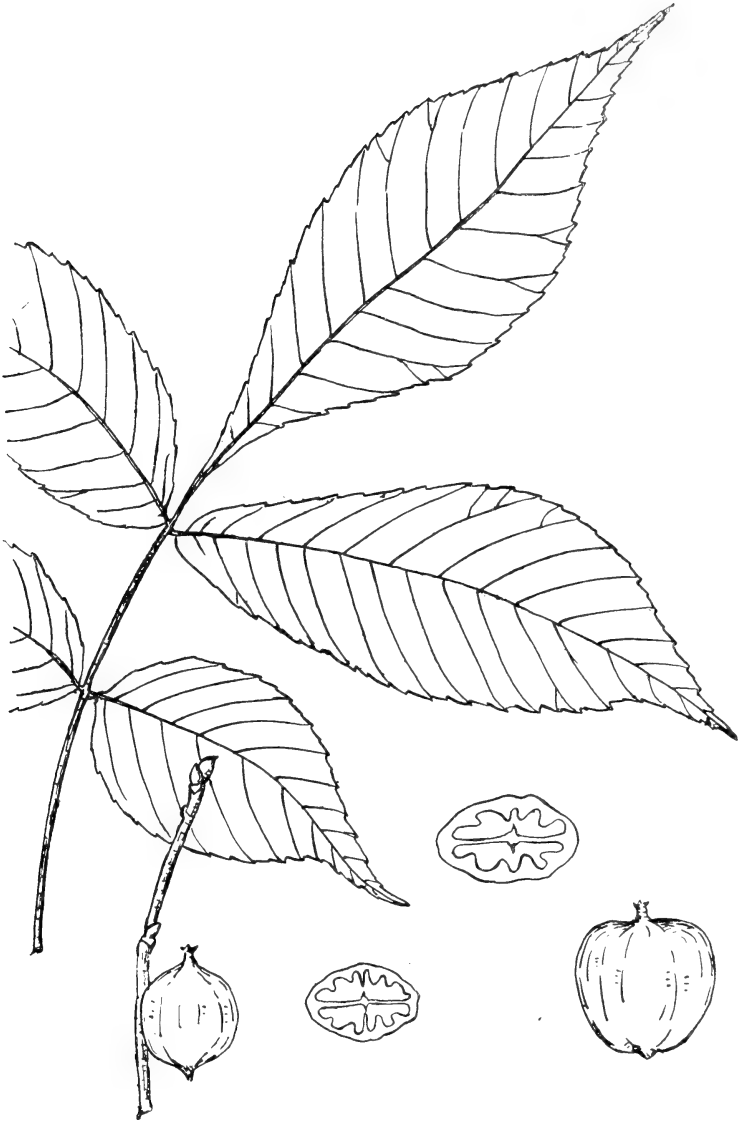
Distribution. Massachusetts west to Michigan and south to Missouri and Georgia. More or less frequent throughout Indiana and associated with *Hicoria ovata.* The habitat and range of this species has not been well studied.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Ridgway) and (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Knox (Ridgway); Kosciusko (Scott); Marion (Wilson); Miami (Gorby); Posey (Schneck).

Additional records are: Posey (MacDougal and Wright); Tippecanoe (Coulter); Laporte, Vermillion, Warren and Wells (Deam).

Economic uses. Wood and uses same as that of the shellbark hickories.

PLATE 30.



HICORIA MICROCARPA (Nuttall) Britton. SMALL FRUITED HICKORY.
(x ½.) (Nut, x 1.)

6. Hicoria álba (Linnæus) Britton. WHITE HICKORY. (*Carya alba* (Linnæus) K. Koch). Plate 31. Bark of trunk tight, never scaly, fissured, furrows shallow, light gray; twigs at first densely hairy, becoming at the end of the season reddish-brown, finally a dark gray, remaining more or less pubescent during the season; winter buds ovoid, the terminal one at time of fruiting about 12 mm. (½ inch) long; outer scales broadly ovate and pointed, hairy, dark or reddish-brown; leaves fragrant, 2-3.5 dm. (8-14 inches) long, main axis hairy; leaflets 5-9, generally 7, sessile or the terminal one on a short stalk, oblong-lanceolate to obovate-lanceolate, taper-pointed at the apex, hairy when they unfold, becoming at maturity firm, smooth and a dark yellow green above, paler or brownish beneath, and remaining more or less densely hairy, especially along the veins; fruit subglobose, elliptic, generally about 4 cm. (1½ inches) long, the sutures depressed, husk thick, splitting to the base or nearly so; nut globose, or elliptic, rounded at the base, rounded or short-pointed at the apex, generally smooth, with the angles obscure except at the apex; shell thick; kernel sweet.

Distribution. Southern Ontario south to Florida and west to Texas and Kansas. Well distributed throughout Indiana but nowhere abundant. In the northern part it is rather rare, becoming more or less frequent in the southern part especially in the southwestern part. It is generally found in drier situations than the preceding species and of the hickories it is the most frequently associated with *Hicoria glabra* (Black Hickory).

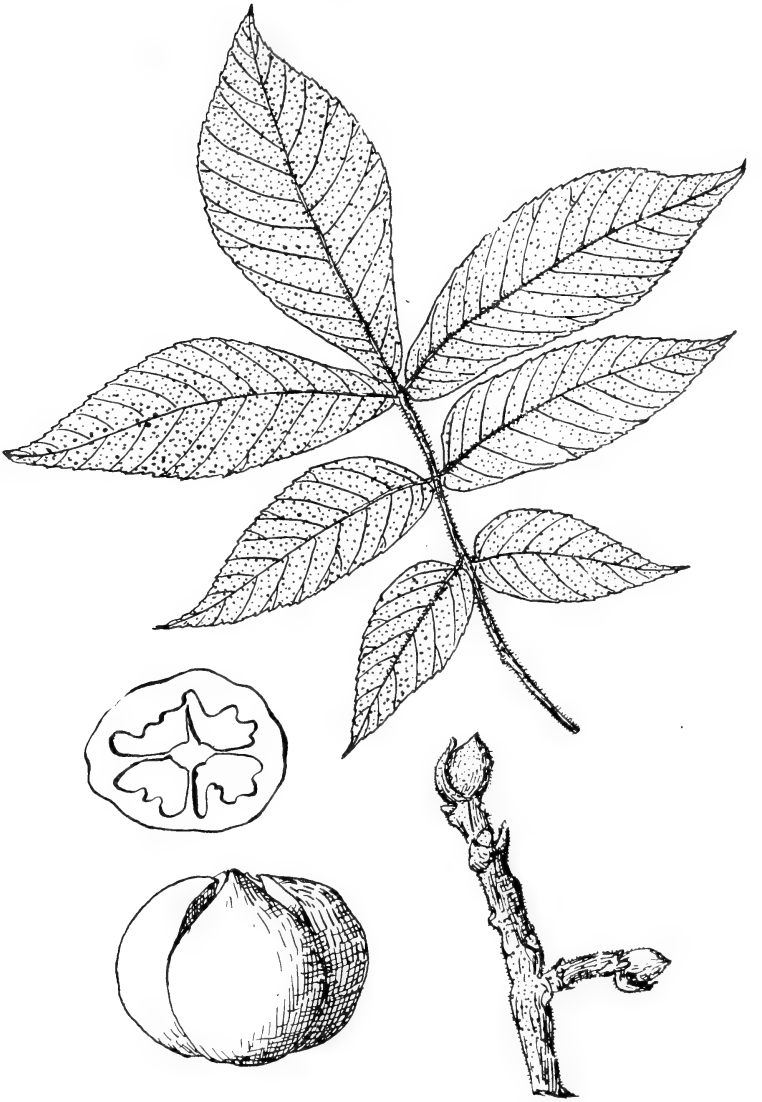
The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Knox (Ridgway); Kosciusko (Clark) and (Scott); Marion (Wilson); Miami (Gorby); Posey (Schneck); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Tippecanoe (Coulter); Gibson and Posey (Deam).

Economic uses. Wood and uses similar to that of the shellbark hickory.

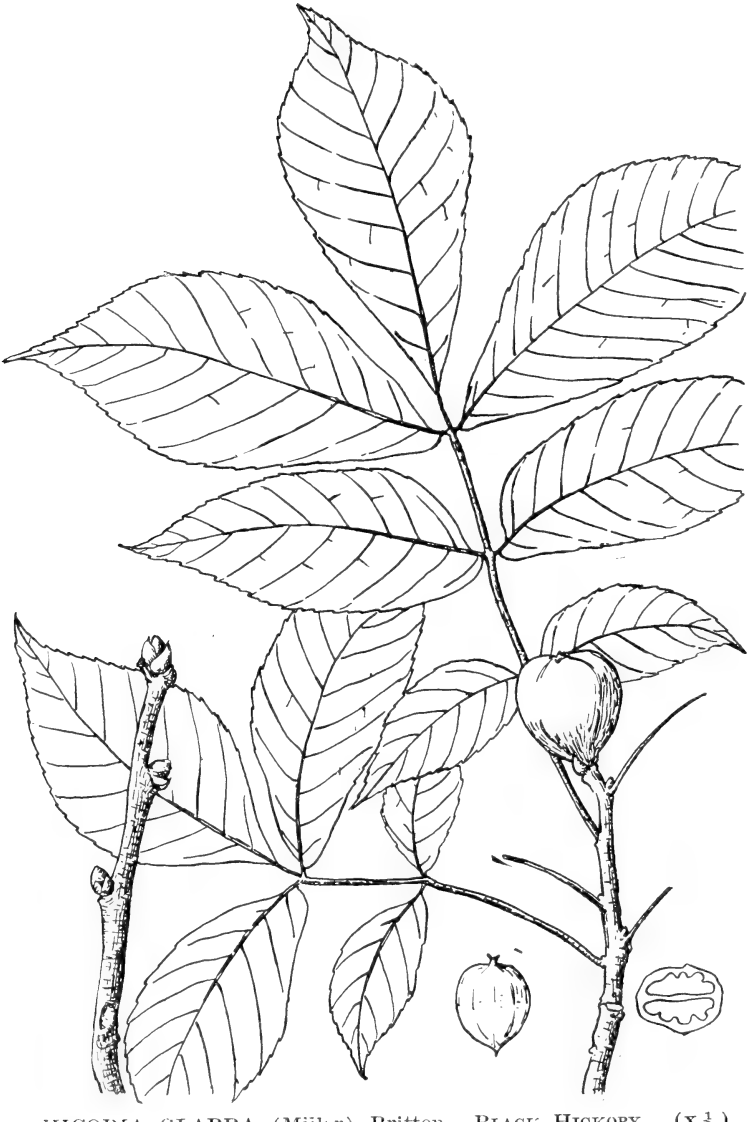
7. Hicoria glàbra (Miller) Britton. BLACK HICKORY. PIGNUT HICKORY. (*Carya glabra* (Miller) Spach.) Plate 32. Bark of trunk generally a dark gray, varying to nearly black, from whence its most common name, fissured, furrows narrow and rather deep on old trunks, the ridges rather broad and somewhat scaly on old trunks but not flaking off; twigs slender, often hairy at first, becom-

PLATE 31.



HICORIA ALBA (Linnæus) Britton. WHITE HICKORY. (x $\frac{1}{3}$.) (Twig, x $\frac{1}{2}$.) (Nut and cross section, x 1.)

PLATE 32.



HICORIA GLABRA (Miller) Britton. BLACK HICKORY. (x $\frac{1}{2}$.)
(Twig with buds, x 1.)

ing glabrous and reddish-brown; winter buds ovoid, the terminal one about 6 mm. long at fruiting time and about 8 mm. (¼ inch) in March, scales pointed, light or reddish-brown, more or less pubescent; leaves 1.5-3 dm. (6-12 inches) long, main axis smooth or nearly so; leaflets 3-9, generally 5 or 7, the lateral sessile, the terminal short stalked, 6-15 cm. (2¼-6 inches) long. taper pointed at the apex, hairy at first, becoming at maturity glabrous and a dark yellow-green above, paler or a yellow-brown and smooth or with a few hairs in the axils of the veins beneath; fruit generally obovoid, varying to subglobose or elliptic, generally about 3-4 cm. (about 1¼ inches) long, sutures elevated, usually somewhat depressed at the apex, husk rather thin, tardily separating, usually to nearly the middle, sometimes merely breaking open; nut varying from obovoid to elliptic, generally smooth, sometimes depressed both ways with rounded angles, tapering at the base, generally rounded at the apex, sometimes sharp-pointed; shell rather thick; kernel sweet or astringent.

The species is quite variable and some forms are found which show great variation. The following is given as an example. Deam's numbers 9,214 and 10,241 were taken from a tree in an open dry woods on the farm of Dr. J. Gardner, about four miles southwest of Bedford. The tree is about 3 dm. (12 inches) in diameter and has long branches, drooping almost to the ground. Bark of trunk nearly black, deeply fissured, the furrows about 4.5 cm. (1¾ inches) deep, twigs at first densely covered with hairs, rarely somewhat smooth at maturity; terminal buds ovoid, rather blunt, 1-2 cm. (about ⅝ inch) long at fruiting time, outer scales deciduous, rather blunt, reddish brown, covered with scales and densely hairy, inner scales light brown and silky; leaves 2-4 dm. (8-16 inches) long, main axis stout and densely covered with brown hairs even at maturity; leaflets 7 or 9, lanceolate-oblong to lanceolate-obovate, 5-18 cm. (2-7 inches) long, firm at maturity, dark green and smooth above, paler and a yellow-green below, and thickly covered with brown hairs; fruit subglobose, covered with yellow scales and somewhat hairy, about 2.5 cm. (1 inch) long; husk rather thick, tardily splitting to about the middle or below; nut globose, rounded at both ends, scarcely angled; shell thick; kernel sweet. This tree agrees very well with the description of variety **odorata.**

Distribution. Maine west to Nebraska, south to Florida and west to Texas. Found throughout Indiana. Rare or frequent in the northern counties, frequent in almost all the southern counties, and in cut over land in the southern counties it is often the prin-

cipal stand on the hills. It is the most frequently associated with the white and black oaks. Often in our area the greater part of the trunk is too burly to be used for other than for fuel purposes.

The published records of the distribution are as follows: Cass (Benedict and Elrod); Carroll (Thompson); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Marion (Wilson); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Delaware, Owen, Posey and Warren (Deam)

Economic uses. Wood and uses similar to that of the shell bark hickory.

BETULACÀCEÆ. THE BIRCH FAMILY.

Trees or shrubs with watery juice; leaves alternate (in pairs on the older branches of Betula,) pinnately-veined; flowers of two kinds, the staminate in long catkins, 1-3 together, the pistillate in short catkins; fruit a nut or samara.

Staminate flowers solitary in the axil of each bract, without a calyx, pistillate flowers with a calyx; nut more or less inclosed in the involucral bracts, wingless.
- Staminate aments in winter enclosed with bud scales; bark of tree smooth and close, gray; pistillate involucral bracts foliaceous at maturity, flat, and more or less irregularly 3-cleft ..... 1 Carpinus.
- Staminate aments naked in winter, appearing in threes at the ends of the branches; bark of trunk shreddy, grayish-brown; pistillate bracts growing together at maturity and enclosing the nut ..... 2 Ostrya.

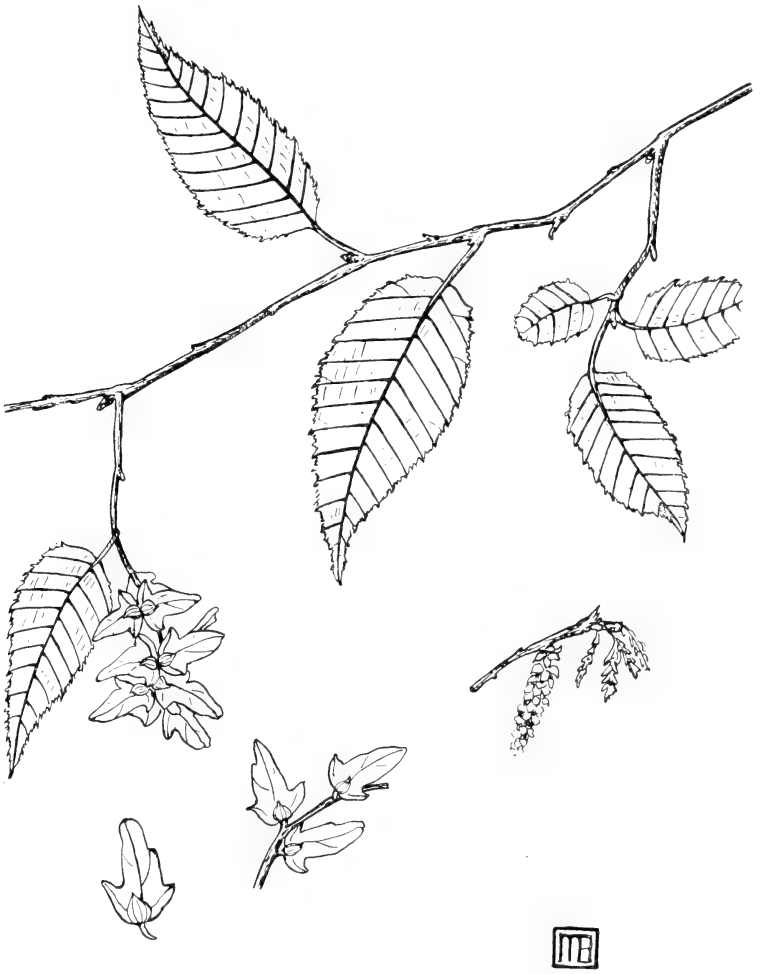
Staminate flowers 3-6 in the axil of each bract, with a calyx, pistillate without a calyx; nut winged.
- Stamens 2, pistillate aments solitary, hop-like and papery at maturity; winter-buds covered with scales; bark on old trees separating in flakes or scales ..... 3 Betula.
- Stamens 4, pistillate aments racemose, woody at maturity; winter buds without scales; bark on old trees not separating in flakes ..... 4 Alnus.

1. CARPÌNUS. THE HORNBEAM.

(Carpinus is derived from the Celtic words *car*, wood and *pin*, the head; referring to the fact that the wood was used for the yokes of cattle.)

Carpinus caroliniàna Walter. WATER BEECH. BLUE BEECH. SWAMP BEECH. Plate 33. Trees with fluted or ridged trunks;

PLATE 33.



CARPINUS CAROLINIANA Walter. BLUE OR WATER BEECH. (x ½.)

bark smooth, close, gray; leaves ovate to oblong, short to long pointed, double-serrate, sometimes unequal-sided, hairy when young, glabrous at maturity except on the veins beneath, pubescence not

glandular; flowering season April or May, staminate catkins 2-3 cm. (¾-1⅛ inches) long, appearing early in the spring on the sides of the twigs of the previous season; pistillate catkins 1-2 cm. (⅜-¾ inch) long, on the shoots of the season; nut ovate, about 5 mm. (1/5 inch) long, somewhat compressed, each face with 4-6 prominent ribs.

Distribution. Northern Minnesota and southern Quebec, south to the Gulf States and west to Texas and Kansas. It is frequent in all parts of Indiana in moist rich soil. The proximity of streams apparently has little influence on its distribution. It is quite tolerant in its moisture requirements, ranging from the tamarack bogs to comparatively dry woods. It is tolerant of shade and is seldom found outside of the forest. In our area it is usually a small tree with a diameter of 1-2 dm. (4-8 inches) and a clear bole of 2-5 m. (6-16 feet).

The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (McCaslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) (Coulter) and (Youse); Lake (Higley and Radden); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Laben and Conner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Brown (Wright); Montgomery (Evans); Putnam (Cook) and (Grimes); Tippecanoe (Coulter); Bartholomew, Blackford, Crawford. Delaware, Hamilton, Hancock, Jackson, Knox, Laporte, Morgan, Owen, Porter, Posey, Steuben, Vermillion, Warren and Wells (Deam).

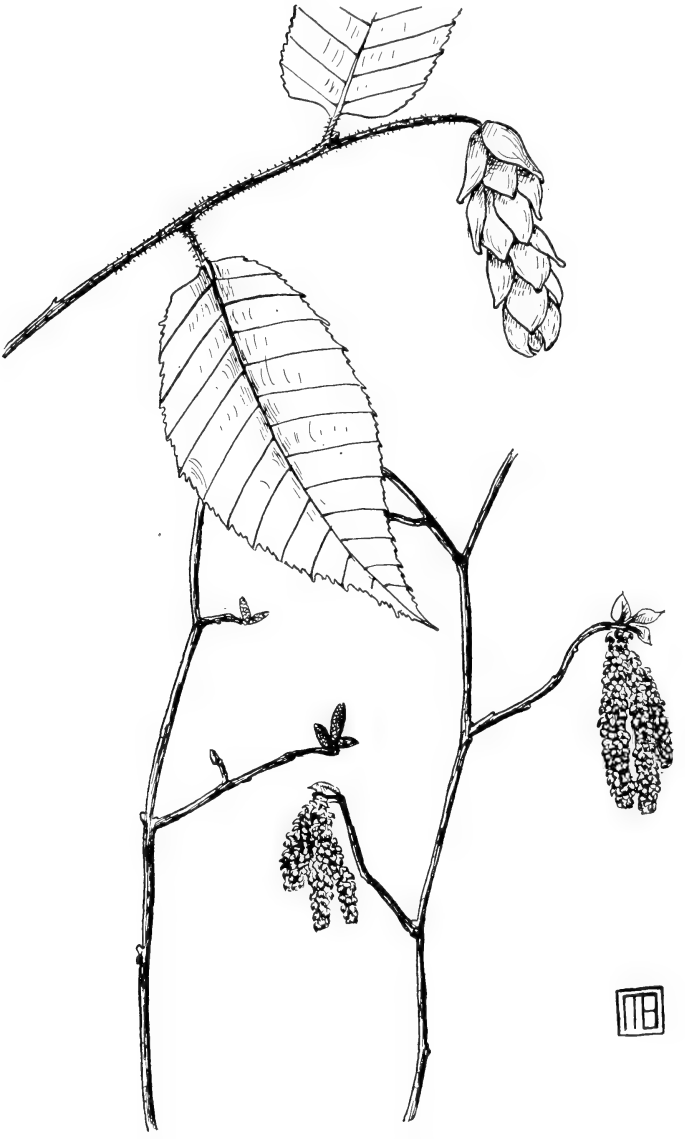
Economic uses. Wood heavy, hard, tough, strong, light brown. The tree is so small and crooked and the wood so difficult to work that it is of little economic importance.

2. ÓSTRYA. THE HOP HORNBEAMS.

(Ostrya is from the Greek, *ostreon*, a scale or shell, in allusion to the fruit.)

Ostrya virginiàna (Miller) Willdenow. IRONWOOD. HORNBEAM. (*Ostrya virginiana* (Miller) K. Koch.) Plate 34. A small tree with shreddy brown bark; winter buds acute; branches slender; young twigs green, hairy, becoming smooth and brown; leaves ovate to lanceolate, acute at the apex, rounded wedge-shape or cordate at

PLATE 34.



OSTRYA VIRGINIANA (Miller) Willdenow. IRONWOOD. (x $\frac{1}{2}$.)

the base, sharply serrate, 6-10 cm. (2½-4 inches) long, mature leaves glabrous above, with pubescent veins and tufts of hairs in the axils of the veins below; flowering period April or May; staminate aments about 4 cm. (1½ inches) long at time of flowering; nuts light brown, about 8 mm. (1 3 inch) long, ovoid, flattened, obscurely longitudinally ribbed, enclosed in a papery, ovate bag about 2 cm. (¾ inch) long, formed by the union of the mature bracts; the aggregate fruit resembles the hop, hence its common name.

Distribution. Valley of St. Lawrence River south to the Gulf States and West to Texas and Minnesota. It occurs more or less frequently in dry soil in all parts of Indiana, and is usually associated with beech, white ash and sugar maple. It is less frequent in the southwest part of the state, and in a greater part of Posey County it is wanting. It is usually a tall, slender tree, ranging from 1-2 dm. (4-8 inches) in diameter and 6-12 m. (20-40 feet) in height. It is shade enduring and is commonly found in thick woods.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Kosciusko (Clark) and (Coulter); Lake (Higley and Radden); Marion (Wilson); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben Bradner); Tippecanoe (Coulter); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Rose); Putnam (Cook) and (Grimes); Fulton, Hamilton, Hancock, Laporte, Madison, Marion, Porter, Steuben, Warren and Wells (Deam.

Economic uses. Wood very hard, tough, close-grained, strong, light brown, used for fuel, handles for tools, and mallets. The size and quality of the timber make this tree of little economic importance, except for fuel. It was the favorite wood of the pioneers for making wooden wedges or gluts.

3. BÉTULA. THE BIRCHES.

(Betula is derived from the Celtic, *batu*, the name for the Birch.)

Bark smooth, often separating freely in thin plates, thick and furrowed, or scaly on the trunks of old trees; staminate flowers appear early in spring at the ends of the branches of the year; pistillate spikes ripen in autumn, nuts small, winged, bearing at

the apex the persistent stigmas. Trees or shrubs, the bark and wood of some of which contain an aromatic volatile oil.

Bark of twigs frequently with a slight wintergreen flavor; fruiting aments sessile or nearly so; leaves with 7-15, usually 9-11 pairs of veins; wings of nut about as wide as the body ..... 1 B. lutea.

Bark of twigs usually bitter, not wintergreen flavored; fruiting aments stalked; leaves with 5-9 pairs of veins; wings of nut wider than the body.

Bark of trunk greenish-white to reddish-brown, scaly and usually shaggy, leaves glaucous beneath; fruiting aments erect or nearly so ..... 2 B. nigra.

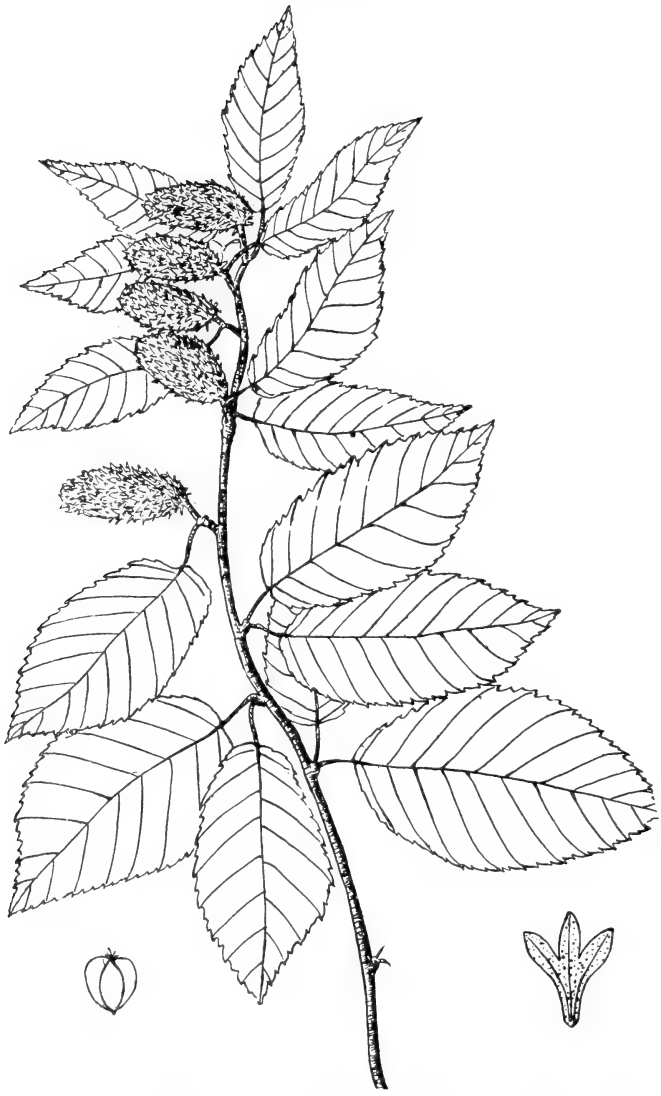
Bark of trees chalky white, not scaly or shaggy; leaves not glacous beneath; fruiting aments drooping or spreading.

Upper surface of leaves shiny; staminate catkins usually solitary; dark triangular spots on the bark at the base of the limbs ..... 3 B. populifolia.

Upper surface of leaves not shiny; staminate catkins usually 2 or 3; no dark spots on the bark at the base of the limbs ..... 4 B. papyrifera.

1. Betula lùtea Michaux. BIRCH. Plate 35. Bark of old trunks fissured into wide plates, usually rolling back from one edge, rarely tight, dull dark brown, bark of small trees and the branches of old trees silver or dark gray, freely peeling off in thin strips, never smooth; the year's shoots hairy, greenish gray, becoming smooth and reddish-brown by the end of the second year, not aromatic when bruised, sometimes when chewed a faint wintergreen odor may be detected; winter buds pointed, light to a reddish-brown, smooth, scales usually with a fringe of hairs; leaves usually appearing in pairs, ovate to oblong-ovate, 4-14 cm. (1½-5½ inches) long, taper-pointed, oblique and wedge-shaped, rounded or slightly cordate at the base, 7-15 pairs of lateral veins, usually 9-11, sharply and rather coarsely serrate, hairy on both sides when they appear, becoming at maturity dark green and somewhat smooth above, usually with a few long hairs remaining, occasionally entirely smooth, paler and more or less hairy on the veins beneath, both surfaces covered more or less with resinous dots; petioles permanently hairy, generally 10-12 mm. (about ½ inch) long; flowers appear in May, staminate catkins in clusters at the ends of the branches, about 6 cm. (2½ inches) long, scales broadly ovate, blunt, fringed with hairs, green tipped with a margin of reddish-brown, pistillate spikes solitary in the axils of the leaves, 2-4 cm. (¾-1½ inches) long, generally about 3 cm. (about 1 inch) long, commonly about half as

PLATE 35



BETULA LUTEA F. A. Michaux. YELLOW BIRCH. (x $\frac{1}{2}$.)
(Bract and nut, x 2.)

thick as long, erect or ascending, sessile or on very short stalks; scales very variable, 5-11 mm. (1/5-½ inch) long, generally about 8 mm. (1/3 inch) long, usually about ¼ longer than wide, sometimes wide as long, densely pubescent on the back, less so at the tips, glabrous or nearly so on the inside, ciliate, occasionally with brown or black glands on the margin, commonly lobed to more than 1/3 of their length, the lobes ascending or divaricate, the lateral generally the larger and almost as long as the narrower middle lobe; nuts divested of the wings, slightly obovate, about 3 mm. (⅛ inch) long, wings about 2/3 as wide as the nut and usually with a fringe of hairs at the very blunt apex.

Distribution. Newfoundland west to Manitoba, south to Delaware and southern Indiana, and in the Alleghany Mountains south to Georgia. In Indiana it is rare and local. It is found in the northern counties in colonies on the borders of lakes, in tamarack swamps and wet woods. It has not been reported south of Miami County except in Crawford County, where it appears on the cliffy sides of a deep ravine about 1 mile east of Taswell. In the northern part of the State it is associated with the black ash, white elm, tamarack, silver-leaf maple and red elderberry. In Crawford County it is found on the sides of the dry cliffs, associated with the hemlock and laurel (*Kalmia latifolia*).*

In our area this species of birch is not a large tree. In the northern part of the state it sometimes attains a height of 15 m. (45 feet); and a diameter of 4-6 dm. (24-39 inches). The trunks are short, usually 2-4 m. (6-12 feet) long.

This species by different authors has been variously called *Betula lenta*, *Betula alleghanensis* and *Betula lutea*. However it appears to be a regional form of the later species, and the preceding botanical description has been made from copious Indiana material, collected from several parts of the state, and drawn to cover only the form occurring in our area.

Betula lenta does not occur in our area and the records for its distribution in Indiana should be referred to *Betula lutea*. Dr. Schneck and Ridgway reported *Betula lenta* as occurring in the lower Wabash Valley but an examination of Dr. Schneck's herbarium material failed to reveal a specimen. It is believed this Indiana reference should be referred to lutea.

Transferring the *lenta* references, the published records of the distribution are as follows: Fulton (Hessler) a few in a tamarack

*This is the only known station for the laurel in Indiana, though it is said to occur in Floyd County west of New Albany. It literally covers the banks of the ravine near Taswell and sometimes attains a height of 5 m. (15 feet) and a diameter of 7 cm. (3 inches).

swamp; Miami (Gorby); Noble (Van Gorder) as rare; Steuben (Bradner).

Additional records are: Crawford, Laporte, Porter and Steuben (Deam).

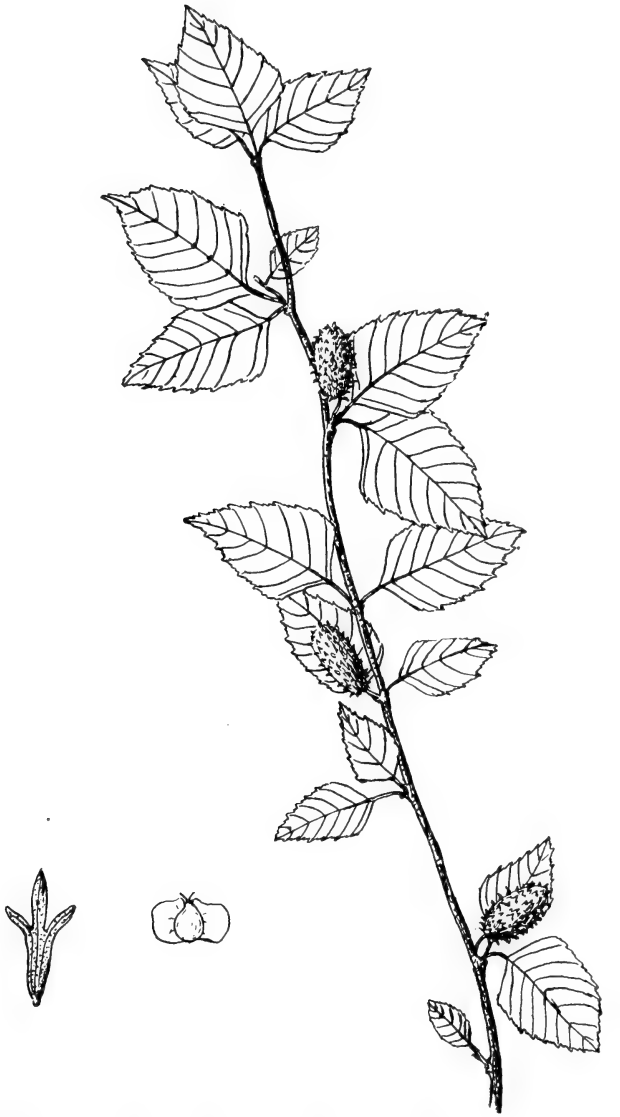
Economic uses. Occurring in too limited numbers to be of economic importance.

2. Betula nigra Linnaeus. BIRCH. WATER BIRCH. RED BIRCH. Plate 36. Bark on young trees and on the branches separating freely into large, thin papery scales which roll back and usually persist for years; young twigs hairy, becoming smooth and reddish, hence the common name "red birch"; leaves rhombic-ovate, smooth above, pubescent beneath, rarely nearly glabrous, irregularly toothed, taper-pointed at apex, short wedge-shaped at base, usually broadly so; staminate catkins 6-9 cm. (2½-3½ inches) long. flowers expand in March, April or May; mature fertile catkins 2-5 cm. (¾-2 inches) long, about 1 cm. (⅜ inch) thick, erect or spreading, on short hairy stalks; bracts velvety, ciliate, the three lobes nearly equal and frequently tipped with dark brown; nuts ovate, the wing as broad or broader than the body.

Distribution. Massachusetts to Minnesota, south to the Gulf States and west to Texas. In Indiana it is found principally in the southern part of the state along streams or in the "flats", which are inundated a part of each year. In the flats it is most frequently associated with the soft maples, sweet gum and pecan, and sometimes forms the principal stand. In the hilly parts of the State in the range of its distribution it is confined to the low banks of streams where it is frequent or rare. Along the streams it is usually found to have a short crooked trunk, but in the flats it is a tall straight tree. In size in our area it ranges from 2-8 dm. (8-32 inches) in diameter and 10-30 m. (33-97 feet) high. It is doubtful if it occurs in Indiana east of Jefferson County, or in the area bounded on the south by the C. H. & D. Railroad west of Indianapolis and the Big Four between Indianapolis and Cincinnati, and on the north by the Wabash Railroad between Fort Wayne and Lafayette. In the northern counties it is rare and local, except along the course of Yellow River, in Marshall and Starke counties, where it is found more or less frequently. In Posey County, in the vicinity of Hovey Lake, it is the principal stand, and it is here that it attains its greatest development.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Gibson (Schneck); Jackson, Lake and Martin (Blatchley); Knox (Ridgway); Miami (Gorby); vicinity

PLATE 36.



BETULA NIGRA Linnæus. WATER OR RED BIRCH. (x ½.)
(Bract and nut, x 2.)

[11—28415]

of New Albany (Clapp); Owen (Blatchley); Posey (Schneck); Putnam and Vigo (Blatchley).

Additional records are: Monroe (Blatchley); Brown, Clark, Marshall, Posey and Starke (Deam).

Economic uses. Wood light, strong, close-grained, heart wood light brown. Representative uses are furniture, heading, wooden ware, moulding and shoe-lasts. The supply in this State is not of sufficient quantity to be of much importance.

3. Betula populifòlia Marshall. BIRCH. Plate 37. Outer bark chalky white, that on the trunks of old trees nearly black, inner bark orange, not separable into thin layers; leaves nearly triangular; usually long taper-pointed, truncate or nearly so at the base, smooth and shiny on both sides, 3-7 cm. (1-2¾ inches) long; staminate catkins about 5-10 cm. (2-4 inches) long, mature pistillate catkins 1.5-3.5 cm. (½-1¼ inches) long, about 7 mm. thick; nut oval, narrower than the wing. This is the gray or white birch of text books.

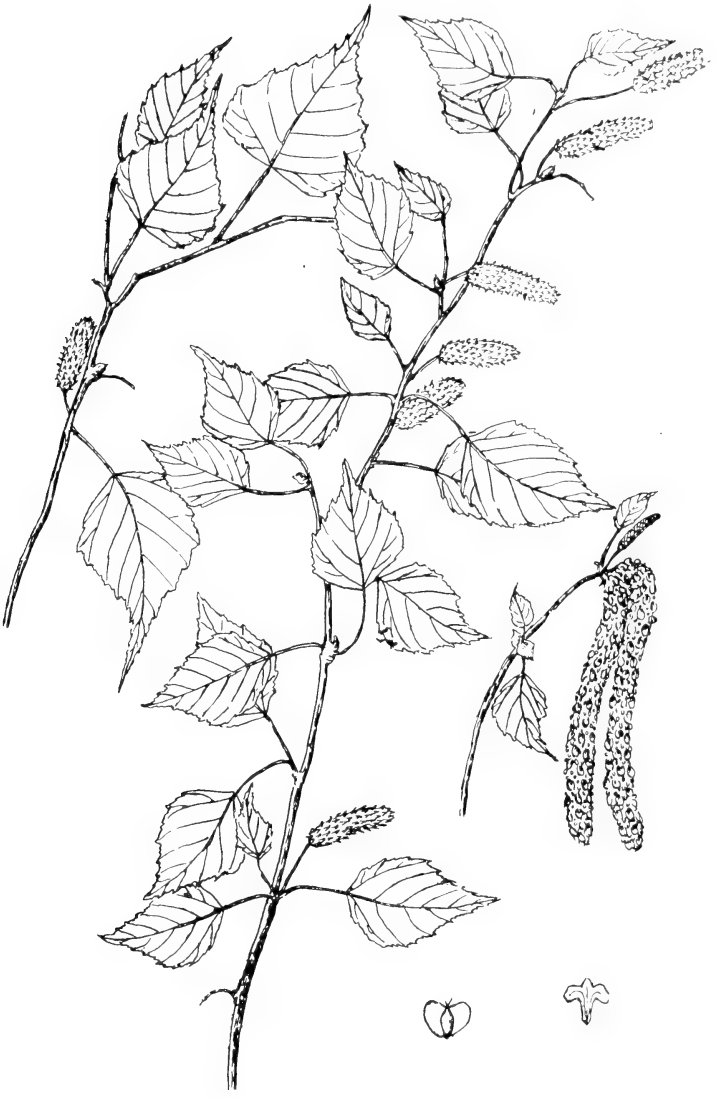
Distribution. Nova Scotia south to Delaware and westward through New England to New York. It again appears in Indiana in Lake and Tippecanoe Counties. It has been definitely reported in the following counties: Tippecanoe (Golden) as "sparsely along Wabash River", Lake (Higley and Radden) as "rare", Lake and Porter (Blatchley) as "scarce." In the most favorable conditions in its range it seldom is more than 4 dm. (16 inches) in diameter and 12 m. (39 feet) in height. In our area it is rare and a small tree of 1-2 dm. (4-8 inches) in diameter and of no economic importance.

Additional records are: Laporte (Deam).

Horticultural value. Occasionally planted as an ornamental tree. Its native habitat is a moist soil, although it adapts itself to drier situations. It is usually a short-lived tree and if a birch is desired, other species or horticultural varieties should be chosen.

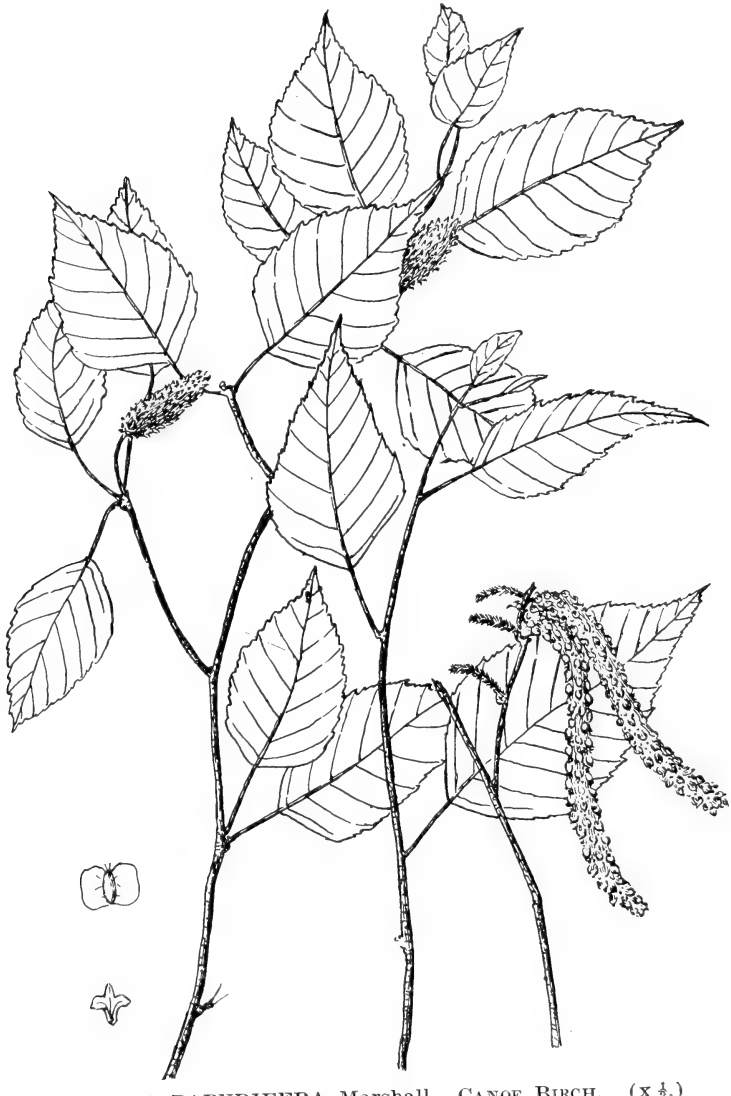
4. Betula papyrífera Marshall. BIRCH. Plate 38. Bark thin, creamy white, chalky, readily separating in thin layers; young twigs green, viscid, becoming reddish or dark brown at the end of the season and in a few years the characteristic white of the older branches; leaves ovate, 4-10 cm. (1½-4 inches) long, irregular toothed, gradually tapering at the apex, rounded, wedge-shaped or cordate at the base, dark green and smooth above, paler with hairs on the veins and dotted with conspicuous glands beneath, staminate catkins pendulous, 2 or 3 together, 5-10 cm. (2-4 inches) in length, scales fringed, mature pistillate catkins pendulous, 2-4 cm.

PLATE 37.



BETULA POPULIFOLIA Marshall. GRAY OR WHITE BIRCH (x $\frac{1}{2}$.)
(Bract and nut, x 2.)

PLATE 38.



BETULA PAPYRIFERA Marshall. CANOE BIRCH. (x ½.)
(Bract and nut, x 2.)

(¾-1½ inches) long and about 8 mm. (1/3 inch) thick, scales slightly hairy, the middle lobe acute, the two lateral lobes shorter, orbicular and diverging almost at right angles; nut oval, about 1.5 mm. (1/20 inch) long with wings twice as wide.

Distribution. Alaska and Labrador south to New York, northern Indiana, Colorado and Washington. In Indiana it has been noted only in Lake and Porter Counties. In favorable conditions in the range of its distribution it is a large tree, assuming a height of 30 m. (98 feet) and a diameter of more than a meter (39 inches). In our area it is a rare and small tree. This is the tree from which the Indians made their canoes and is frequently called the "canoe birch."

The published records of the distribution are as follows: Lake (Blatchley) and (Hill).

Additional records are: Lake and Porter (Deam).

Economic uses. Wood light, close-grained, strong and tough, light brown. Representative uses are spools, shoe-shanks, shoe pegs, tooth picks, wood bottles, etc. The greater supply is in Maine, where it is the principal wood industry. In Indiana the tree is so small and the supply so limited as to be of no commercial value.

Horticultural value. Sometimes used for ornamental planting. It is not long-lived, requires much light, is adapted to a moist or dry soil.

4. ÁLNUS. THE ALDERS.

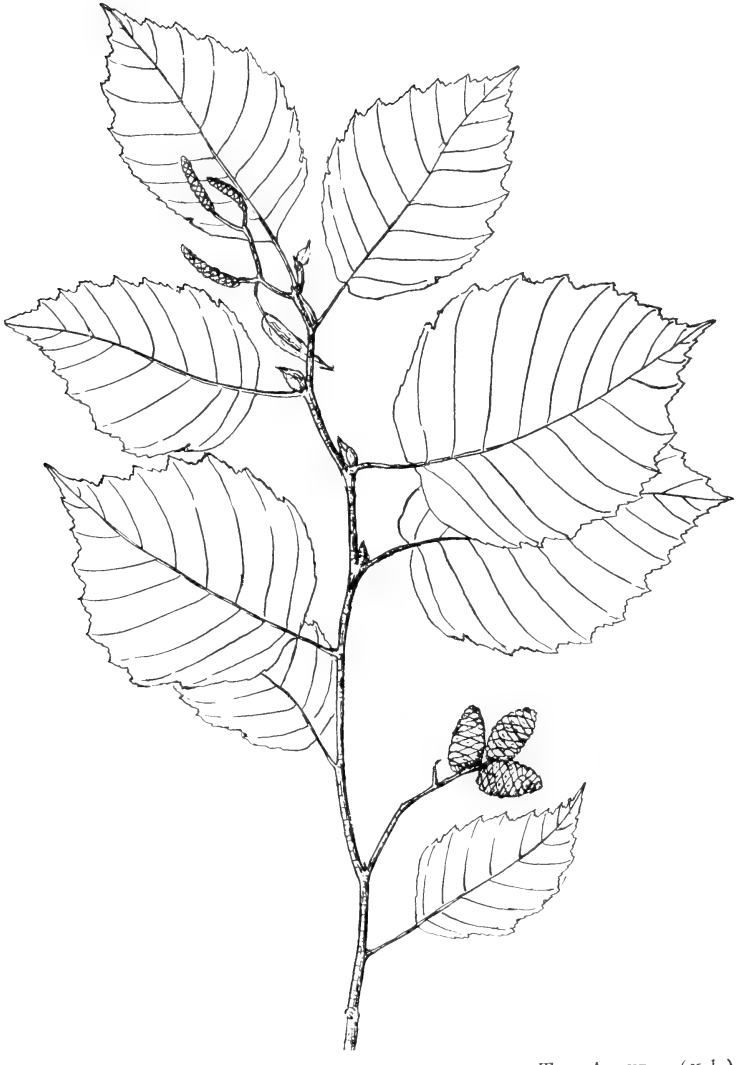
(From the Celtic words, *al*, near, and *lau*, the banks of a river.)

Bark astringent; leaves variously toothed or lobed; mature pistillate catkins oblong to ovoid, 1-2 cm. (⅜-¾ inch) long, becoming woody and remaining on the tree for several months. A small tree or usually shrub-like in our area.

Leaves sharply doubly serrate, the ends of the primary veins forming the apex of the larger teeth, glaucous and pubescent beneath ..... 1 A. incana.
Leaves singly serrate, pale green and pubescent beneath .. 2 A. rugosa.

1. Alnus incàna (Linnæus) Muenchhausen. TAG ALDER. SPECKLED ALDER. Plate 39. Bark reddish or bottle green with gray dots, whence its common name; leaves usually of a broadly oval type, short-pointed at the apex, widely rounded at the base, blade 4-10 cm. (1½-4 inches) long, 3-7 cm. (1¼-3 inches) wide, dark green and glabrous above, paler, glaucous and pubescent at least on the veins

PLATE 39.



ALNUS INCANA (Linnæus) Muenchhausen. TAG ALDER. (x ½.)

beneath; staminate catkins terminal, 2-7 cm. (¾-2¾ inches) long, pistillate catkins lateral, bent downward, at maturity resembling a small cone; scales thickened at the tip.

Distribution. Newfoundland and Saskatchewan south to Pennsylvania, and west to Iowa and Nebraska. In Indiana it has been noted only in the vicinity of Lake Michigan where it is locally frequent in low woods and low places between the dunes near the lake. It frequently attains a diameter of 1-1.5 dm. (4-6 inches) and a height of 9 m. (29 feet).

The published records of the distribution are as follows: Lake and Porter (Blatchley).

Additional records are: Lake (Umbach); Porter (Chase); Lake and Porter (Deam).

2. Alnus rugòsa (Du Roi) Sprengel. ALDER. Plate 40. Trunk fluted or angled, resembling *Carpinus*, bark thin, smooth or nearly so, grayish brown; bud scales thickly black resinous dotted; leaves ovate or oval, very short pointed or rounded at the apex, rounded or somewhat wedge-shaped at the base, rather regularly and minutely serrate, 4-11 cm. (1½-4½ inches) long, smooth and dark green above, lighter below, with more or less rusty pubescence beneath, especially along the veins, under surface of green leaves sufficiently resinous to adhere to paper if pressure is applied; staminate catkins 5-8 cm. (2-3 inches) long, 3-5 together, expanding early in the spring, pistillate catkins erect.

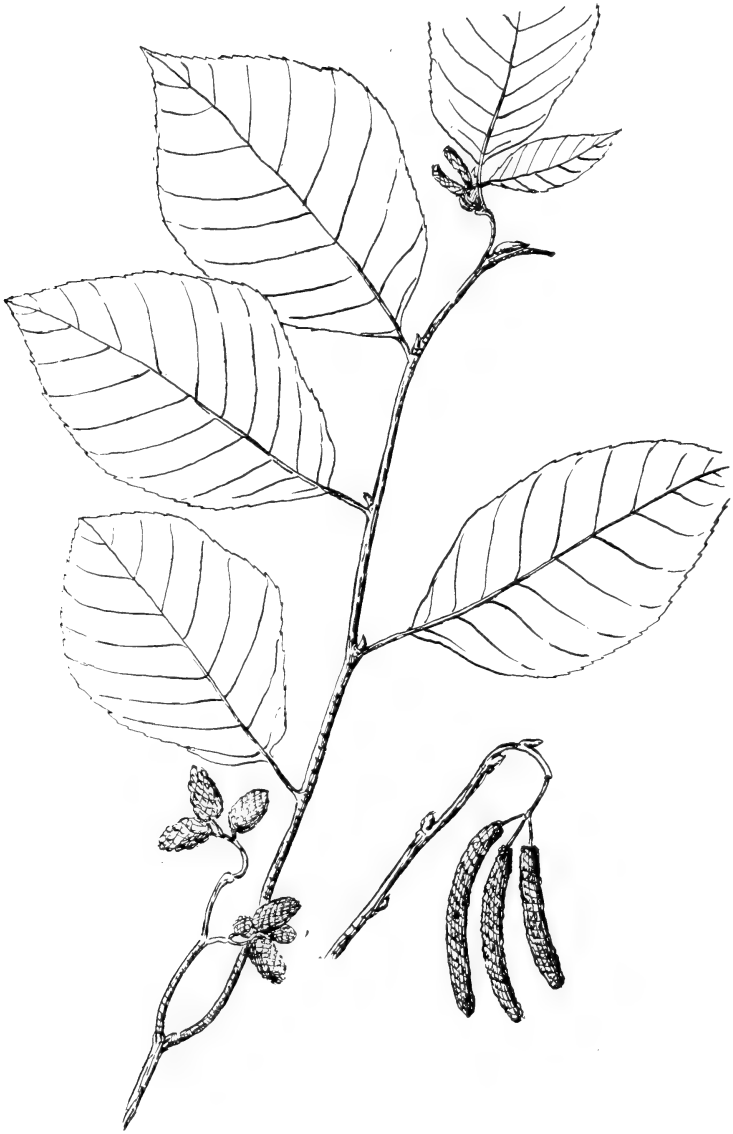
Distribution. Maine to Florida, west to Texas, rarely inland to Minnesota. In Indiana it is found in widely separated parts of the State. It is local in its distribution, usually growing in clumps in swamps or along the banks of streams. It is usually shrub-like, although it occasionally attains a diameter of 7 cm. (3 inches) and a height of 5 m. (16 feet).

The published records of the distribution are as follows: Clark (Baird and Taylor); Gibson (Schneck); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Coulter); Lake (Higley and Radden); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Posey (Schneck); Tippecanoe (Coulter).

Additional records are: Jefferson (Young); Monroe (Blatchley); Jackson and Starke (Deam).

Economic uses. Not of sufficient size or abundance to be of any commercial value.

PLATE 40.



ALNUS RUGOSA (Du Roi) Sprengel. ALDER. (x ½.)

PLATE 41.

FAGUS GRANDIFOLIA Ehrhart. BEECH (x ½.) (Nut, x 1.)

FAGÀCEÆ. THE BEECH FAMILY.

Trees with watery juice; leaves alternate, pinnately-veined; flowers of two kinds; fruit a 1-seeded nut. This is the most important family of trees occurring in the State.

Staminate flowers in heads on drooping peduncles; nuts triangular, inclosed in a woody husk armed with recurved prickles ..... 1 Fagus.
Staminate flowers in slender catkins; nuts not as above.
Nuts inclosed in a woody husk armed with numerous straight prickles ..... 2 Castanea.
Nuts seated in a scaly and woody cup ..... 3 Quercus.

1. FÀGUS. THE BEECH.

(From the Greek word *phago*, to eat, because the nuts were formerly used as food.)

Trees with pale smooth bark; buds long, acute, chestnut-brown; staminate flowers in globose heads, stamens 8-16, pistillate flowers 2-4 in a cluster in the axils of the upper leaves; nuts usually 2 in an oval shell, which opens to discharge the nuts.

Fagus grandifòlia Ehrhart. BEECH. RED BEECH. WHITE BEECH. YELLOW BEECH. Plate 41. Bark light to a dark gray; twigs reddish-brown the first year, turning to gray; leaves ovate to oblong-ovate, usually rather long taper-pointed, wedge-shaped to cordate at base, regularly and usually minutely serrate, the veins ending in the apex of the teeth, silky when young, at maturity becoming smooth above and nearly so beneath, blade 6-13 cm. (2½-5 inches) long; flowers appear in May; nuts 1-1.5 cm. (⅜-½ inch) long, triangular, reddish-brown, pubescent.

Distribution. Nova Scotia, Ontario and Wisconsin, south to the Gulf States and west to Texas. Found in all parts of Indiana, though not frequent in the prairie region of the northwestern part of the State. It is frequent to very common in almost all parts of the State on high ground. In point of number it ranks first of Indiana trees. It is usually associated with sugar maple, buckeye, ironwood, white ash, red oak, linden and yellow poplar. Among the hills in the southern part of the State the oak is the dominant stand on the south slope of the hills and the beech the dominant stand on the north side. In Jackson, Scott and some adjacent counties it adapts itself to wetter conditions and is found in the flats associated with sweet gum and pin oak. It grows to be a large tree in our area, reaching a height of 35 m. (115 feet) and a diameter of a meter (39 inches).

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Montgomery (Rose) and (Thompson); Putnam (Cook), (Grimes) and (MacDougal); Tippecanoe (Coulter) and (Dorner); Clark, Decatur, Delaware, Floyd, Gibson, Hancock, Hendricks, Jennings, Laporte, Madison, Monroe, Montgomery, Morgan, Owen, Porter, Wells (Deam).

Economic uses. Wood very hard, strong, usually tough, difficult to season, close-grained, takes a high polish, sap wood white, heart wood light or reddish-brown. Some trees are composed principally of white wood, hence the name "white beech", and are much tougher than those that are principally red wood, which are popularly known as "red beech". Our best botanists have failed to separate the two kinds of trees botanically. Used chiefly for building material, frame stuff, heading, staves and fuel.

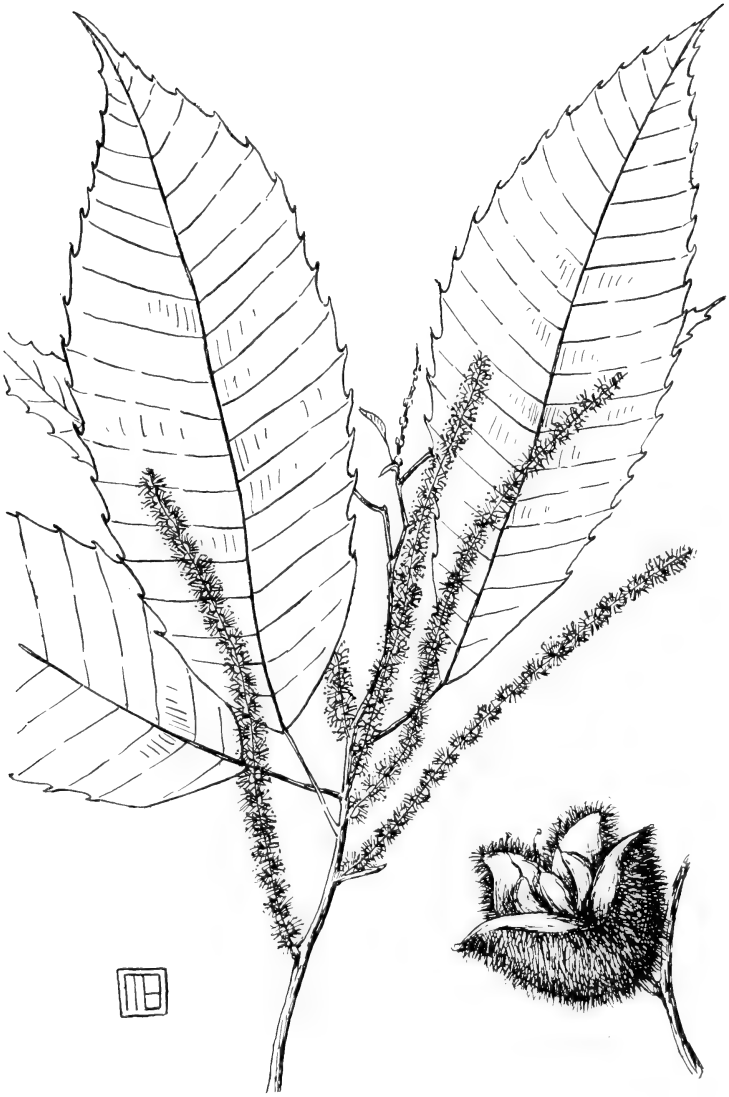
Horticultural value. Its dense shade, clean appearance of the limbs and trunk, slender branches which turn up at the extremities and freedom from disease and insects make this one of the most desirable trees for ornamental and shade tree planting. It is not easy to transplant and because it does not grow rapidly and straight it is not frequently used. When grown in the open it is not inclined to grow tall. It is best adapted to a moist, rich and well drained soil.

2. CASTÀNEA. THE CHESTNUT.

(Named from a town in Thessaly, famed for its chestnut trees).

Castanea dentàta (Marshall) Borkhausen. CHESTNUT. Plate 42. Bark of old trees deeply fissured, dark gray or brown, bark of young trees smooth; twigs at first hairy, soon smooth; leaves oblong-lanceolate, 1-3 dm. (4-12 inches) long, taper-pointed, wedge-shaped or obtuse at the base, coarsely serrate with incurved teeth, veins terminating in the teeth; flowers appear after the leaves in June or July, strong-scented, staminate aments terminal and from the axils of the lower leaves, 1-2 dm. (4-8 inches) long, pistillate flowers appear in clusters of 2-5 just below the staminate aments or in the

PLATE 42.



CASTANEA DENTATA (Marshall) Borkhausen. CHESTNUT. (x ½.)

axils of later leaves; fruit ripens in September or October, consists of 1-3 nuts, rarely 1 or 5, enclosed in a round, spiny burr, about 5-7 cm. (2-3 inches) in diameter; nuts flattened and edible.

Distribution. Maine, Ontario and Michigan south to Delaware and Tennessee and in the mountains to Alabama and west to Arkansas. In Indiana it is found only in the southern part of the State. Not known north of the 39th degree of latitude, except a few trees on the south bank of White River about two miles east of Anderson in Mound Park, which was a site of an Indian village. It is scattered in its distribution and occurs only in a few counties in any abundance. The greatest numbers are found in Clark, Crawford, Floyd, Jackson, Harrison and Washington counties. It is found on dry soil and is associated with black, white and scarlet oaks.

The published records of the distribution are as follows: Clark (Baird and Taylor), (Coulter) and (Smith); Crawford (Coulter); Decatur (Ballard); Delaware, Jay, Randolph and Wayne (Phinney); Floyd (Coulter); Gibson (Schneck); Harrison (Coulter); Jackson (Ridgway); Jefferson (Young); Knox (Coulter); Martin (Ridgway).

Additional records are: Posey (Wright); Clark, Floyd, Jackson and Washington (Deam).

Economic uses. Wood light, soft, not strong, checks and warps in seasoning, yellowish-brown and durable in contact with the soil. A large tree in our area, and formerly much used for rails because it split easily, and for fence posts and crossties on account of its lasting qualities in contact with the soil. The supply in this State is practically exhausted. Its principal uses are for fence posts, crossties, telegraph and telephone poles and lumber. The bark is rich in tannin and where available has been used in tanning. The nuts are edible and in the east are a profitable crop. The nut weevil usually destroys the nuts in this State. The leaves are extensively used as a decoction or infusion for the relief of whooping cough.

Horticultural value. In the forest the chestnut grows tall with a clean bole. In the open it develops a wide crown and does not grow tall. In its natural range it is one of the most desirable trees for ornamental and shade tree purposes. Usually the tree does not live to any great age if planted outside of its natural range. An objection to it is the litter made by the burrs of the fruit. This tree is not recommended for forest planting because a fungous bark disease has appeared in the east which threatens to kill all trees of this species.

3. QUÉRCUS. THE OAKS.

(From the Celtic, *quer*, fine, and *cues*, tree; in reference to the quality of the trees.)

The leaves of the Indiana species are deciduous; flowers appear in April or May, staminate flowers in slender pendulous catkins, the pistillate solitary or in clusters in a scaly bud-like cup; fruit an acorn which takes one or two years to mature, ripening in the autumn. The trees that mature their fruit the first year are classed as white oaks and those that mature them the second year are called red, black or bristle-tipped oaks.

The oaks are the longest lived of our native trees. They are peculiar in the amount of their annual growth, especially the white oaks. An examination of the annual rings of the oak will show that the rate of growth is nearly uniform from youth to old age. The slowest rate of growth will be found for the first five to twenty years. Almost all other trees show large annual rings in early years with a gradual decrease after the tree has fully matured With some trees the maximum growth rate is reached midway between youth and old age. The vitality of the acorn is short and nuts over a year old seldom, if ever, germinate. Nuts that are to be planted should be planted soon after they fall from the tree.

This is the largest genus of Indiana trees and furnishes some of our most valuable hardwoods. The bark of some species contains a large percentage of tannin, and formerly tan bark was an important article of commerce in the State. On account of their astringent properties, the bark, as well as the galls of some species are used in medicine.

The heavy fruiting of the oaks was an important item to the pioneer, who was accustomed to feed his swine on the nuts of the forest, which were known as "mast", of which the acorns formed the greater part.

Bark gray, more or less scaly; mature leaves never with bristle tips; fruit maturing the first year.
- *Leaves lyrate or sinuate lobed.
  - Mature leaves pale or glaucous and glabrous beneath. 1 Q. alba.
  - Mature leaves finely pubescent beneath.
    - Terminal scales of the cup not awned.
      - Pubescence on leaves beneath brownish; fruit nearly sessile; cup one-third to half as high as the ovoid acorn ..... 2 Q. stellata.
      - Pubescence on leaves beneath whitish; fruit stalked, cup nearly covering the depressed globose acorn ..... 3 Q. lyrata.

Terminal scales of the cup awned, forming a fringe around the cup, rarely wanting..... 4 Q. macroecarpa.
*Leaves with sharp or rounded teeth, sometimes somewhat lobed in No. 5.
Fruit peduncled.
Peduncles exceeding the petioles..... 5 Q. bicolor.
Peduncles equaling or shorter than the petioles.
Bark flaky..... 6 Q. Michauxii.
Bark close and furrowed..... 7 Q. Prinus.
Fruit sessile or on very short peduncles..... 8 Q. Muhlenbergii.
Bark dark, furrowed; leaves with bristle tips; fruit maturing the second year.
**Leaves more or less deeply lobed, the lobes or teeth conspicously bristle pointed.
Mature leaves green and smooth beneath, except tufts of hairs in the axils, somewhat regularly lobed.
Leaves lobed to about the middle, lobes wedge-shaped, broadest at the base; cup saucer-shaped; nut about 2 cm. (¾ inch) broad..... 9 Q. rubra.
Leaves lobed to beyond the middle, rarely a few not so deeply lobed, at least some of the lobes broadest at the apex.
Cup saucer-shaped, rarely enclosing the nut for more than 1/3 its length.
Leaves glossy above; cup about 1-1.5 cm. (about ½ inch) broad.....10 Q. palustris.
Leaves dull above; cup 1.5-2.5 cm. (about ¾ inch) broad.....11 Q. Schneckii.
Cup hemispheric or top-shaped, generally enclosing the nut for ½ its length.
Inner bark gray or reddish, scales of the cup closely appressed.
Cup brown, scales at maturity glabrous, glossy, acute, kernel white.....12. Q. coccinea.
Cup ashy, scales not glossy, hairy, blunt; kernel yellow.....13. Q. ellipsoidalis.
Inner bark orange, scales at the top of the cup loose.....14 Q. velutina.
Mature leaves with a gray or rusty pubescence beneath, generally irregularly lobed.....15. Q. falcata.
**Leaves entire or with few teeth, or 3-5 lobed above the middle.
Leaves entire, oblong, pointed at both ends.....16 Q. imbricaria.
Leaves obovate, 3-5 lobed above the middle, lobes rounded.....17 Q. marylandica.

1. Quercus álba Linnæus. WHITE OAK. Plate 43. Bark usually light gray, sometimes a very dark gray, not deeply fissured, flaky, especially on the upper part of the trunk and larger branches, sometimes the lower part of the trunk is more deeply fissured with the

ridges of the bark very firm, the wood of such trees is usually considered much tougher than those with a more flaky bark; twigs at first green, often tinged with red, hairy, becoming reddish-brown, smooth and glossy, covered with a glaucous bloom, finally becoming an ash gray; winter buds broadly ovate, blunt, reddish-brown, smooth, about 2 mm. (1/10 inch) long; leaves mostly obovate in outline, varying to oblong, 1-2 dm. (4-8 inches) long, with yellow midrib and prominent lateral veins, the margin very variable, usually with 7 lobes, sometimes with 3-9, lobes ascending, usually blunt and entire, sometimes with 1 or 2 secondary lobes, sinuses of the lobes rounded at the base, blades wedge-shaped at base, acute to rounded at the apex, reddish when they unfold, pubescent, becoming a bright green above, paler or glaucous beneath, smooth both above and below; flowers appear in May when the leaves are about one fourth grown; acorns sessile or sometimes stalked; nut ovoid to oblong, inclosed from ¼ to 1/3 of its length in the cup-shaped cup, 1.5-2 cm. (about 1 inch) across; scales of cup obtuse and woolly.

Distribution. Southern Maine, Ontario westward to Minnesota and southward to Florida and Texas. Found in all the wooded parts of Indiana.

The white oak is one of the largest trees that grows in the State. It is adapted to several kinds of soil and is frequent to very common in all situations in Indiana, except in low and poorly drained soil. It attains its greatest size in rich, moist and well-drained lowlands. In point of number it ranks second among Indiana trees. In the north-central part of the State it forms the principal stand on the clay ridges, which are popularly known as "white oak" ridges. The soil of these ridges is the poorest of the locality, except where there are black oak (*Quercus velutina*) ridges. In the northern counties where the ridges are composed of more sand and gravel, they are more frequently covered with a mixture of white and black oaks and about an equal number covered with a pure stand of each species. In the vicinity of Lake Michigan the white oak is rarer and the black oak is the prevailing species. In the central part of the State the white oak is frequent in moist rich woods where beech and maple are not the principal stand. In the southern counties it is frequently found in pure stands on the hills and slopes, and is more or less frequent on the lower slopes of all the hills. In this section the hills usually have white oak, black oak, beech, or maple for the principal stand. In the southwestern counties it is frequent in moist, rich and well-drained soil.

PLATE 43.

QUERCUS ALBA Linnæus. WHITE OAK. (x ½.) (Acorn x 1.)

[12—28415]

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor) and (Smith); Clay (Wilson); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Youse); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Montgomery (Rose); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Bartholomew, Blackford, Clark, Daviess, Delaware, Hamilton, Knox, Laporte, Posey, Steuben, Warren and Wells (Deam).

Economic uses. Wood heavy, hard, close-grained, tough, strong, durable and of a light brown color, sap wood lighter. It is the most valuable timber of America because of its wide range of uses. The fact of its adaptation to so many uses has so reduced the seemingly inexhaustible supply that now large trees are rarely seen. The principal uses are general construction, interior finish, cooperage, wagon and carriage stock, furniture, agricultural implements, crossties, posts, baskets and fuel. Millmen and lumbermen usually grade as white oak the following species: burr oak, swamp white oak, chinquapin oak, basket oak, post oak and overcup oak.

Horticultural value. Soil requirements as given above; hardy in all parts of the state; grows slowly; difficult to transplant, especially after it has attained some size. It is most successfully propagated by planting the seed on the site where the tree is expected to grow. The seed should be planted in the fall soon after it matures. In the work of reforesting it is advised to dibble in the seed, covering with earth to a depth of about twice its width. The seed may be broadcasted, but this method is attended with more elements of failure. When this method is employed the nuts are easily gathered by rodents, and germinated nuts may be unable to find a foothold in the ground. The distance apart the seed should be planted depends primarily on the quality of the seed and the attention the owner expects to give to the planting. It is usually planned to give each nut 3-4 square feet of space.

Quercus álba X Muhlenbergii. Plate 44. Bark of a white oak type, branchlets in October gray and somewhat pubescent; winter buds ovoid, blunt, reddish-brown, more or less gray pubescent;

PLATE 44.

QUERCUS ALBA X. MUHLENBERGII. (x ½.) (Acorns, x 1.)
Hybrid oak. A cross of the white and chinquapin oaks.

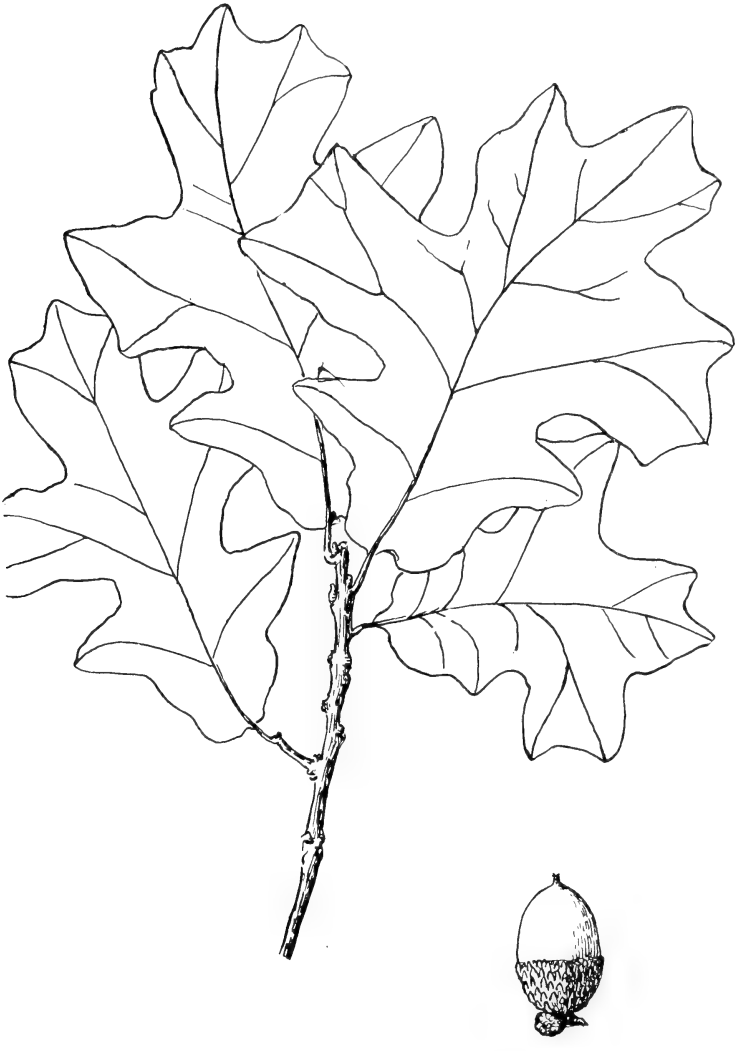
leaves obovate in outline, 6-12 cm. (2¼-4¾ inches) long, wedge-shaped at base, coarsely toothed and irregularly lobed, sinuses wide or narrow, lobes and teeth ascending except the lowest pair, lobes and teeth generally triangular, sometimes oblong, dark green above, paler and densely gray pubescent beneath; petioles 1.5-3 cm. (½-1¼ inches) long; acorns on stalks about 0.5 cm. (1/5 inch) long; nut ovoid, about 2 cm. (¾ inch) long, rounded or flat at the base, rounded at the apex, chestnut brown, pubescent near the summit, enclosed for 1/3 or more of its length in the thin saucer-shaped cup; cup rounded at the base, pubescent within; scales blunt, thickened on the back, brown, densely gray pubescent.

Distribution. This hybrid oak was discovered by E. B. Williamson in an open woods about 2 miles northwest of Bluffton, October 9, 1904. An effort was made to save the tree, but it was cut a few years afterward. The determination was made by George B. Sudworth and a specimen is deposited in the National herbarium. The tree was located on a slope, associated with *Quercus alba* and *Muhlenbergii*.

2. Quercus stellàta Wangenheim POST OAK. IRON OAK. SAND BURR OAK (Gibson County). Plate 45. Bark a light or medium gray, resembling that of the white oak, fissured, deeply so on old trees, tight not scaly on the trunks; branchlets stout, brownish-woolly at first, becoming smooth, gray to dark brown after the first year; winter buds broadly ovate, blunt or acute, hairy; leaves on stalks about 12 mm. (½ inch) long, obovate in outline, usually 1-1.5 dm. (4-6 inches) long, about 1 dm. (4 inches) across at the widest point, wedge-shaped at the base, usually 5-lobed, the two lower lobes small with rounded or pointed ends, the two upper and terminal lobes larger and frequently with 2-3 secondary lobes, the ends of the lobes usually rounded, sometimes with rather sharp points, sinuses oblique, usually wide and with rounded bases, leaves thick and firm, dark green, shiny and with a few scattered hairs above, densely covered with grayish hairs beneath; fruit sessile or short stalked, often in pairs or clusters; nut ovate or ovate-oblong, about 1.5 cm. (⅝ inch) long, hairy at the apex, enclosed by the cup for about half its length; cup hemispheric, somewhat elongated at the base; scales rusty pubescent, acute at the top and obtuse at the base of the cup.

Distribution. In uplands from Massachusetts and New York to Florida and west to Missouri and Texas. In Indiana it is rare and local. It has been reported from Lake County in the northern part of the State where its appearance must be regarded as excep-

PLATE 45.



QUERCUS STELLATA Wangenheim. POST OAK. (x ½.) (Acorn, x 1.)

tional. It has again been reported from Miami and Hamilton counties. In Gibson and Posey counties it is more or less frequent on the eastern border of the Wabash flats on the dune sands, which vary in width from ¼ to 4 miles. In Point Township in Posey County, on the high ground, it is the most abundant oak and grows to be a large tree. In other parts of the State where found it may be common on a small area and then not appear again for miles. It is usually found on sterile hill tops associated with the white and black oaks. In our area, except Gibson and Posey counties, it is a medium sized tree, seldom attaining a height of 25 m. (80 feet) or a diameter of 8 dm. (32 inches), usually about half this size.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Gibson (Schneck); Hamilton (Wilson); Lake (Higley and Radden); Miami (Gorby); Vigo (Blatchley).

Additional records are: Clark and Posey (Deam).

Economic uses. Wood heavy, hard, tough, close-grained and durable in contact with the soil. Used principally for crossties, fence posts, wagon stock and construction material.

3. Quercus lyràta Walter. OVERCUP OAK. BURR OAK. Plate 46. Bark on the trunk deeply fissured, ridges large, surface somewhat scaly, resembling the white oak in color; twigs reddish-green and hairy at first, becoming smooth and gray or light brown; winter buds ovoid, blunt, more or less hairy, about 3 mm. (⅛ inch) long; leaves obovate-oblong, 6-20 cm. (2½-8 inches) long, pointed at the apex, wedge-shaped or narrowed at the base, divided into 5-9 lobes, sinuses shallow or deep and rounded, the lobes horizontal or ascending, the terminal one generally the largest and bearing two lateral lobes, the two lobes below the terminal are generally the longest, leaves a bronze-green and hairy on both surfaces when they unfold, becoming at maturity smooth and dark green above, paler and pubescent below, usually silvery beneath, petioles 2-20 mm. (⅛-⅞ inch) long; acorns sessile or on short stalks which are sometimes 2 cm. (¾ inch) long and are generally near the plane of the base of the cup; nut depressed, globose, about 2 cm. (¾ inch) long, pubescent at the top, inclosed almost entirely in the rather thin cup which is reddish-brown and pubescent within, scurfy pubescent and light gray without, frequently splitting at the top; scales pointed on the back, developing a tubercular ridge, which is large and very prominent at the base of the cup, gradually becoming smaller toward the top.

PLATE 46.

QUERCUS LYRATA Walter. OVERCUP OAK. (x ½.) (Acorn, x 1.)

Distribution. Maryland to Missouri, south to Florida and west to Texas. In Indiana it has been definitely noted only in Gibson and Knox counties, where Robert Ridgway says it is common in swamps along the Wabash and its tributaries. Several specimens of this species were in the herbarium of Dr. Schneck which were taken in Illinois just west of the above named counties. It is a large tree resembling the burr oak and is not generally separated from it.

The published records are: Posey (Wright).

Additional records are: Posey (Deam).

Economic uses. Wood and uses similar to that of the white oak.

4. Quercus macrocárpa Michaux. BURR OAK. MOSSY CUP OAK. Plate 47. Bark on the trunk gray to a brown, deeply fissured; the branchlets on young trees developing corky wings which are usually wanting on mature trees; twigs at first hairy and yellowish, becoming at the end of the season smooth or nearly so and a light gray or light brown; winter buds ovoid, round or rather acute at the apex, 3-5 mm. (1/8-1/5 inch) long, reddish-brown, the scales nearly smooth with ciliate margins; leaves obovate-oblong in outline, 1-3 dm. (4-12 inches) long, narrowed at the base, rounded or pointed at the apex, 5-9 lobed, sinuses shallow or deep, lobes very variable, some leaves are barely lobed while others are cut to the midrib, the terminal lobe usually the broadest, leaves bronze-green when they appear, becoming firm at maturity, glabrous and a dark green above, whitish beneath and covered with a woolly pubescence; petioles 1-3 cm. (3/8-1¼ inches) long; acorns usually solitary, sometimes in pairs or in clusters of 3, usually on short stalks, sometimes on stalks 3 cm. (1¼ inches) long; nut very variable in size and shape, ovoid to oblong, 2-3 cm. (¾-1¼ inches) long, hairy at the apex, inclosed from 1/3 to almost its entire length in the deep cup-shaped cup; cup rounded or gradually tapering at the base, hairy within; scales woolly, at the base thin or thickened and rounded at the apex, those at the top drawn to a long awn and forming a fringe border around the cup.

Distribution. Nova Scotia to Manitoba south to Georgia and west to Texas and Wyoming. Frequent to common in moist rich soil throughout Indiana. In a few of the hilly counties bordering the Ohio River it does not occur so frequently. It is generally found along or near the banks of streams. In point of number, size, and value it ranks as one of the most valuable trees of the State.

PLATE 47.

QUERCUS MACROCARPA Michaux. BURR OAK. (x $\frac{1}{2}$.) (Acorns, x $\frac{1}{2}$.)

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod); Clark (Baird and Taylor); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Jefferson (Clapp); Posey (MacDougal and Wright); Putnam (Grimes); Tippecanoe (Coulter) and (Dorner); Blackford, Delaware, Gibson, Knox, Laporte, Posey, Starke, Vermillion and Wells (Deam).

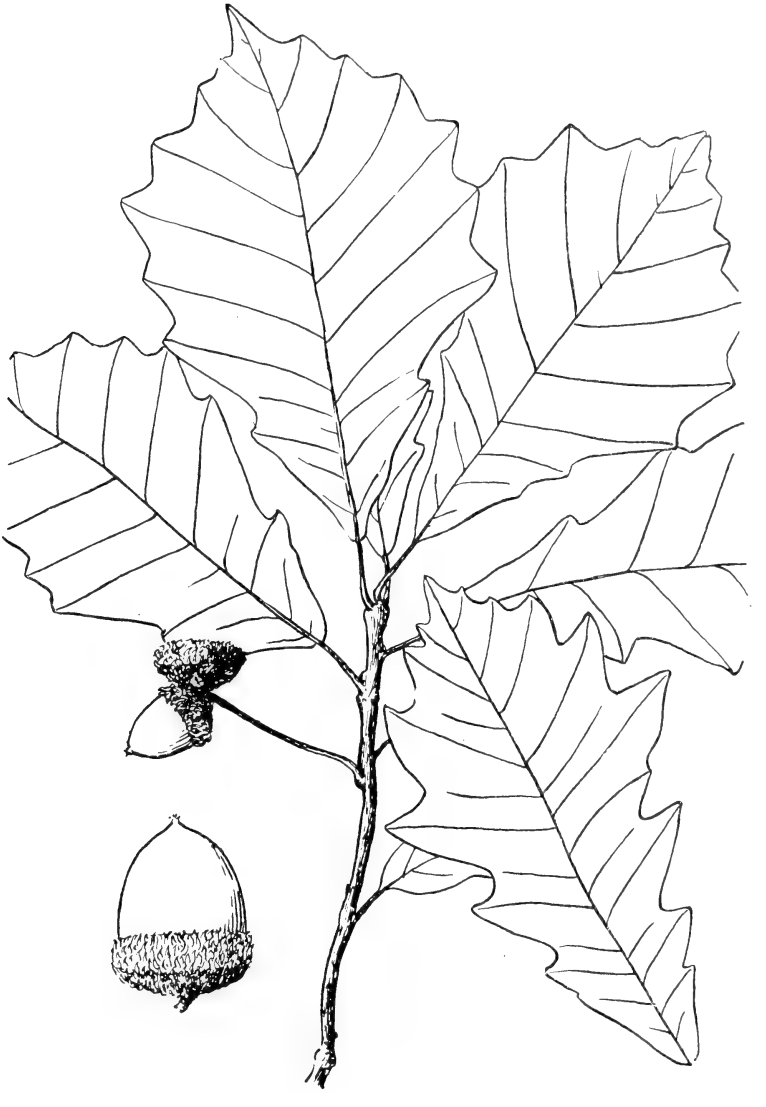
Economic uses. Wood and uses similar to that of the white oak.

5. Quercus bícolor Willdenow. SWAMP WHITE OAK. Plate 48. Bark on the trunk deeply and irregularly fissured, sometimes on old trees separating and curling up at the side into long plates, which seldom fall off, gray or reddish-brown; branchlets green, slightly pubescent when they appear, becoming glabrous and a purplish-brown by the end of the year; winter buds ovoid, blunt, brown, about 3 mm. (⅛ inch) long, scales somewhat hairy, leaves on petioles 5-20 mm. (¼-⅞ inch) long, obovate to oblong-obovate, 0.7-2 dm. (3-8 inches) long, rounded or pointed at the apex, wedge-shaped or narrowly rounded at the base, coarsely round toothed or somewhat pinnatifid, teeth glandular tipped, primary veins running to the points of the teeth, bronze-green and hairy on both surfaces when they unfold, at maturity becoming thick, dark green, smooth and shiny above, whitish with woolly hairs beneath; acorns usually in pairs on stalks 2.5-8 cm. (1-3 inches) long; nut ovoid, 2-2.5 cm. (¾-1⅛ inches) long, somewhat hairy near the summit, inclosed for fully one third its length in the shallow cup-shaped cup which is pubescent within; scales acute, closely appressed except the tips which sometimes form a fringe-like border at the top, scurfy pubescent and frequently tuberculate; kernel sweetish.

Distribution Maine to Michigan and eastern Iowa, south to Florida and west to Texas. Frequent throughout Indiana in wet woods, usually associated with the burr oak from which it is not commonly separated. It grows to be a large tree, although as a rule not quite so large as the burr oak.

The published records of the distribution are as follows: Carroll (Thompson); Cass (Coulter); Clark (Baird and Taylor) and

PLATE 48.



QUERCUS BICOLOR Willdenow. SWAMP WHITE OAK. (x ½.)
(Acorn, x 1.)

(Smith); Clay (Wilson); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Youse); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley).

Additional records are: Knox (Schneck); Monroe (Mottier); Putnam (Grimes); Tippecanoe (Coulter); Blackford, Kosciusko, Noble, Porter, Posey, Starke, Warren and Wells (Deam).

Economic uses. Wood and uses similar to that of the white oak.

6. Quercus Michaúxii Nuttall. COW OAK. BASKET OAK. Plate 49. Bark gray, flaky; twigs stout, dark green and hairy, soon becoming smooth, reddish-brown and finally gray; winter buds ovoid or oval, acute, reddish, somewhat hairy, about 6 mm. (¼ inch) long; leaves on petioles 1-3 cm. (⅜-1¼ inches) long, obovate or oval, 7-18 cm. (3-8 inches) long, short taper-pointed at the apex, wedge-shaped or narrowly rounded at the base, margin coarsely and deeply toothed, the teeth rounded, leaves hairy on both surfaces when they unfold, at maturity becoming firm, smooth and dark green above, paler beneath and remaining densely covered with whitish hairs; acorns sessile or nearly so, solitary or in pairs; nut ovoid, 2-3 cm. (1-1¼ inches) long, hairy at the apex, enclosed for about half its length by the thick and deeply cup-shaped cup which is somewhat flat at the base and pubescent within; scales mostly acute, pubescent and much thickened on the outer face.

Distribution. Delaware south to Florida and west to Missouri and Texas. In Indiana it is found only in a few counties along the lower Wabash. Robert Ridgway says it is common in rich bottom lands along the lower Wabash. In size and habit it much resembles the swamp white oak for which it is often mistaken.

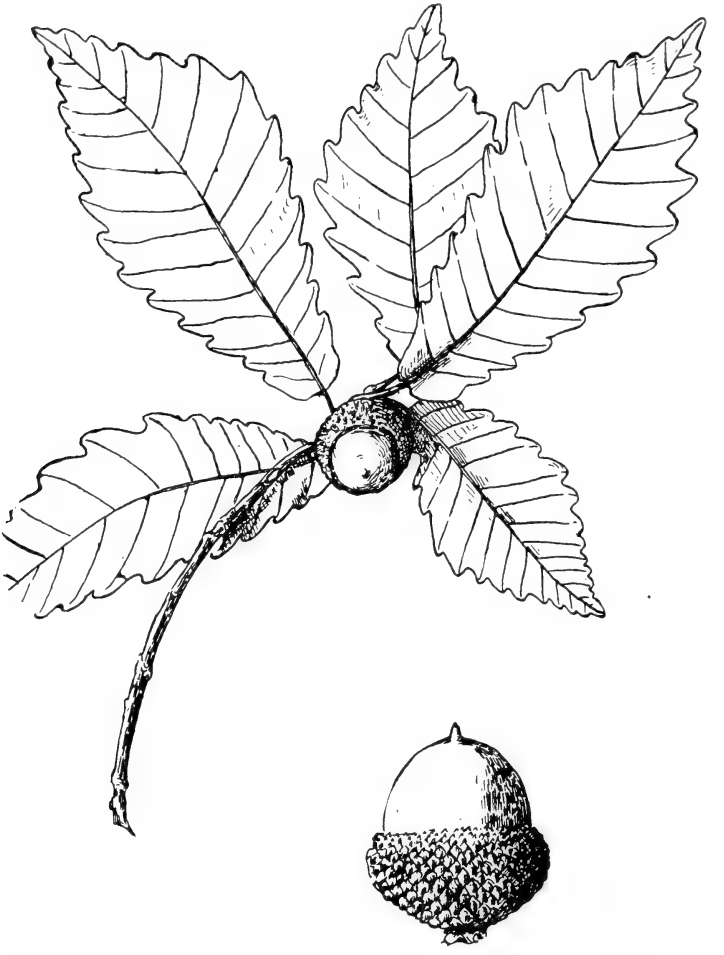
The published records of the distribution are as follows: Gibson (Ridgway); Knox (Ridgway) and (Thomas).

Additional records are: Gibson (Schneck).

Economic uses. Wood similar to the white oak and the supply so limited as to be of little commercial importance.

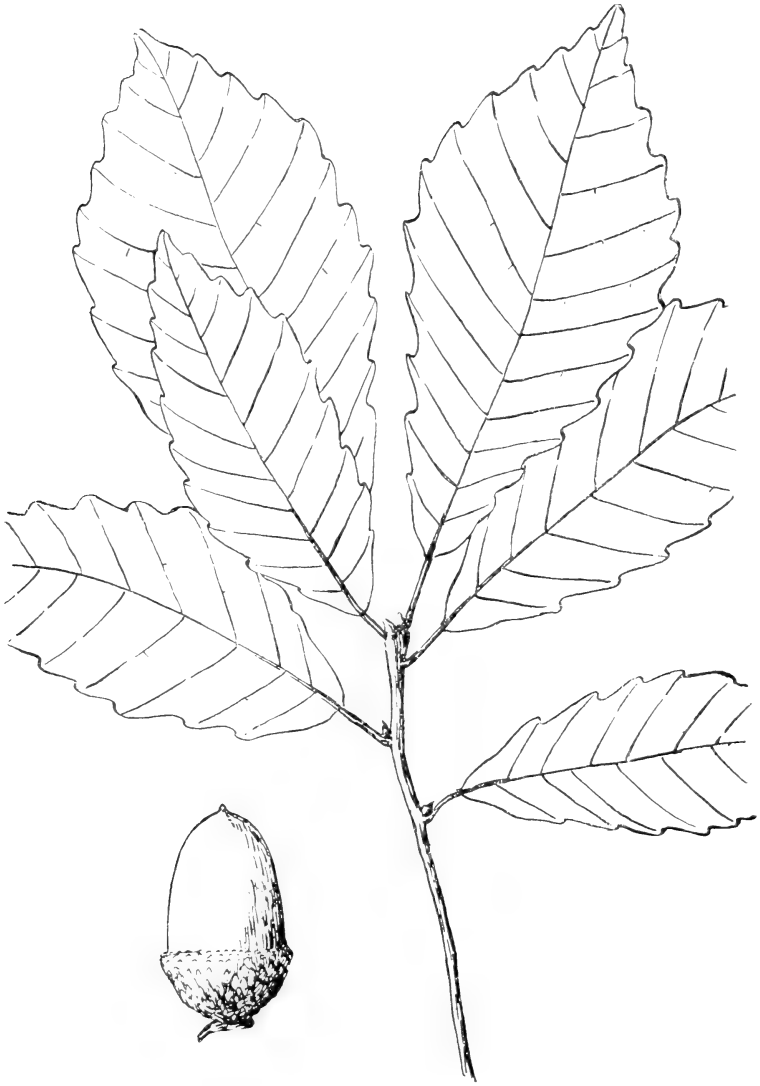
7. Quercus Prìnus Linnæus. CHESTNUT OAK. TANBARK OAK. Plate 50. Bark on the trunk, deeply fissured, the furrows wide and ridges continuous, dark gray brown or nearly black, smooth on the small branches; twigs purplish green, usually nearly smooth, turning to a gray, reddish or dark brown; winter buds ovate, taper-pointed, about 7 mm. (¼ inch) long, light brown, scales blunt,

PLATE 49.



QUERCUS MICHAUXII Nuttall. Cow Oak. (x ½.) (Acorn, x 1.)

PLATE 50.



QUERCUS PRINUS Linnæus. CHESTNUT OAK. (x ½.) (Acorn, x 1.)

hairy and ciliate on the margins; leaves obovate to lanceolate, 1-2 dm. (4-8 inches) long, taper-pointed, rarely rounded at the apex, wedge-shaped, rounded or heart shaped at the base, margins coarsely round toothed, almost glabrous above and densely pubescent beneath when they appear, becoming at maturity firm, smooth and a dark green above and grayish pubescent beneath with prominent lateral veins; petioles 1-3 cm. (⅜-1¼ inch) long; acorns on short, stout stalks, usually about 12 mm. (½ inch) long, solitary or in pairs; nut ovoid or oblong ovoid, usually taper-pointed, sometimes depressed at the apex, 2-3 cm. (¾-1⅛ inch) long, hairy at the summit, enclosed for about a third of its length in the shallow cup-shaped cup; cup tapering at the base and hairy within; scales rather loose, thickened on the back, reddish-brown and pubescent; kernel sweetish.

Distribution. Maine to Ontario, south to Alabama and Tennessee. It is believed that in Indiana it is confined in its distribution to the knob area of the south central part and extending as far north as Brown County. It is frequent or common where it occurs and in Clark, Floyd, Scott and Washington counties it is generally associated with Pinus virginana.

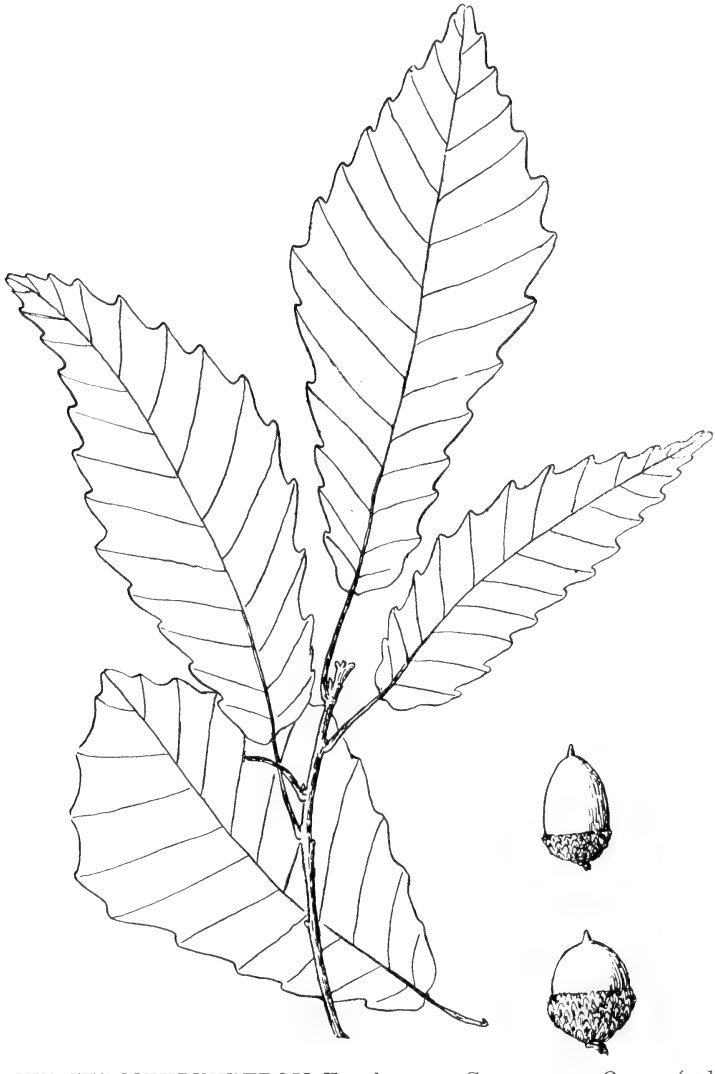
The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Franklin (Meyncke); Gibson and Posey (Schneck)*; Hamilton (Wilson)**; Miami (Gorby)**; vicinity of New Albany (Clapp); Tippecanoe (Cunningham)***; Wayne (Petry and Markle)****.

Additional records are: Clark (Deam).

8. Quercus Muhlenbérgii Engelmann. CHINQUAPIN OAK. SWEET OAK. YELLOW OAK. TANBARK OAK. Plate 51. Bark on old trunks not thick, usually close and broken up on the surface into small scales, on some trees the bark separates in large flakes, usually a light gray; sometimes a dark gray; twigs at first green tinged with red, hairy, becoming smooth and gray; winter buds ovate, acute, about 5 mm. (3/16 inch) long, reddish-brown, blunt and more or less hairy; leaves on petioles 1-3 cm. (⅜-1¼ inches) long, blades very variable, oblong-lanceolate to broadly obovate, 0.5-2 dm. (2-8 inches) long, usually taper-pointed, sometimes rounded, wedge-shaped, narrowed or sometimes slightly cordate at the base, margins coarsely and regularly toothed, primary veins straight prominent and ending in a gland in the points of the teeth, teeth in-

*Dr. Schneck in his notes says this reference should read *Quercus Michauxii* Nuttall.
**It is believed these records are based on broad leaf forms of *Quercus Muhlenbergii*.
***Should be referred to *Quercus Muhlenbergii*. Acad. Science 1901: page 300.
****No doubt this is *Quercus Muhlenbergii*.

PLATE 51.



QUERCUS MUHLENBERGII Engelmann. CHINQUAPIN OAK. (x ½.)
(Acorns, x 1.)

curved, leaves hairy above and below when they unfold, becoming at maturity thick, smooth and bright green above, paler and pubescent beneath, sometimes silvery pubescent below; acorns sessile or nearly so, solitary or in pairs; nut ovate or oval, 1.5-2 cm. (½-¾ inch) long, pubescent at the summit, enclosed for ¼-½ its length in a thin, cup-shaped, light or silvery gray cup which is pubescent within and hoary pubescent without; scales acute or somewhat blunt, thickened at the base; kernel sweet and edible.

This oak has been the subject of much study on account of the great variation of its leaves and fruit. On some trees the leaves from the top of the tree will be very thick, narrow, with long, sharp and incurved teeth, while the leaves from the lower branches will be rather thin, broadly obovate and with short and almost straight teeth. It has not been noted that the depth of the cup varies to any great extent on the same tree, but on some trees the cups are very shallow with oblong nuts, while on other trees the cups are deep and with ovoid nuts. As a rule the acorns with a shallow cup are smaller than those with the deep cup. Specimens with the broad leaves and deep cups have led some to call the tree chestnut oak (*Quercus Prinus*), from which it may easily be distinguished by the bark on the trunk of the tree. The bark on the chestnut oak is deeply furrowed and in color resembles the red oak group of oaks.

Distribution. Vermont to Minnesota, south to Florida and west to Texas. Found in all parts of Indiana. In the northern part it is usually found along the banks of streams, where it is often frequent. At a distance from the streams and lakes it is generally quite rare. In the western and southwestern parts it is generally frequent along the dry banks of streams and on gravelly or clayey hills. In the southern part of the State it becomes more abundant, and is often frequent or common along the bluffs of streams and on the limestone knobs. In our area in good soil it is a large tree.

The published records of the distribution are as follows: Bartholomew and Brown (Elrod); Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor); Dearborn (Collins); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jackson (Elrod); Jay (M'Caslin); Jefferson (Coulter) and (Young); Kosciusko (Clark); Lake (Higley and Radden); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod).

[13—28415]

Additional records are: Crawford and Gibson (Schneck); vicinity of New Albany (Clapp); Posey (Wright); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter) and (Dorner); Allen, Brown, Decatur, Franklin, Hendricks, Jennings, Knox, Marion, Morgan, Posey, Sullivan, Warren and Wells (Deam).

Economic uses. Wood heavy, hard, strong, close-grained, seasons with some difficulty. Uses same as that of white oak.

9. Quercus rùbra Linnæus. RED OAK. Plate 52. Bark on young trees and on the small branches of old trees smooth and light gray, becoming on old trunks rather regularly and coarsely fissured, ridges rounded, furrows usually not deep, dark gray; branchlets at first green and hairy, soon becoming smooth and a reddish-brown by the end of the season, and in two or three years gray; winter buds ovoid, pointed, the terminal at fruiting time about 6 mm. (¼ inch) long, reddish or chestnut brown, the inner scales hairy, and the outer more or less hairy on the margins; leaves oblong or obovate, 8-22 cm. (3-9 inches) long, generally wedge-shaped at the base, sometimes truncate or rarely slightly cordate, divided into 5-11 lobes, commonly 9, lobes generally extending about half way to the midrib, lobes wedge-shaped, tapering from the base and mostly 3-toothed at the apex and tipped with long bristles, hairy when they unfold, becoming smooth and a dull dark green above, and smooth or with tufts of hairs in the axils of the veins and a yellow-green beneath; petioles 2.5-5 cm. (1-2 inches) long; acorns solitary or in pairs, sessile or on short stalks; nut ovoid, 2-2.5 cm. (¾-1 inch) long, flat at the base, rounded at the apex, gray or reddish-brown, more or less pubescent, especially at the apex, enclosed for about ¼ its length in a shallow saucer-shaped cup; cup flat at the base, rarely somewhat tapering; scales blunt, light or reddish-brown, the margins a darker and reddish-brown, covered more or less with a grayish pubescence.

Distribution. Nova Scotia and Minnesota, south to Florida and west to Kansas. It is more or less frequent or common throughout Indiana in moist rich woods and along streams. It is the largest and most valuable of the biennial oaks.

The published records are as follows: Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor) and (Smith); Clay (Wilson); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp);

PLATE 52.

QUERCUS RUBRA Linnæus. RED OAK. (x ½.) (Acorn, x 1.)

Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Jennings, Steuben and Wells (Deam).

Economic uses. Wood heavy, hard, strong, close-grained, light reddish-brown and sap wood thin. Used principally for building material, finishing lumber, car and wagon stock and heading.

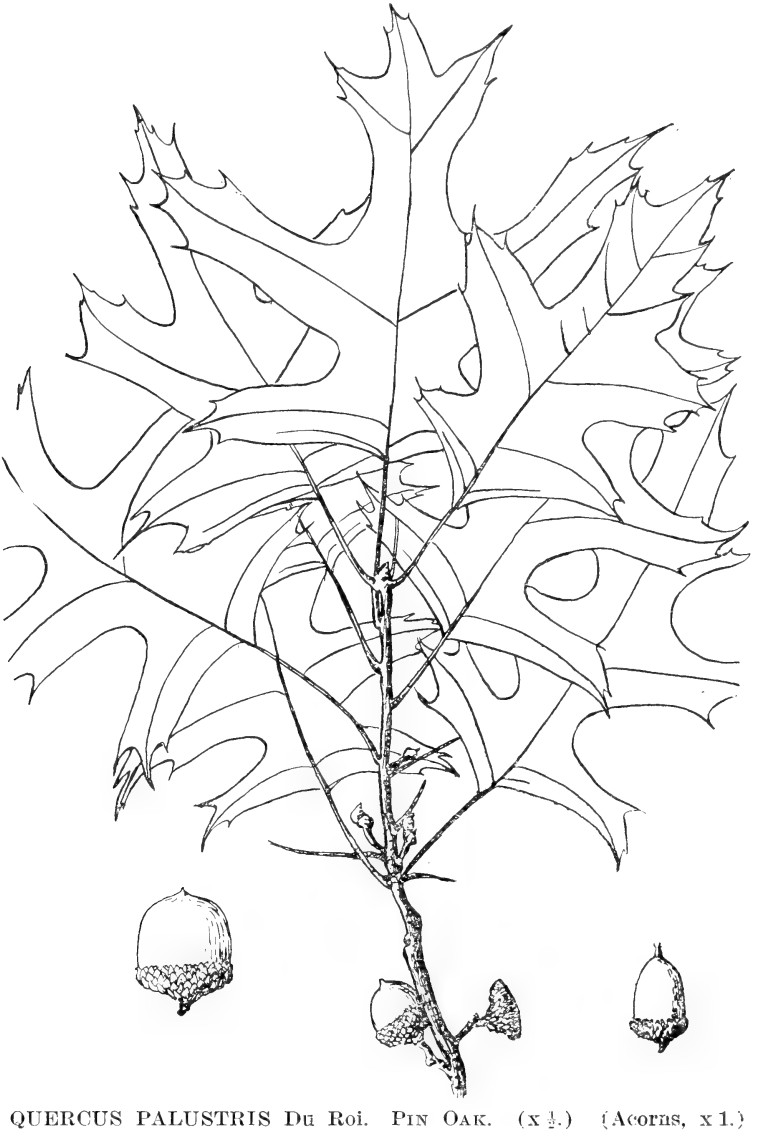
Horticultural value. The red oak is one of the most desirable of our oaks for shade and ornamental purposes. It is adapted to a moist, rich soil, grows rapidly, branches large and ascending, has a clean appearance and is generally free from injurious pests.

10. Quercus palústris Du Roi. PIN OAK. SWAMP OAK. WATER OAK. Plate 53. Bark on mature trunks close with broken, shallow fissures, bark on small trees and branches smooth, from a gray to a dark brown in color; shoots at first hairy and reddish, becoming smooth and a dark reddish brown by the end of the season; winter buds ovate, taper-pointed at the apex, about 3 mm. (⅛ inch) long, scales blunt, light brown, nearly smooth, margins much broken and often ciliate; leaves ovate, oval to obovate in outline, 6-15 cm. (2½-6 inches) long, acute at the apex, truncate or wedge-shaped at the base, deeply divided into 5-7 lobes, sinuses wide and rounded at the base, the lobes varying from triangular to obovate in outline and sometimes falcate, hairy and reddish when they first appear, becoming thin, smooth, shiny and dark green above, paler and smooth beneath except for the tufts of brownish hairs in the axils of the principal veins; petioles 2-5 cm. (¾-2 inches) long; acorns sessile or nearly so, solitary or in clusters; nut subglobose or ovoid, about 12 mm. (½ inch) long and about as wide, the ovate type about half as large and sharp-pointed at the apex, hairy, enclosed about ¼ its length in the saucer-shaped cup; cup usually nearly flat on the bottom, sometimes slightly taper-pointed at the base, the ovate type of fruit always with the tapering base, with a few hairs on the inside; scales blunt, reddish-brown and hairy except on the darker colored margins.

In all our area but one specimen has been noted that has the small ovate and sharp-pointed acorns. It was located in Wells County and has been destroyed. Dr. Geo. Engelmann says this form is found in the vicinity of St. Louis.

Distribution. Massachusetts and Michigan, south to Tennessee and west to Missouri. Found throughout Indiana. Infrequent in

PLATE 53.



QUERCUS PALUSTRIS Du Roi. PIN OAK. (x ½.) (Acorns, x 1.)

the northern tier of counties, soon becoming frequent farther south. It is more or less frequent in the remaining part of the State, becoming somewhat common in the lower Wabash bottoms and in the "flats" in the southern counties. It prefers wet woods, borders of swamps and ponds and is rarely found in dryer situations. It is usually associated with the red oak, the pin oak taking the more moist locations. In the northern part of the state it is most commonly associated with the red, burr and swamp white oaks, soft maples, water elm and black ash. In the southern part with the sweet gum, red, burr and swamp white oaks, soft maples and water elm. Along the well drained banks of streams the red oak may be frequent and the pin oak rare or wanting, while at the same time it is common in near by wet woods or sloughs.

In all our area it is a medium or large tree. It is tardy in the natural pruning of its lower branches, and when the dead branches break off they usually do so at some distance from the trunk. The many stumps of the dead branches which penetrate to the center of the tree have given it the most common name pin oak.

The published records of the distribution are as follows: Carroll (Thompson); Cass (Coulter); Clark (Smith); Clay (Wilson); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Clark); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley).

Additional records are: Posey (Wright); Putnam (Grimes); Tippecanoe (Coulter); Gibson, Posey, Sullivan and Wells (Deam).

Economic uses. Wood and uses similar to that of the red oak.

Horticultural value. For street and ornamental planting it is the most desirable of all the oaks. It is adapted to a moist soil, grows rapidly, a medium sized tree, produces a dense shade and in the open develops a pyramidal crown. Like the other oaks it is somewhat difficult to transplant on account of its large tap root. For this reason in planting oaks small seedlings should be used.

11. Quercus Schnéckii Britton. RED OAK. (*Quercus texana* Buckley). Plate 54. Bark of young trees smooth, becoming on old trees dark brown tinged with red, fissured, ridges flat, furrows usually not deep and wide; branchlets at first greenish and hairy, becoming reddish and finally smooth and a light brown; winter buds broad or narrow ovoid, the terminal ones at fruiting time about 5 mm. (1/5 inch) long, rather blunt at the apex, scales light

PLATE 54.

QUERCUS SCHNECKII Britton. RED OAK. (x ½.) (Acorns, x 1.)

brown, glabrous or nearly so; leaves ovate to obovate in outline, generally 8-18 cm. (3-7 inches) long, generally truncate at the base, sometimes wedge-shaped, 5-9 lobed, the lobes extending more than half way to the midrib, the middle lobes generally 1½ or more times as long as the undivided part of the leaf, subtended by these lobes, usually 2-3 times as long, lobes oblong, wedge-shaped or widest at the apex, sinuses variable and rounded at the base, some of the lobes somewhat divided at the apex and ending in several sharp teeth, at maturity bright green, shiny and smooth above, paler or yellow-green and smooth beneath except for tufts of brown hairs in the axils of the primary veins; petioles generally 2-5 cm. (1-2 inches) long; acorns solitary or in pairs, sessile or nearly so; nut ovoid, those of the northern part of the State about 17 mm. (⅝ inch) long and nearly as wide, those of the lower Wabash Valley about 21 mm. (¾ inch) long and somewhat narrower, reddish-brown, covered more or less with gray hairs, inside of shell densely covered with very pale brown hairs, enclosed for about 1/3 its length in the deeply saucer-shaped cup; cup generally tapering at the base, sometimes rounded or nearly flat; scales blunt, their margins thin, broken, sometimes the end tinged with red, covered or nearly so with gray scales or hairs, giving them a gray woolly appearance.

Distribution. Iowa and northern Indiana south to Florida and west to Texas. The distribution in Indiana has not been determined. In Wells County it is associated with the red oak and is equally abundant. According to Ridgway and Schneck, it is frequent in the lower Wabash bottoms and to a great extent supplants the red oak. It is believed that it is more or less frequent along the Wabash and its tributaries.

This species so closely resembles *Quercus rubra* that it is not commonly separated from it. It may generally be distinguished by the leaves being deeper lobed and by its smaller fruit. In Wells County the fruit is generally ¼ smaller than *Quercus rubra* and nearly the same shape. In the Lower Wabash bottoms it is generally about the same size and somewhat longer.

The published records of the distribution are as follows: Bartholomew (Elrod); Gibson, Knox, Posey and Vermillion (Schneck); Knox (Ridgway).

Additional records are: Posey and Wells (Deam).

Economic uses. Wood similar and uses the same as that of the red oak.

PLATE 55.

QUERCUS COCCINEA Muenchhausen. SCARLET OAK. (x ½.)
(Acorn, x 1.)

12. Quercus coccínea Muenchhausen. BLACK OAK. RED OAK. SCARLET OAK. Plate 55. Bark of the trunk dark brown, irregularly fissured, bark of the twigs smooth and reddish-brown, inner bark red; winter buds ovoid, about 7 mm. (¼ inch) long, somewhat blunt at the apex, reddish-brown, more or less hairy, especially near the apex; leaves oval or obovate in outline, 7-15 cm. (3-6 inches) long, truncate or wedge-shaped at the base, divided into 5-9 lobes, usually 7, the sinuses wide and rounded at the base, the lobes measured along the midrib from the tip to the base of the sinuses more than twice as long as the undivided part of the leaf, the terminal lobe 3-toothed, the middle lobes the largest, frequently with two small lobes, the midrib of the two basal lobes usually curved backward, the midrib of the remaining lateral lobes ascending, leaves red and hairy when they expand, becoming at maturity a bright green and smooth above, paler and smooth beneath or with a few hairs on the veins and in the axils; petioles 4-6 cm. (1½-2½ inches) long; acorns sessile or nearly so, solitary or in pairs; nut oval or oblong-ovoid, 1.5-2 cm. (¾ inch) long, enclosed for ½-2/3 its length, covered with a coat of brown hairs to the top of the cup, usually glabrous above the cup; cup deep, stout, top-shaped, smooth within, the green cup presenting a glossy appearance; scales acute, closely appressed when green, somewhat spreading at the top of the cup on drying, their tips covered with hairs which give the top of the cup a hoary appearance, the lower scales somewhat thickened at their bases; kernel white within, less bitter than that of the black oak.

Distribution. Maine to Minnesota and southward to North Carolina and Missouri. Found throughout Indiana, usually in dry, sandy or gravelly soil in the northern and southwestern parts and on the dry hills in the southern part. In the northwestern counties bordering Lake Michigan it is locally somewhat frequent. In the northeastern and eastern-central parts it is very rare, or does not occur at all. It is locally frequent in the western-central counties, becoming frequent or common in the southwestern counties. In the whole of the southeastern part it is more or less frequent on the hills associated with the black and white oaks and black hickory. In all of its range it is generally associated with the black oak from which it is not usually separated. It is commonly classed as a black or red oak, which in general appearance, especially the bark, it resembles. It may be separated from the black oak by its somewhat rougher outer bark and its red inner bark, by its shiny cup, closer appressed scales and by the white kernel of the nut. It

differs from the red oak in that it usually grows in dry soil, has the leaves deeper lobed, acorn about half the size and with a deeper cup.

The published records of the distribution are as follows: Cass (Coulter); Clark (Smith); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Jefferson (Coulter) and (Young); Knox (Ridgway)*; Kosciusko (Clark); Miami (Gorby); Noble (Van Gorder); Posey (Schneck); Vigo (Blatchley).

Additional records are: Clark (Deam); Putnam (Grimes); Tippecanoe (Coulter).

Economic uses. Wood similar to the red oak though not so valuable.

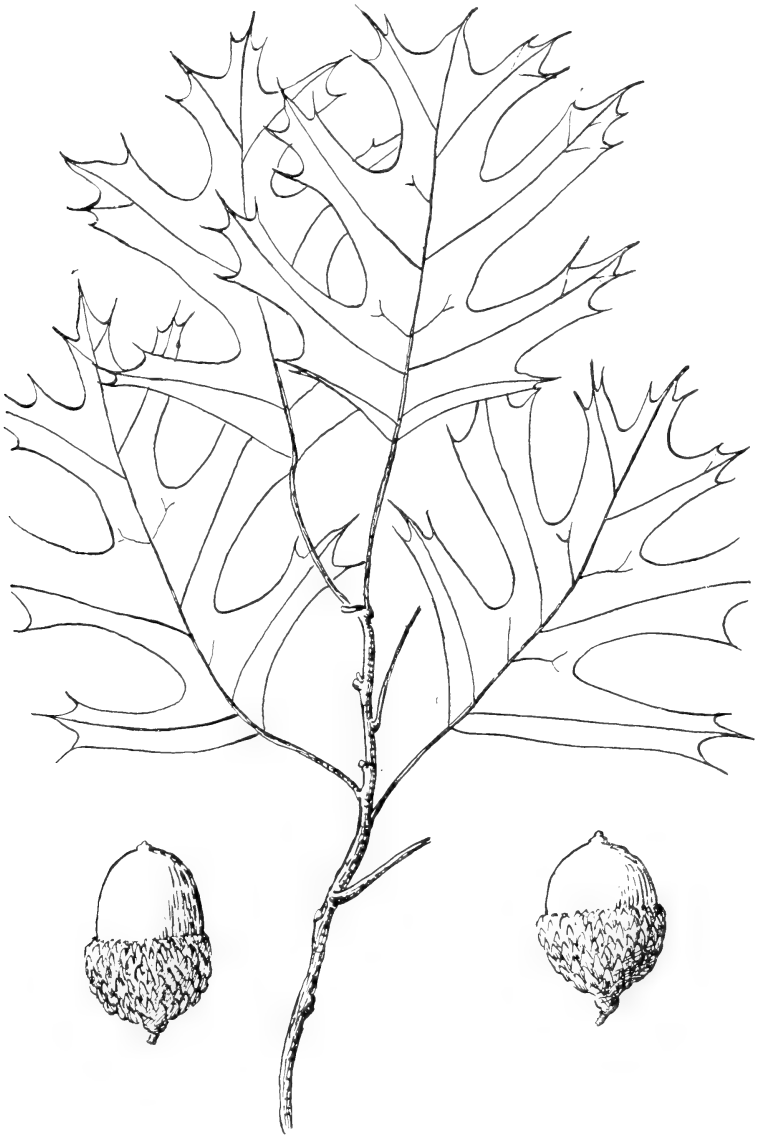
13. Quercus ellipsoidàlis E. J. Hill. PIN OAK. Plate 56. Bark on the trunk a gray or dark brown, fissured, inner layers yellow; branchlets at first hairy, becoming smooth and a grayish or reddish-brown; winter buds ovate, taper pointed, about 5 mm. (⅛ inch) long, reddish-brown, scales more or less hairy with ciliate margins; leaves oval to nearly orbicular or obovate in outline, 7-15 cm. (3-6 inches) long, truncate or wedge-shape at the base, 5-7 lobed, usually 7-lobed, the terminal lobe oblong to triangular, the lateral lobes usually narrowed at their base, sinuses deep and rounded, leaves hairy when they unfold, becoming at maturity thin, smooth and a bright green above, paler and glabrous beneath, except that the axils of the principal veins have tufts of brown hairs, petioles usually smooth, 2.5-5 cm. (1-2 inches) long; acorns sessile or nearly so, solitary or in pairs; nut depressed oval or oblong, 1.5-2 cm. (½-¾ inch) long, more or less hairy, especially toward the base, enclosed from 1/3 to ½ its length by the cup; cup cup-shaped, tapering at the base, slightly pubescent within; scales rather blunt, slightly hairy; kernel yellow and bitter.

Distribution. Northwestern Indiana and southern Wisconsin west to eastern Iowa and southeastern Minnesota. In Indiana it has been reported from Lake County only. Specimens taken near Liverpool, Lake County, by Rev. E. J. Hill, are in the Deam herbarium. In its range it has been commonly mistaken for the pin oak (*Quercus palustris*) which it closely resembles.

Commonly found on dry or upland ground, although it grows in moist or wet soils. Of the bristle tipped oaks, it is most frequently associated with the red and scarlet oaks.

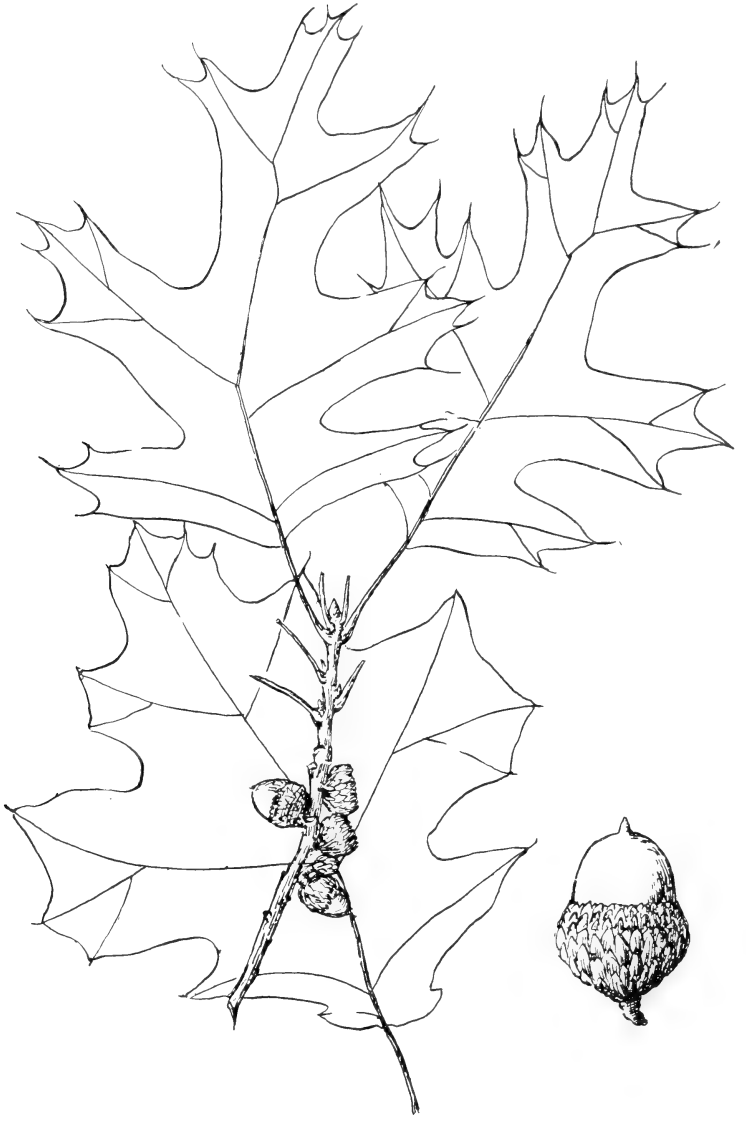
*Quercus Schneckii Britton.

PLATE 56.



QUERCUS ELLIPSOIDALIS E. J. Hill. PIN OAK. (x $\frac{1}{2}$.) (Acorns, x 1.)

PLATE 57



QUERCUS VELUTINA Lamarck. BLACK OAK. (x ½.) (Acorn, x 1.)

14. Quercus velutina Lamarck. BLACK OAK. YELLOW OAK. Plate 57. Bark on trunks deeply fissured, thick, not scaly, dark brown to nearly black, rarely light brown, inner bark deep orange, bark on young branchlets smooth and dark brown; winter buds ovate, taper-pointed, hairy, scales blunt, rusty pubescent, about 8 mm. (1/3 inch) long; leaves obovate to oblong, very variable in size and form, usually 12-18 cm. (5-7 inches) long, 5-9 lobed, usually 7-lobed, truncate or wedge-shaped at the base, the lateral lobes varying from ovate to obovate, the sinuses generally deep and wide and rounded at the base, although the margins of some of the obovate type are very shallow lobed, hairy when they first appear, becoming at maturity thin and firm, smooth, glossy and a bright green above, paler or a yellow green beneath, usually smooth, sometimes with hairs in the axils of the veins, or rarely the whole under surface covered with hairs; the leaves on some individuals approach the scarlet oak in shape, but on the whole are a little larger; petioles 2-8 cm. (¾-3 inches) long, usually smooth, sometimes hairy; acorns sessile or nearly so, solitary or in pairs; nut ovoid, oblong, or subglobose, 1.5-2 cm. (½-¾ inch) long, more or less covered with hairs, especially near the summit and the part enclosed by the cup, enclosed for about half its length in the cup-shaped cup; cup rounded at the base, hairy within; scales light brown, rather blunt pointed, hoary pubescent, loose above the middle, sometimes appearing as a fringe.

Distribution. Maine, Ontario and Minnesota south to Florida and west to Texas. Found throughout Indiana in dry, sandy, and sterile soil. In the northern counties on the gravelly hills it is frequent or common; in some of the dry sandy areas and on the dune region of Lake Michigan it is the principal species, and sometimes forms almost pure stands. In the east central part of the State it varies from very rare to somewhat frequent. In Wells County a few trees are found in two localities only about 20 miles apart. In the western and southern parts of the State it is frequent to common on dry, sandy or gravelly soil and on the sterile hills. While not so uniformly distributed throughout the State as the white oak, yet in point of number it nearly equals it, or may even exceed it.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Clay (Wilson); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter); Knox (Ridgway) and

(Thomas); Kosciusko (Youse); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley).

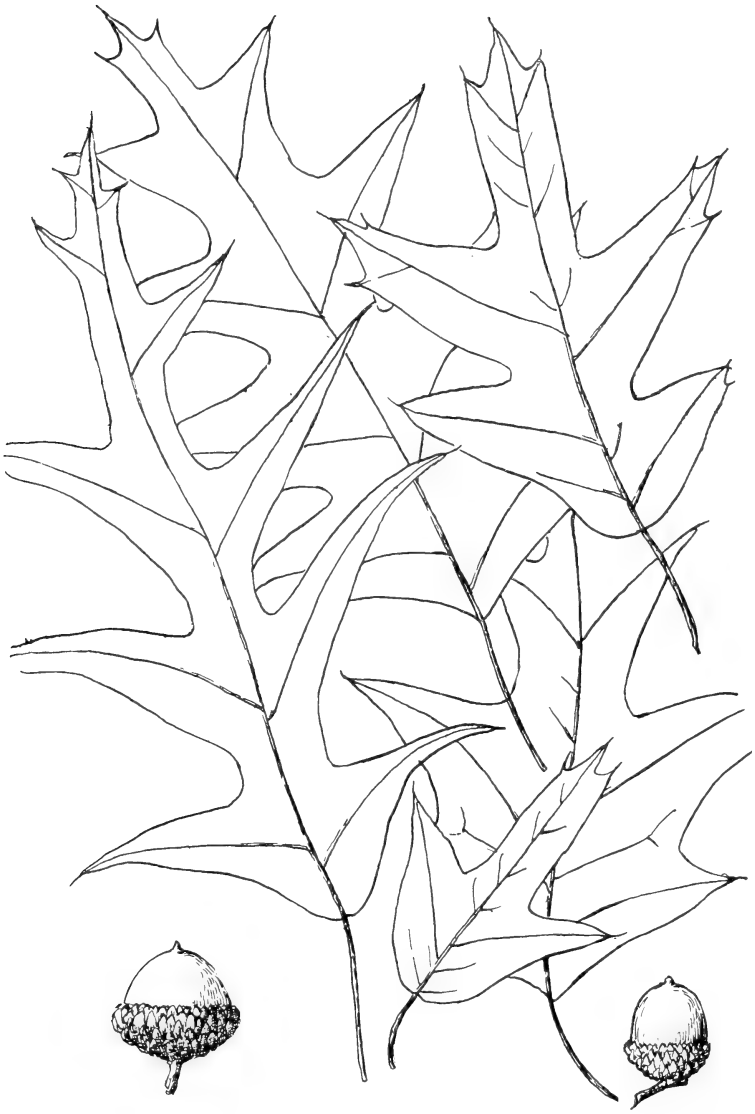
Additional records are: Tippecanoe (Coulter); Crawford, Floyd, Franklin, Laporte, Owen, Posey, Steuben and Wells (Deam).

Economic uses. Wood heavy, hard, strong, coarse-grained and not as valuable as the red oak, from which it is not distinguished commercially. Uses similar to that of the red oak.

15. Quercus falcàta Michaux. BLACK OAK. RED OAK. Plate 58. Bark thick, rather deeply fissured, furrows usually narrow, sometimes wide, ridges generally broad, and broken into short plates about 0.5 dm. (2 inches) long, varying from a light to a dark gray, the outer dead bark reddish, the inner layers orange tinged with red; shoots at first hairy, becoming at maturity nearly smooth or remaining hairy, greenish-red or gray-brown, the second year becoming a dark gray brown; terminal winter buds ovoid, sometimes somewhat angled, generally 4-6 mm. (1/5 inch) long at time of fruiting, acute, light reddish-brown, more or less pubescent, scales blunt; leaves ovate, oblong or obovate, very variable in outline, 8-22 cm. (3-9 inches) long, generally somewhat curved, wedge-shaped, rounded or truncate at the base, shallow or deeply lobed, generally about 2/3 of the distance to the midrib, lobes 3-11, commonly 5-9, the number, size and shape of the lobes exceedingly variable, the longest lateral lobes are generally near the middle of the leaf, sometimes the lowest pair, sometimes the upper pair are the longest, terminal lobe triangular or oblong, generally widest at the base, although frequently widest at the apex, lateral lobes widest at the base and gradually becoming narrower toward the apex, rarely somewhat wider at the apex, generally somewhat curved, lobes generally sharp pointed, sometimes wide-angled or rounded at the apex, margins of the lobes entire, wavy, toothed or lobed, sinuses wide and rounded at the base, dark green and smooth above at maturity, generally densely pubescent beneath; petioles 1-6 cm. (3/8-2 1/2 inches) long, pubescent, generally yellow; acorn sessile or nearly so; nut broadly ovoid, nearly flat at the base, rounded at the apex, about 1 cm. (3/8 inch) long, more or less pubescent all over, light brown, enclosed for nearly half its length by the deep cup-shaped cup; cup rounded at the base or somewhat tapering, pubescent within; scales blunt, pubescent, reddish-brown, the margins darker and smooth.

Distribution. New Jersey and Missouri, south to Florida and west to Texas. In Indiana it is confined to a few counties in the

PLATE 58.



QUERCUS FALCATA Michaux. SPANISH OAK. (x $\frac{1}{2}$.) (Acorn, x 1.)

southwestern part of the State. Dr. Schneck reported it from Gibson and Posey counties as very rare. Ridgway reports it from Gibson County as common in clayey and poor soil but rare in rich soil. He remarks that the bark of the specimens found in rich soil was light and scaly, like that of the white or chinquapin oaks, while the bark of those found on clayey soil was darker and resembled that of the true black oaks. In Point Township in Posey County, in which Dr. Schneck did not work it is the most common oak. It is usually found in low ground and is associated with *Quercus bicolor, Quercus palustris, Quercus Schneckii, Quercus stellata* and *Quercus velutina.* The whole of this township is low and a peculiar feature is to find the preceding oaks intimately associated. In this locality it is one of the largest trees, frequently attaining a diameter of 10 dm. (40 inches). Sometimes the lower branches shade off tardily which gives the tree the appearance of the pin oak.

This is the Spanish oak of text books, but no one in this State was found who recognized it by that name. A majority of the persons questioned answered that it was a "kind of a black or red oak."

This species by some authors has been divided into two species, but it is believed the characters on which the division is made are not constant. A study of hundreds of trees in the lower part of Posey County in May, September and November shows that the bark will vary from a light to a very dark gray; that the leaves on the same tree will sometimes vary from 3-lobed to 11-lobed, and the bases from rounded or truncate to wedge-shaped. Trees that have the 3-5 lobed type of leaves with a rounded base on the lower branches will also have in the top the more characteristic 7-9 lobed leaves with a wedge-shaped base.

The published records of the distribution are as follows: Fountain (Brown); Gibson (Ridgway) and (Schneck); Posey (Schneck).

Additional records are: Posey (Deam).

Economic uses. Wood and uses similar to that of the red oak.

16. Quercus imbricària Michaux. BLACK OAK. SHINGLE OAK. PEACH OAK. JACK OAK. WATER OAK. Plate 59. Bark on the trunk deeply fissured, the ridges much broken, dark brown to nearly black; branchlets at first hairy, becoming smooth, gray, reddish or a dark brown; winter buds ovoid, pointed at the apex, about 3 mm. (⅛ inch) long, reddish brown, scales ciliate; leaves elliptic to oblong-lanceolate, sometimes somewhat falcate, 8-16 cm.

PLATE 59.

QUERCUS IMBRICARIA Michaux. SHINGLE OAK. (x $\frac{1}{2}$.) (Acorn, x 1.)

(3-6 inches) long, acute at the base, bristle pointed, wedge-shaped or rounded at the base, margins entire, wavy or rarely 3-toothed at the apex on vigorous sterile branches, hairy on both surfaces and pinkish when they first appear, becoming smooth and deep green above and remaining hoary pubescent beneath; petioles 0.5-2 cm. (⅛-¾ inch) long; acorns nearly sessile, solitary or in pairs; nut ovoid or subglobose, about 1 cm. (⅜ inch) long, rounded at both ends, slightly hairy, enclosed from 1/3-½ its length in the cup-shaped cup; cup rounded at the base, shiny and usually with a few hairs on the inside; scales blunt, reddish-brown and hairy except on the darker colored margin.

Distribution. Pennsylvania and Wisconsin south to Georgia and west to Arkansas. Found throughout Indiana. Rare to very rare in the northern part and may be wanting in a few counties. In Wells County a few trees are found on the low border of a pond near the lake in Jackson Township which is the only place it is found in the county. It occurs more frequently in the southern counties, and in the southwestern counties it becomes more or less frequent, being associated with the black oak in dry, sandy or sterile soil, and with the pin oak in moist soil. In our area it is a medium sized tree, usually not very tall.

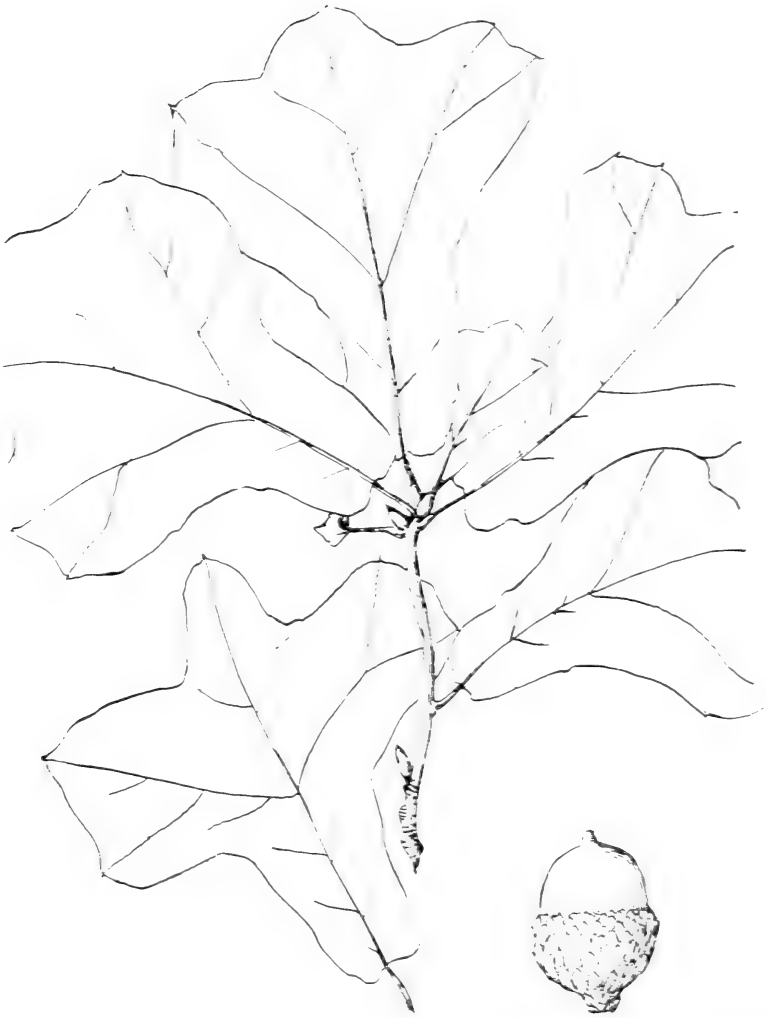
The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Clay (Wilson); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Knox (Ridgway); Kosciusko (Clark); Miami (Gorby); Noble (Van Gorder); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Jefferson (J. M. Coulter) and (Young); Posey (MacDougal and Wright); Tippecanoe (Coulter); Clark, Dubois, Gibson, Kosciusko, Sullivan, Vermillion, Warren and Wells (Deam).

Economic uses. Wood inferior and uses similar to that of the red oak.

17. Quercus marylándica Muenchhausen. BLACK JACK OAK. Plate 60. Bark deeply divided into plates about 2-7 cm. (1-3 inches) long, branchlets stout, at first covered with a coat of light brown hairs, becoming scurfy-pubescent, reddish-brown, and finally smooth or nearly so, ashy gray or brown; winter buds narrow ovoid, about 6 mm. (¼ inch) long, sharp-pointed, light or reddish brown, covered with brown hairs; leaves broadly obovate, on petioles 0.5-3 cm.

PLATE 60.



QUERCUS MARYLANDICA Muenchhausen. BLACK JACK OAK. (x $\frac{1}{2}$.)
(Acorn, x 1.)

(¼-1¼ inches) long, blades 8-16 cm. (3-6 inches) long, sometimes almost as wide, usually 3-lobed, rarely 5-lobed, size and position of the lobes very variable, sometimes the margin is only undulate-lobed, generally only shallow lobed, the primary veins indicate the lobes and terminate in a bristle, very hairy when they expand, becoming very thick at maturity, smooth, shiny and a deep green above, paler or a yellow-brown beneath, with a coat of brown hairs, or sometimes smooth or nearly so late in the fall; acorns solitary or in pairs, sessile or nearly so; nut depressed ovoid or sub-globose, 1-2 cm. (½-¾ inch) long, usually puberulent near the apex, sometimes smooth, the inside of the shell covered with brown woolly hairs, nut enclosed from 1/3-½ its length in the depressed hemispheric cup which is more or less hairy within; scales blunt, light or reddish-brown, thickly covered with hairs, not closely appressed, those near the top of the cup rather loose.

Distribution. New York to Nebraska, south to Florida and west to Texas. Known definitely from southern Indiana only. It is believed that in its distribution in this state it is confined to the southern and southwestern part of the State, where it is usually associated with the post oak (*Quercus stellata*) on the tops and sides of sterile hills. W. B. Van Gorder has noted it in isolated colonies in a few places in Greene County, remarking that "the trees are of all sizes up to 3 dm. (12 inches) in diameter." In our area the black jack is a small gnarly tree seldom attaining a height of 9 m. (30 feet) or a diameter of 3 dm. (12 inches).

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Fountain (Brown); Gibson (Ridgway) and (Schneck); Knox (Thomas); Posey (Ridgway) and (Schneck).

Additional records are: Clark and Crawford (Deam); Greene (Van Gorder); Knox (Blatchley); vicinity of New Albany (Clapp).

Economic uses. Too rare to be of any economic importance.

ULMÀCEÆ. THE ELM FAMILY.

Trees with watery juice; buds scaly; leaves alternate, simple, serrate, 2-ranked, pinnately-veined; fruit a samara or drupe.

Leaves with primary veins parallel; flowers borne on the twigs of the preceding season; fruit a samara..... 1 Ulmus.
Leaves 3-veined at the base; flowers borne on the twigs of the season, fruit a drupe..... 2 Celtis.

1. ÚLMUS. THE ELMS.

Trees with deeply furrowed bark; leaves short petioled, with lateral veins prominent and parallel, oblique or unequally heart-shaped at the base, taper-pointed at the apex, mostly double-serrate; flowers clustered or racemose, expanding before the leaves in March or April; fruit a samara surrounded with a wide membranous margin, suborbicular to oblong, about 1-1.5 cm. (½ inch) long.

Inner bark mucilaginous; leaves very rough above; flowers nearly sessile, calyx lobes pubescent; fruit suborbicular, not ciliate ..... 2 U. fulva.

Inner bark not mucilaginous; leaves smooth or somewhat rough above; flowers on slender pedicels, calyx lobes glabrous or pubescent only on the margins; fruit ovate to oval, ciliate.

Branches without corky wings; faces of samara smooth .. 1 U. americana.

Branches (at least some of them) with corky wings; at least one face of the samara pubescent.

Bud scales downy-ciliate, young branches pubescent; calyx lobes 7-9, glabrous or nearly so; wing of samara as wide as the seed ..... 3 U. Thomasi.

Bud scales and branches almost glabrous; calyx lobes 5, glabrous; wing of samara not as wide as the seed ..... 4 U. alata.

1. Ulmus americàna Linnæus. WHITE ELM. WATER ELM. SWAMP ELM. GRAY ELM. BITTER ELM. SOUR ELM. RED ELM (frequently in the southwestern counties). Plate 61. Bark deeply fissured, the ridges rather broad, ashy gray or darker, especially in the swamps in the southwestern part of the State; twigs round, glabrous or slightly pubescent; buds glabrous; leaves oval to obovate-oblong, 5-12 cm. (2-5 inches) long, hairy both above and below when they expand, becoming at maturity dark green, smooth, or rough above, especially on vigorous shoots or on young trees, paler and smooth or somewhat pubescent beneath and yellow before falling; fruit on pedicels 1-3 cm. (⅜-1 inch) long, jointed near the middle, ripening when the leaves begin to unfold.

Distribution. Quebec to Florida, west to Nebraska and Texas. Found in low ground in every county of the State. It is frequent to very common along flood plains, in swamps, on borders of lakes and on low ground generally. In our area it is usually a large tree, attaining a height of 20-30 m. (65-100 feet) and a diameter of 16 dm. (48 inches).

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown);

PLATE 61.

ULMUS AMERICANA Linnæus. WHITE OR WATER ELM. (x ½.)

Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Young); Knox (Ridgway); Kosciusko (Youse); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (Wilson); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter) and (Dorner); Blackford, Crawford, Posey, Steuben and Wells (Deam).

Economic uses. Wood hard, tough, fibrous, flexible, difficult to split. Warps very much on seasoning. Principally used for slack cooperage. Also for agricultural implements, furniture, hubs, crates, basket handles, trunk slats, veneer cores, stable floors, staves and heading. Takes stains better perhaps than any of our native woods and when varnished makes a good imitation of oak, mahogany or walnut.

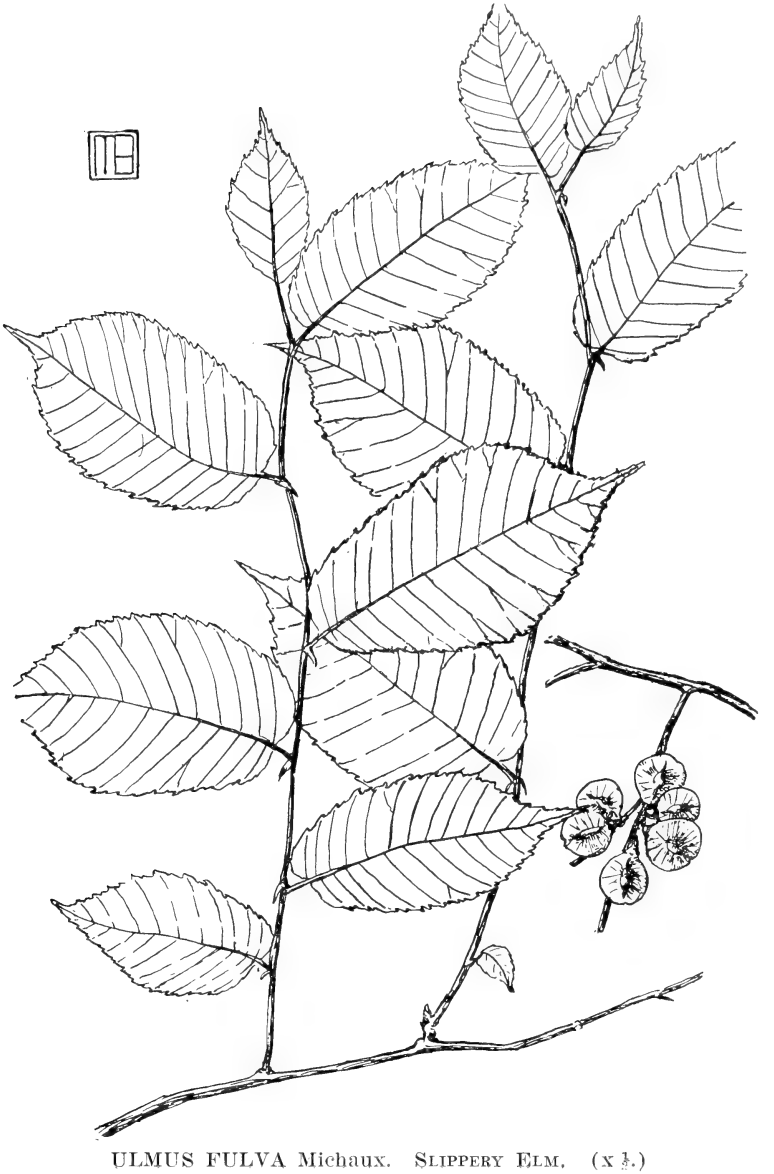
Horticultural value. It is a favorite for shade tree planting, easily propagated, grows rapidly, adapted to wet, moist or fairly dry soils, very variable in form, usually developing a vase shaped crown with large arching branches and numerous gracefully drooping branchlets, leaf period long, long lived. Recently in a few localities its use for shade tree purposes has been discouraged on account of the elm borer and elm-leaf beetle.

2. Ulmus fulva Michaux. SLIPPERY ELM. RED ELM. Plate 62. Bark deeply fissured, reddish-brown; twigs round, grayish or light brown, rough, pubescent; buds a dark chestnut-brown, covered with rusty-brown hairs; leaves ovate-oblong, 10-15 cm. (4-6 inches) long, sharply double-serrate, with callous-tipped teeth, hairy on both surfaces when they unfold, becoming at maturity thick, dark green, very rough above, paler and rough and more or less pubescent beneath, yellow before falling, fragrant when dried and remaining so for years; fruit ripening when the leaves are about one-half grown, on short pedicels about 3 mm. (⅛ inch) long, jointed near the base.

Distribution. Basin of St. Lawrence River south to Florida and west to North Dakota, Nebraska and Kansas. Found in limited numbers in all parts of Indiana. It is adapted to a rich moist soil and is found in drier situations than the white elm. It is associated with the sugar maple, beech, white ash, linn and yellow poplar, and is generally frequent where these species are rather abundant. A tree 20-25 m. (65-80 feet) high and 3-6 dm. (1-2 feet) in diameter.

The published records of the distribution are as follows: Carroll (Thompson); Clark (Baird and Taylor) and (Smith); Dearborn

PLATE 62.



ULMUS FULVA Michaux. SLIPPERY ELM. (x ½.)

(Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Clark); Marion (Wilson); Marshall (Hessler); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

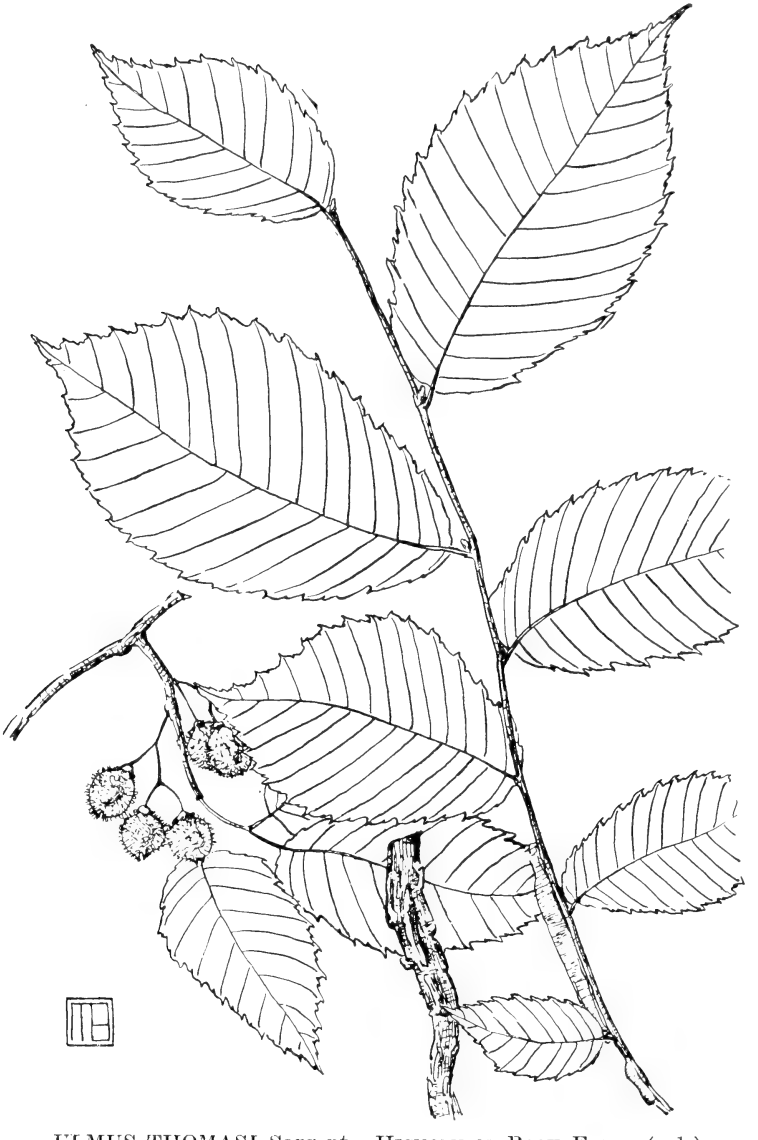
Additional records are: Monroe (Blatchley); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Crawford, Delaware, Hamilton, Hancock, Knox, Madison, Posey and Wells (Deam).

Economic uses. Wood hard, strong, light when well seasoned, not warping as much as the preceding. On account of these qualities it is a favorite wood among farmers for wagon racks. Uses same as those of the white elm and in addition is used for bending stock, wagon poles, cross-ties and fence posts. The supply in Indiana is almost exhausted. The inner bark collected in the spring, is used in medicine on account of its mucilaginous character.

3. Ulmus Thomási Sargent. HICKORY ELM. ROCK ELM. Plate 63. Similar in appearance, size and habit to the white elm, from which it may be easily distinguished in the winter condition by the corky ridges of some of the branchlets. The bark of the trunk resembles that of the white elm; twigs brown and hairy, becoming smooth after the first season; leaves oval to obovate, 5-12 cm. (2-5 inches) long, hairy on both surfaces when they expand, becoming at maturity firm, smooth, or somewhat rough, rarely very rough, dark green and shiny above, paler and pubescent beneath; fruit ripening when the leaves are about one-half grown, on pedicels about 0.5-1 cm. ($\frac{1}{8}$-$\frac{3}{8}$ inch) long.

Distribution. Quebec and Ontario south to northern New Jersey and westward to Nebraska and Missouri. The distribution of this species in Indiana is not definitely known, although it is believed to occur at least in sparing numbers in all parts of the State. It is not commonly separated from the white and slippery elm. It was no doubt more or less frequent throughout at least the eastern part of Indiana since it is known to have been frequent in Noble, Wells and Franklin counties. In some parts of the State persons familiar with timber separate what they call the red elm from the slippery elm. They say the red elm is difficult to split, has about two inches of sap wood, bark bitter and not mucilaginous; that the slippery elm splits more easily, sap wood about 1 inch thick and has a mucilaginous bark. It is believed that what is popularly known and referred to as the red elm is the hickory elm, because it cor-

PLATE 63.



ULMUS THOMASI Sargent. HICKORY OR ROCK ELM. (x $\frac{1}{2}$.)

responds to the qualities of the hickory elm and invariably, where the red and slippery elm are separated, the hickory elm occurs but is not recognized as such, and where the slippery and red elm are not separated, the hickory elm is known and recognized. It prefers a well drained soil, similar to that of the slippery elm.

The published records of the distribution are as follows: Dearborn (Collins); Franklin (Meyncke); Hamilton (Wilson); Noble (Van Gorder); Parke (Hobbs); Steuben (Bradner); Wayne (Petry and Markle).

Additional records are: Jefferson, Posey and Wells (Deam).

Economic uses. Wood hard, heavy, strong, flexible, close-grained with thick sap wood. Uses same as the two preceding. Supply is so limited as to be of no economic importance.

4. Ulmus alàta Michaux. WINGED ELM. WAHOO ELM. Plate 64. Bark not deeply fissured, reddish-brown, branchlets with flat corky wings; leaves elliptic-oblong to ovate-oblong, 3-10 cm. (1-4 inches) long, nearly smooth above and hairy beneath when they unfold, becoming at maturity firm, dark green and smooth above, paler and pubescent below; fruit ripens before or with the unfolding of the leaves, pedicels 4-8 mm. (⅛-¼ inch) long.

Distribution. Northern Virginia and southern Indiana, south to Florida and west to Missouri and Arkansas. In Indiana it is a small tree and only locally found in a few counties bordering the Ohio River and in the southwestern part of the State. The record for the southwestern part of the State is based upon Dr. Schneck's report of the plants of that part of the State. An examination of Dr. Schneck's herbarium material for specimens of this species shows sheets with leaves and twigs only, which were at first labeled *Ulmus alata* and afterward the name *Thomasi* was written above. The writer made diligent search for this species in Posey County but was unable to find it. *Ulmus Thomasi* was rarely found and since Dr. Schneck did not report *Ulmus Thomasi* and subsequently substituted this name on his herbarium sheets, it is believed the preceding location should be referred to *Ulmus Thomasi.*

The published records of the distribution are as follows: Clark (Baird and Taylor); Crawford (Blatchley); Gibson (Schneck); Harrison (Blatchley); Miami (Gorby)*; Vigo (Blatchley)**.

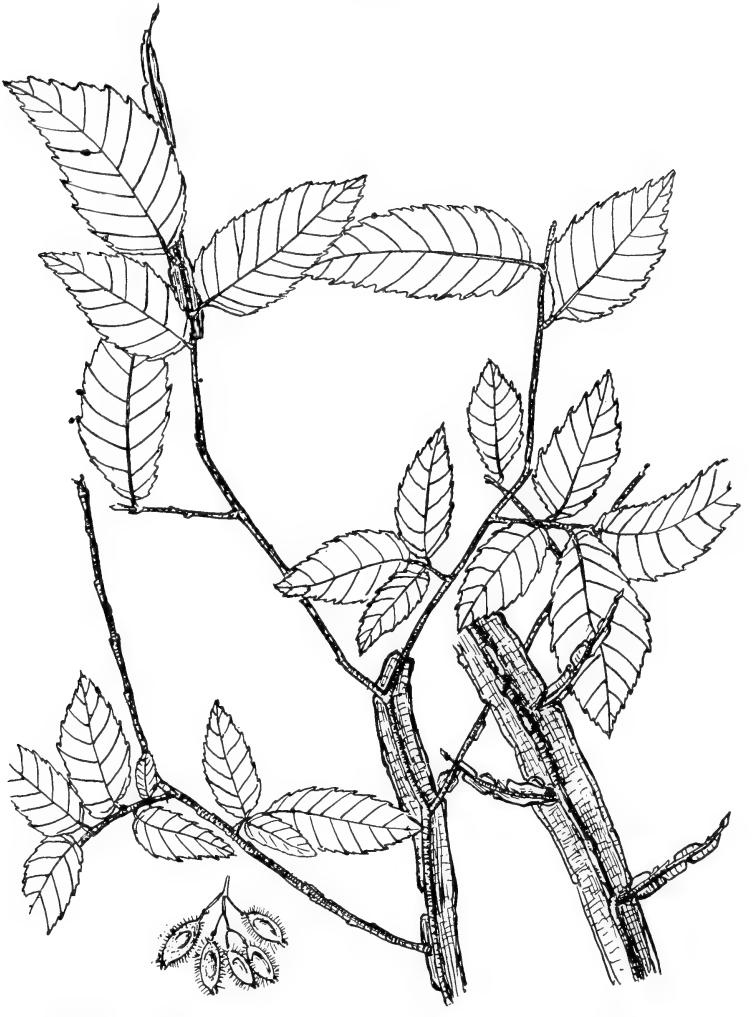
Additional records are: Crawford (Deam).

Economic uses. Too rare to be of any economic importance.

*It is believed this record should be referred to *U. Thomasi* since the location is north of the range of *U. alata* and *U. Thomasi* was not reported from that locality where it occurs more or less frequently.

**Mr. Blatchley says this record was founded on a leaf and twig specimen and may have been *Thomasi.*

PLATE 64.



ULMUS ALATA Michaux. WINGED ELM. (x ½.) (Fruit, x 1.)

2. CÉLTIS. THE HACKBERRIES.

Trees with leaves with 3 rarely 4-5 primary veins at the base; staminate flowers usually in clusters, pistillate solitary or few together in the axils of the leaves near the end of the twigs; fruit a drupe, ovoid or globose, pulp thin and sweet, frequently remaining on the tree until late winter or early spring; stone bony, wrinkled. In Indiana there are three species commonly not separated.

Leaves sharply and coarsely serrate, nutlet 6-8 mm. (about ¼ inch) long ..... 1 C. occidentalis.
Leaves entire or nearly so, nutlet 5-6 mm. (about 1/5 inch) long.
  Leaves of a rather broad ovate type, nutlet white, shrub or a small tree ..... 2 C. pumila.
  Leaves of an ovate-lanceolate type, nutlet yellowish-white, a large tree ..... 3 C. mississippiensis.

1. Celtis occidentàlis Linnæus. HACKBERRY. WHITE HACKBERRY. Plate 65. Bark on old trees irregularly furrowed, sometimes some of the surface warty and rough; fruiting branches smooth, young branches varying from smooth to very hairy; leaves of an ovate type, 6-18 cm. (2¼-7 inches) long, usually long taper-pointed, oblique or slightly cordate at the base, margins sharply serrate, leaves on the fruiting branches smooth or nearly so, those on the vegetative branches more or less rough and more or less hairy on both surfaces, petioles 0.5-2 cm. (1/5-¾ inch) long, more or less hairy above; flowering season April or May; fruit at maturity dark purple or nearly black, borne on stalks usually about one third longer than the leaf stalks; nutlet globose, longer than wide, 6-8 mm. (¼ inch) long, 5-6 mm. (1/5 inch) wide, covering light brown.

Forms with pubescent twigs and leaves with a rough upper surface have been distinguished as variety **crassifolia** (Lamarck) Gray. There are many young trees with rough leaves and pubescent twigs and frequently both pubescent and smooth leaves occur on the same tree. The smooth ones in places exposed to the sun, and the rough ones in the shade of other leaves or other trees. It is believed this character is not constant enough to form a basis of division. A shrubby form with thick leaves of an ovate type, entire or nearly so, is found on the hills in southern Indiana, and is tentatively referred to this species.

Distribution. Valley of the St. Lawrence south to the Gulf States and west to Texas and Manitoba. Frequent in Indiana along streams and sparingly found in rich bottom lands and on limestone hills. In the greater part of our area it grows to be a

PLATE 65.

CELTIS OCCIDENTALIS Linnæus. HACKBERRY. ($\times \frac{1}{2}$.)

large tree, frequently 30 m. (95 feet) high and 1 m. (39 inches) in diameter.

The published records of the distribution are as follows: Carroll (Thompson); Clark (Baird and Taylor); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark); Lake (Higley and Radden); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

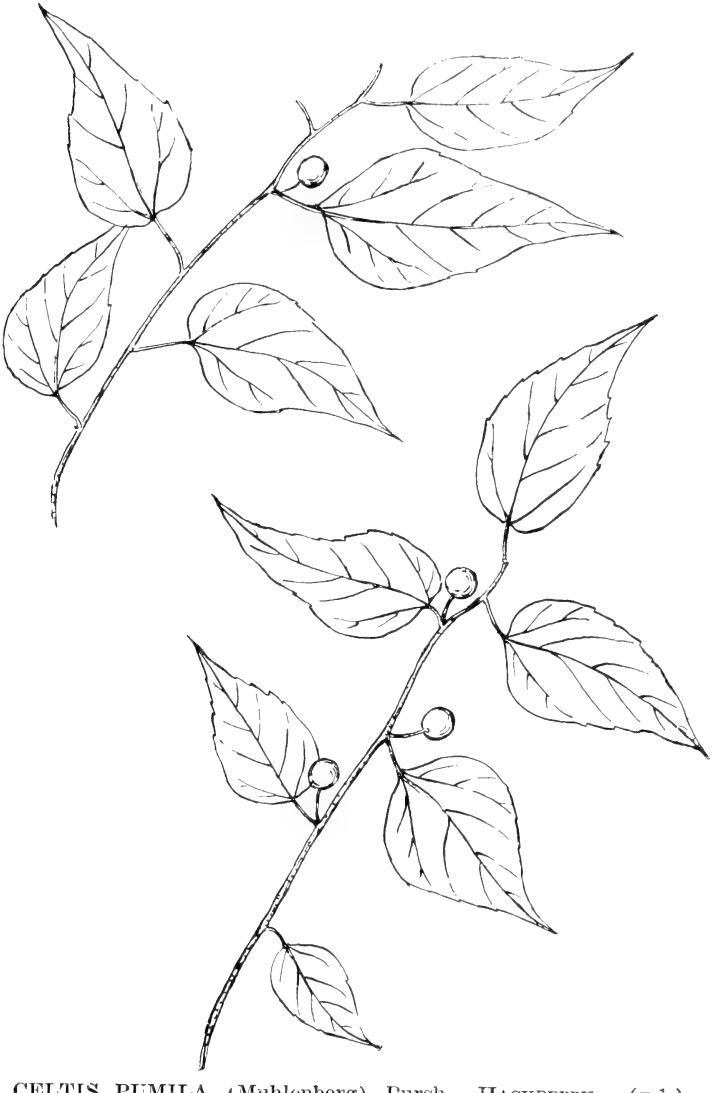
Additional records are: Crawford (Schneck); Lake (Hill); Montgomery (Evans); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Allen, Crawford, Dearborn, Delaware, Floyd, Fulton, Jefferson, Jennings, Lawrence, Monroe, Montgomery, Owen, Stark, Vermillion and Wells (Deam).

Economic uses. Wood yellowish-white, rather heavy, not strong, coarse grained, soft, shrinks moderately, works well, takes a good polish. Good clean lumber is sometimes sold for ash from which it is difficult to distinguish, at least before seasoning. The supply has been so reduced as to be of little economic importance. It is used principally for building material, interior house finishing, staves, heading, bending stock and implements.

Horticultural value. Adapted to a moist rich soil, stands pruning well but is somewhat difficult to train up to make desirable shade or ornamental trees. Frequently used as a shade tree but not equal to the elm which it most resembles. The leaves and twigs are frequently affected with galls which detract from the appearance of the tree.

2. Celtis pùmila (Muhlenberg) Pursh. HACKBERRY. Plate 66. Bark thin, smooth and gray on the shrub-like forms, warty or fissured near the base on the larger forms, ridges flat and broken, dark-gray brown; twigs thorn-like, due to winter killing, at first reddish-brown and hairy, at maturity becoming somewhat smooth on the fruiting branches and remaining hairy on the vegetative branches, gray brown; leaves of an ovate type, broadly-ovate to oval-oblong, taper-pointed, unequal, rounded or sometimes cordate at the base, margins generally entire or nearly so, frequently coarsely toothed above the middle, rarely to near the base, hairy on both sides when they first appear, becoming thick at maturity, smooth or rough and dark green above, paler and smooth or nearly so beneath;

PLATE 66.



CELTIS PUMILA (Muhlenberg) Pursh. HACKBERRY. (x ½.)

[15—28415]

petioles 1-1.5 cm. (⅜-½ inch) long, densely hairy above and smooth beneath; flowers appear in May; fruit, wine or dark maroon color, on stalks that curve upward, the stalks about the same length of the petioles, nutlets globose, slightly longer than wide, 5.5-6 mm. (1/5 inch) long, 5-5.5 mm. (1/5 inch) wide, covering white.

This species may be distinguished from the preceding by the relatively smaller leaves, many of which are entire or nearly so, by the flowers appearing about two weeks earlier, by the nutlet being smaller and the pits of the surface not so deep.

Distribution. Delaware south along the Atlantic coast, west through Pennsylvania to Kansas, Colorado and Utah. In Indiana it is known only from Lake County near the Calumet River at Millers. It is usually found in clumps on the dry wooded sand dunes. Generally a shrub and rarely attaining a diameter of more than 0.5 dm. (2 inches) and a height of 4 m. (13 feet).

This species was reported for the State by Prof. Stanley Coulter in the Proc. Ind. Acad. Science, 1900, page 143. The form reported by Dr. Schneck as occurring on the "rocky banks of Blue River" in Crawford County, is the entire leaved form referred to under the preceding species.

The published records of the distribution are as follows: Lake (Hill).

Additional records are: Lake (Deam) and (Umbach).

Economic uses. Too small and rare to be of any economic value.

3. Celtis mississippiénsis Bosc. HACKBERRY. YELLOW HACKBERRY. 67. Bark on the lower part of the trunk of mature trees covered with wart-like excresences, rarely somewhat irregularly fissured, bark of the upper part of the trunk resembling that of the beech; leaves of an ovate-lancolate type, narrower than those of the preceding species, 4-10 cm. (1½-4 inches) long, entire or occasionally with a few incurved teeth to about the middle of the blade, smooth at maturity both above and below; petioles 0.5-1 cm. (¼-½ inch) long, glabrous or nearly so; flowering season April or May; fruit orange red, on pedicels about the length of the petioles of the leaves; nutlet yellowish-white, globular, about 5 mm. (1/5 inch) in diameter each way.

Distribution. Southern Indiana south to Florida and west to Missouri and Texas. In Indiana it is found only in the southwestern part where it is frequent or common along streams and in the lowlands. It is inclined to grow scrubby and crooked. It is medium sized and frequently becomes a half meter (18 inches) in diameter.

PLATE 67.

CELTIS MISSISSIPPIENSIS Bosc. YELLOW HACKBERRY. (x ½.)

The published records of the distribution are as follows: Franklin (Haymond); Gibson (Schneck); Jefferson (Coulter); Knox (Ridgway); Posey (Schneck) and (Wright).

Additional records are: Gibson and Posey (Deam).

MORÀCEÆ. THE MULBERRY FAMILY.

Trees with a milky sap; leaves 2-ranked, serrate, entire or lobed, 3-5 nerved at the base; fruit berry-like.

Branches without spines; leaves serrate; pistillate flowers in spikes; fruit berry-like, elongated, somewhat resembling the blackberry..... 1 Morus.
Branches with spines; leaves entire; pistillate flowers in heads; fruit orbicular, usually about 5-10 cm. (2-4 inches) in diameter..... 2 Toxylon.

1. MÒRUS. THE MULBERRIES.

(From the Greek, *morea*, the mulberry.)

Leaves rough above, pubescent beneath; staminate-flower spikes 2.5-5 cm. (1½-2½ inches) long..... 1 M. rubra.
Leaves smooth on both sides or nearly so; staminate-flower spikes 1-2 cm. (½-1 inch) long..... 2 M. alba

1. ⅌ Morus rùbra Linnæus. MULBERRY. Plate 68. Leaves broadly ovate, abruptly contracted into a long point, coarsely serrate, frequently 2-7 lobed, more or less cordate at the base; flowers appear in May or June with the leaves; pistillate spikes about half the length of the staminate; fruit ripens in July, cylindric, 1.5-3 cm. (½-1¼ inches) long, dark purple or nearly black at maturity.

Distribution. Western New England, southern Ontario, eastern Dakotas south to the Gulf States and west to Texas. Infrequent in all parts of Indiana, usually found as isolated trees. In the northern part of the State it is found in rich moist soil associated with the slippery elm, beech and sugar maple. In the southern part of the State it is found both in rich soil and on the clay hills. In our area it is a small tree 8-15 m. (25-50 feet) high, with a diameter seldom exceeding 6 dm. (24 inches).

The published records of the distribution are as follows: Carroll (Thompson); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin;) Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas;)

PLATE 68.

MORUS RUBRA Linnæus. MULBERRY. (x ½.)

Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Marion (Shipman); Montgomery (Evans) and (Rose); Tippecanoe (Dorner); Bartholomew, Clark, Crawford, Dearborn, Fountain, Franklin, Hancock, Knox, Marshall, Montgomery, Owen, Posey, Wabash, Warren and Wells (Deam).

Economic uses. Wood light, soft, rather tough, coarse-grained, takes a good polish. Used principally for fence posts and crossties. Too rare to be of any economic importance. Fruit edible and sells on the market at about the same price as the blackberry.

Horticultural value. It is hardy and transplants easily. The fruit is a favorite with birds and squirrels. This tree could with advantage be planted along the borders of orchards to attract birds from the orchard fruits. The timber ranks next to the black locust and osage orange in value for fence post purposes.

2. Morus álba Linnæus. WHITE MULBERRY. A small crooked tree with white or pinkish fruit, introduced from the Old World, escaped from cultivation in the southern part of the State. The leaves are the principal food of the silk worm.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Jefferson (Coulter) and (Young); Kosciusko (Clark); Miami (Gorby); Posey (Schneck).

Additional records are: Jefferson (Deam); Putnam (Grimes); Union (Rose).

2. TÓXYLON. THE OSAGE ORANGE.

(From the Greek, *toxon*, bow, *xylon*, wood, meaning wood suitable for making bows).

Toxylon pomíferum Rafinesque. HEDGE. OSAGE ORANGE. (*Maclura pomifera* (Rafinesque) Schneider.) Plate 69. Bark on young trees gray, becoming on old trees deeply fissured and somewhat shreddy, brown; mature twigs gray; spines about 1.5 cm. (¾ inch) long; leaves 6-12 cm. (2½-5 inches) long, pointed, rounded or somewhat cordate at the base, smooth and glossy green above; flowers appear in May or June; fruit about 1 dm. (4 inches) in diameter, resembling an orange.

Distribution. Missouri and Kansas south to Texas. A small thorny tree introduced into Indiana for hedge fences. Since land has become so valuable its use has been discontinued and many

farmers are digging it up. It is subject to the San Jose scale, which is another objection to it. It has escaped in several parts of the State, freely so in the southwestern part.

PLATE 69.

TOXYLON POMIFERUM Rafinesque. OSAGE ORANGE. (X ½.)
Staminate branch on the left, pistillate on the right.

The published records of the distribution are as follows: Decatur (Ballard); Franklin (Meyncke); Hamilton (Wilson); Jefferson (J. M. Coulter); Kosciusko (Coulter)*; Tippecanoe (Thompson); Vigo (Blatchley).

*From cultivated tree, not escaped in this county

Additional records are: Montgomery (Evans); Putnam (Grimes); Knox (Deam).

Economic uses. Wood heavy, very hard and strong, the most durable in contact with the soil of any of our post timbers. Used principally for fence posts.

Horticultural value. Sometimes used for ornamental and shade tree purposes. Adapted to all kinds of soil, transplants easily and will endure all kinds of abuse and an excessive amount of smoke.

MAGNOLIÀCEÆ. THE MAGNOLIA FAMILY.

Buds pubescent; leaves entire, fruit fleshy, dehiscent.... 1 Magnolia.
Buds glabrous; leaves lobed; fruit a cone of dry carpels, indehiscent..... 2 Liriodendron.

1. MAGNÒLIA. THE MAGNOLIAS.

(Named for Magnol, a distinguished botanist of Montpellier, France.)

Magnolia acuminàta Linnæus. CUCUMBER TREE. Plate 70. Bark furrowed; leaves oblong, some obovate, short-pointed, rounded or cordate at the base, in size and shape resembling the leaf of the pawpaw, 1-3 dm. (4-12 inches) long, very hairy when young, soon smooth and dark green above and smooth or nearly so beneath but paler in color; flowers large, about 6 cm. (2½ inches) long, bell-shaped, pale yellowish-green, appearing in May; fruit cylindrical, 5-7 cm. (2-2¾ inches) long, 1-2 cm. (⅜-¾ inch) wide.

Distribution. Southern Ontario south along the Appalachian Mountains to Alabama and west to Eastern Arkansas. In Indiana it is a small tree and has been only rarely found in a few counties bordering on the Ohio River.

The published records of the distribution are as follows:* Clark (Baird and Taylor); Franklin (Meyncke); Jefferson (Coulter) and (Young); vicinity of New Albany (Clapp); Orange (Elrod and McIntyre) and (Ridgway); Tippecanoe (Coulter).**

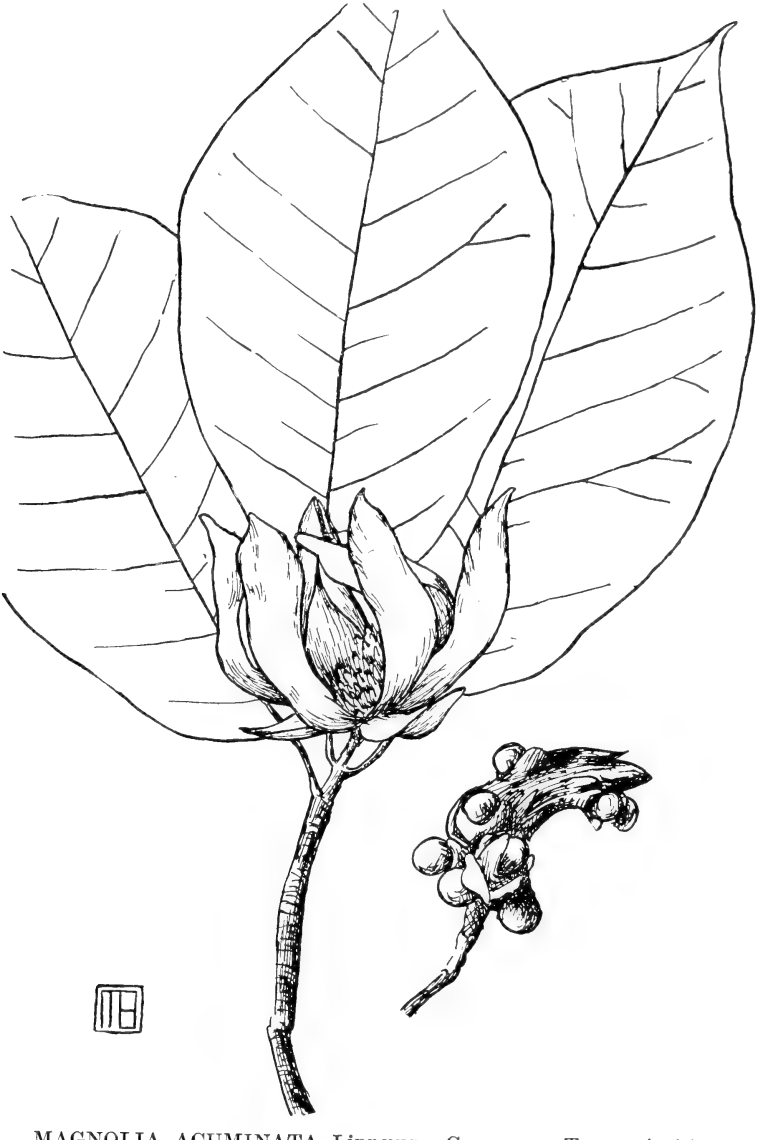
Additional records are: Clark (Deam).

Horticultural value. In the south it is used extensively for shade purposes. Large trees are now growing in Indianapolis, Lafayette and Laporte, which indicate that it is hardy in Indiana. Its use for shade tree planting should be encouraged. It is adapted to a rich and moist soil, has a good habit of growth and produces a good shade.

*Reported by Phinney as occurring in eastern-central Indiana. Reference to Phinney's botany, which is now in the Indianapolis Public Library, in which he kept a record of the plants he noted says: Those that are marked with an X in black have been noted in Indiana and those marked with an X in red have been noted in Ohio and Pennsylvania. The Magnolia acuminata is marked in red, so this reference should be dropped.

**From cultivated tree.

PLATE 70.



MAGNOLIA ACUMINATA Linnæus. CUCUMBER TREE. (x ½.)

2. LIRIODENDRON. THE TULIP TREE.

(From the Greek, *lirion*, lily and *dendron*, tree.)

Liriodendron Tulipífera Linnæus. POPLAR. YELLOW POPLAR. WHITE POPLAR. HICKORY POPLAR. WHITE WOOD. Plate 71. Bark furrowed; leaves 4-6 lobed, very variable in form, smooth, dark green and shiny above, paler beneath, large truncate and notched at the apex, about 12 cm. (5 inches) wide and equally as long, leaf stalks about the same length; flowers appear in May or June on the ends of the branches on stalks about 2 cm. (1 inch) long, large, bell-shaped, about 4 cm. (2 inches) deep, pale greenish-yellow, sometimes tinged with orange red at the base inside; fruit 5-7 cm. (2-2¾ inches) long, upright, many of which remain on the tree during the winter.

Distribution. Rhode Island and northern New York, south to northern Florida, west to eastern Missouri and Arkansas. It is well distributed in all parts of Indiana, occuring as somewhat frequent in the northern part, rather rare in a few counties; and more frequent in the southern part of the State, especially in the southwestern part where it attains its greatest development. It is adapted to a rich moist soil with good drainage. One of Indiana's largest and most useful trees.

The published records of the distribution are as follows: Carroll (Thompson); Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Decatur (Ballard); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Coulter); Lake (Higley and Radden); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Shelby (Ballard); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Montgomery (Coulter) and (Evans); Putnam (Grimes); Tippecanoe (Coulter); Crawford, Decatur, Fountain, Grant, Hancock, Harrison, Huntington, Laporte, Morgan, Noble, Owen, Posey, Shelby, Steuben and Wells (Deam).

Economic uses. Wood light, weak, soft, stiff, straight and moderately coarse-grained, seasons and works well. The sap wood is white and the heart wood a light yellow. The wood of young and

PLATE 71.

LIRIODENDRON TULIPIFERA. Linnæus. TULIP OR YELLOW POPLAR. (x $\frac{1}{2}$.) (Fruit, x $\frac{3}{4}$.)

thrifty trees is almost white which gave rise to the name of "white poplar" and "hickory poplar" to distinguish it from the trees of slower growth with a greater percentage of heart wood. It is used for lumber, siding, shelving and excelsior. The inner bark is used in medicine as a stimulant and tonic.

Horticultural value. It grows rapidly, tall and with short side branches. Its beautiful foliage, the large, fragrant flowers and the fruit on the leafless branches in winter recommend it for shade tree purposes and it is being used more each year for this purpose. It is practically free from insects and fungous diseases. Experiments in growing this tree indicate that it is one of the best trees for reinforcing woodlots and other forest planting. It is propagated by planting seedlings, and little difficulty will be experienced if seedlings about .5 m. (18 inches) high are planted.

ANONÀCEÆ. THE CUSTARD APPLE FAMILY.

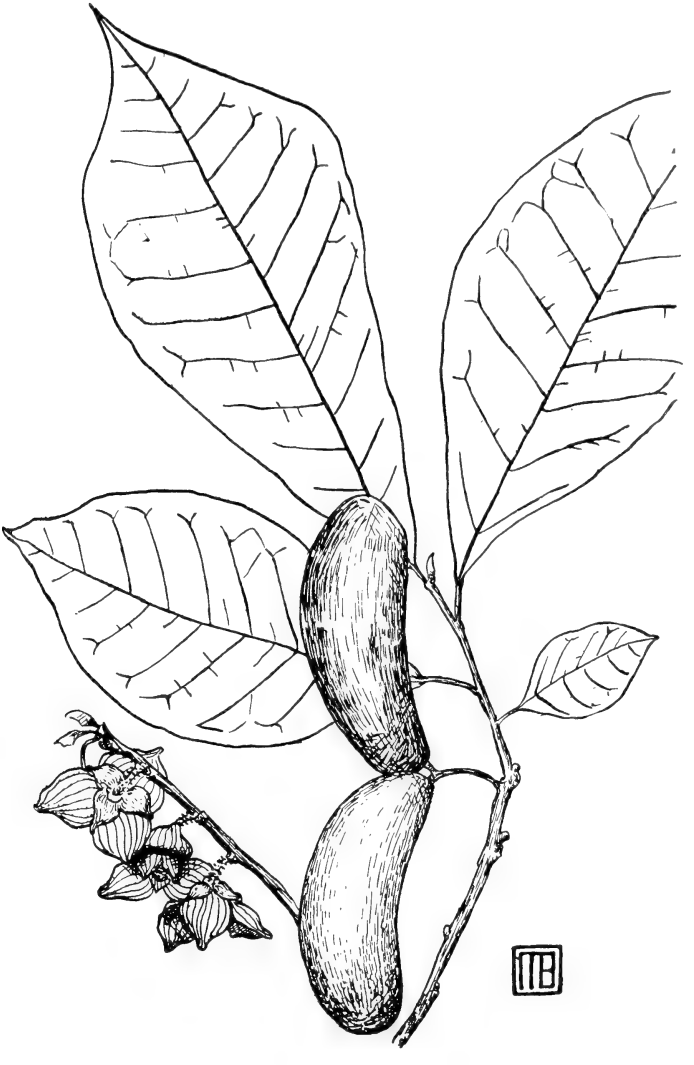
ASÍMINA. THE PAWPAW.

Asímina tríloba (Linnæus) Dunal. PAWPAW. YELLOW PAWPAW. WHITE PAWPAW. Recently called the Hoosier banana. Plate 72. Bark smooth, somewhat ridged on very old trees; branchlets reddish-brown, hairy, becoming smooth; buds sharp-pointed, covered with hairs; leaves obovate, some narrowly so, sharp-pointed, wedge-shaped at base, 1-3 dm. (4-12 inches) long, green above, paler beneath, hairy when expanding, soon glabrous except on the veins beneath; petioles 5-10 mm. (¼-½ inch) long; flowers appear before or with the leaves, drooping; sepals 3, green; petals 6, maroon color; flowering season March or April; fruit begins to ripen about September 1st., 7-13 cm. (2½-5 inches) long, light green, pulp white or yellow, with a few large, dark brown, flattened seeds.

Distribution. Southern Ontario east to eastern Pennsylvania, south to the Gulf States and west to eastern Nebraska, Kansas and Texas. Found in all parts of Indiana, though most frequently in the southern part. It is usually found in colonies in moist rich soil and most frequently associated with the beech and sugar maple.

A shrub or tree, sometimes attaining a height of 15 m. (48 feet) and a diameter of 2 dm. (8 inches). Prof. Stanley Coulter says: "Two forms, not separated botanically are associated in our area. They differ in time of flowering, in size, shape, color and flavor of the fruit, in leaf shape, venation and odor and in color of the bark. They are of constant popular recognition and are probably separate species, never seeming to intergrade." (Report of the Indiana State Geologist, 1899, page 745.)

PLATE 72.



ASIMINA TRILOBA (Linnæus) Dunal. PAWPAW. (x ½.)

The published records of the distribution are as follows: Cass (Hessler); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Decatur (Ballard); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Coulter); Lake (Blatchley); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Montgomery (Thompson); Putnam (Grimes) and (Lewis and Bridges); Tippecanoe (Coulter) and (Dorner); Bartholomew, Clark, Crawford, Decatur, DeKalb, Delaware, Howard, Huntington, Jackson, Jefferson, Jennings, Laporte, Monroe, Morgan, Porter, Posey, Shelby, Wells (Deam).

Economic uses. Wood very light, very soft, light yellow and coarse-grained. Supply is so limited as to be of no economic importance. The mature fruit is edible and relished by many persons. For years horticulturists have urged that the fruit of this tree be developed so that it might become one of our standard fruits.

Horticultural value. It is desirable for ornamental planting on account of its interesting foliage, beautiful and unique flowers and delicious fruit. It prefers the shade and when planted several should be grouped together.

LAURÀCEÆ. THE LAUREL FAMILY.

THE SÁSSAFRAS.

Sassafras Sássafras (Linnæus) Karsten. SASSAFRAS. RED SASSAFRAS. WHITE SASSAFRAS. (*Sassafras variifolium* (Linnæus) Karsten.) Plate 73. Bark aromatic, smooth on young trees, reddish-brown and deeply furrowed on old trees, resembling that of the black walnut; twigs yellowish-green, splotched with dark spots, young twigs hairy, soon becoming smooth; buds ovoid and pointed; leaves alternate, oval to obovate, margin entire or 1-3 lobed, sometimes 5 lobed (the accompanying plate was made from a specimen in the Deam herbarium, which has all the forms of the leaf on one twig), 10-15 cm. (4-6 inches) long, 5-10 cm. (2-4 inches) wide, hairy, when young, smooth at maturity; flowers appear in April or May before or with the leaves, greenish yellow; fruit ripens in August and September, about the size of a pea, blue black.

PLATE 73.

SASSAFRAS SASSAFRAS (Linnæus) Karsten. SASSAFRAS. (x ½.)

Distribution. Northern United States, south to the Gulf States and west to eastern Kansas and Texas. Found in all parts of Indiana. In the western, northwestern and extreme northern counties it is quite frequent and sometimes attains a diameter of more than 2 dm. (8 inches). In the southern counties it sometimes becomes a large tree.* In some counties of the eastern-central part it is rare. In the southern part of the State it is common everywhere and generally persists in cultivated fields for years. Here waste ground is soon covered with it. Sassafras is usually found on poor soil. In the northern part of the State it is generally found in dry, sandy or gravelly soil, or on the black and white oak land. In the southern part it is found everywhere, especially in sterile soil, and is usually associated with the persimmon.

In our area there are two forms of this tree. One is known as white sassafras which is nearly all sap wood and the bark of the roots is white. In contact with the soil the wood soon rots. The other is known as the red sassafras. The bark of the roots and the greater part of the wood is red, and is durable in contact with the soil.

The published records of the distribution are as follows: Cass (Hessler); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark), (Coulter), (Scott) and (Youse); Lake (Higley and Radden); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley).

Additional records are: Montgomery (Evans); Putnam (Grimes); Tippecanoe (Coulter); Allen, Clark, Dubois, Gibson, Harrison, Jackson, Kosciusko, Lake, Laporte, Marshall, Monroe, Morgan, Owen, Starke, Vermillion, Warren and Wells (Deam).

Economic uses. Wood light, soft, brittle, coarse-grained, slightly aromatic, sap wood light yellow, heart wood orange brown, and durable in the ground. Used principally for fence posts. The bark of the roots and pith of the small branches are used in medicine. A tea made from the bark of the roots was used by the pioneers to

*On the land of Joseph Hole, Esq., (Jennings County), bordering the South Fork, are two sassafras trees, the first measuring four feet in diameter four feet from the ground, the other somewhat less. These trees stood near each other. The first tree was cut for saw stocks and shingles; the top of the last cut, forty feet from the stump, measured three feet in diameter. (Rept. Ind. Geol. Surv., 1875, page 177).

"thin the blood". The bark yields a strong aromatic oil which is used in medicine and in the manufacture of perfumery.

Horticultural value. Adapted to almost all kinds of soil, and grows rapidly. It develops a large tap root which makes it difficult to transplant. It may be propagated by seed or planting small seedlings. It is a desirable tree for ornamental planting on account of its rich green foliage and varied shaped leaves, which are velvety while expanding and in autumn turn from green to orange-yellow or bright red. The clusters of blue-black fruit in autumn intensify the decorative effect.

ALTINGIÀCEÆ. SWEET GUM FAMILY.

LIQUIDÁMBAR. SWEET GUM.

(From the Latin, *liquidum*, fluid, *ambar*, amber, in allusion to the fragrant terebinthine exudation.)

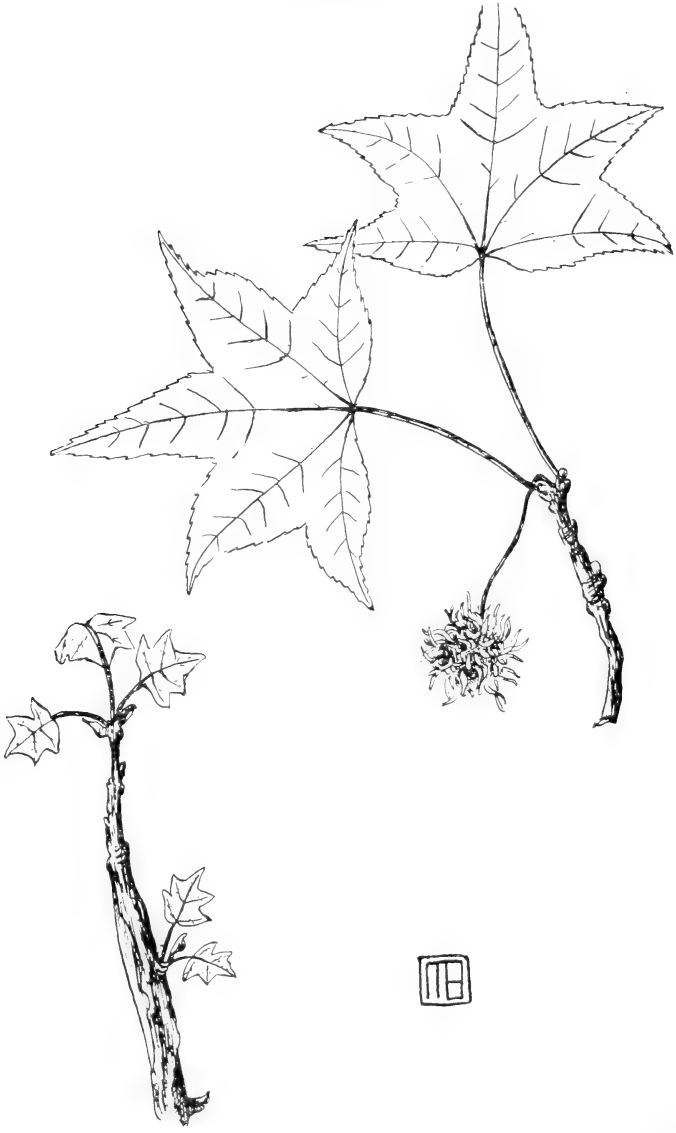
Liquidambar Styracíflua Linnæus. SWEET GUM. GUM. Plate 74. Bark usually deeply furrowed; young branches largely smooth though some occur with more or less corky wings; leaves alternate, nearly round in outline, about 13 cm. (5 inches) wide, cleft into 5-7 wedge-shaped lobes, truncate or heart-shaped at the base, margin serrate, hairy on upper surface when expanding, soon glabrate or nearly so, aromatic when bruised; flowers appearing soon after the leaves, flowering season March, April or May; fruit a globular, horny aggregate of carpels, 3-4 cm. (1¼-1½ inches) in diameter, frequently remaining on the tree during the winter.

Distribution. Connecticut west to southeastern Missouri and eastern Texas, south to the Gulf States, and again appearing in Mexico and on the highlands of Guatemala. In Indiana it is confined to the southern half of the State. It is somewhat frequent along the inundated banks of streams, and in the southwestern counties it is frequent in wet woods. On some of the "flats" of the southern part of the State it is the principal species. Its occurance in our area is the northern limit of its distribution and it does not grow so large in the northern counties as it does in the southwestern part of the State where it attains its greatest size. In the forest it is a straight tall tree with a few short side branches.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Decatur (Ballard); Franklin (Hay-

[16—28415]

PLATE 74.



LIQUIDAMBAR STYRACIFLUA Linnæus. SWEET GUM. (x ½.)

mond) and (Meyncke); Gibson (Schneck); Jefferson (J. M. Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Coulter)*; Miami (Gorby)**; Monroe (Blatchley); vicinity of New Albany (Clapp); Parke (Hobbs); Posey (Schneck); Shelby (Ballard); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Clark, Dearborn, Decatur, Floyd, Gibson, Jackson, Posey, Ripley and Scott (Deam).

Economic uses. Wood heavy, hard, not strong, close-grained, inclined to shrink and warp in seasoning, takes a good polish, sap wood white, heart wood a rich brown which can be finished to imitate walnut or mahogany. In the export trade it is frequently referred to as American mahogany or satin walnut.

Horticultural value. It no doubt would prove to be perfectly hardy in at least the southern two-thirds of the State where it would be a desirable tree for shade and ornamental purposes. When grown in the open it develops a large oval crown, much resembling the maple in form and appearance. It is adapted to a wet or moist soil, somewhat difficult to transplant, grows rapidly; its foliage in summer is a glossy rich green, in autumn turning to brown, orange and crimson tints. It is practically free from disease and injurious insects.

PLATANÀCEÆ. THE PLANE TREE FAMILY.

PLÁTANUS. THE PLANE TREE.

Platanus occidentàlis Linnæus. SYCAMORE. Plate 75. Bark gray below, grayish-green above, splotched with white, on age separating from the tree in thin, brittle plates; buds when chewed at first bitter, followed by a pungent peppery taste; twigs pubescent when young, soon glabrous except a ring below the leaf scar, passing from a greenish-yellow to gray in color, at each node the growth changes direction from 10-25° which gives the twig a zigzag appearance; leaves alternate, broadly ovate in outline, 10-35 cm. (4-9 inches) wide, 3-5 lobed, the broad lobes frequently toothed, light green, hairy when expanding, soon glabrous except on the veins beneath, base of petiole sheathing the axillary buds; flowers appearing in May with the leaves in heads on woolly peduncles;

*From cultivated tree.
**Probably erroneous or from a cultivated tree.

PLATE 75.

PLATANUS OCCIDENTALIS Linnæus. SYCAMORE. (× ½.)

fruit in globular heads, 2-4 cm. (½-1½ inches) in diameter, composed of numerous seeds.

Distribution. Southern Ontario and Maine, south to the Gulf States and west to Nebraska and Texas. Found in all parts of Indiana. It is more or less frequent to common along all the streams of the State. It is also found on the border of lakes, ponds and in swamps and wet woods. In the southern part of the State it is frequently found on the open hillsides. It has the distinction of being the largest deciduous tree of North America. The larger trees are frequently hollow at the base and badly "windshaken," which much reduces their value for lumber. The "windshake" appears to be the more pronounced in the northern part of the State.

The published records of the distribution are as follows: Cass (Benedict and Elrod) and (Coulter); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Youse); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Montgomery (Thompson); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Bartholomew, Blackford, Crawford, Decatur, Jefferson, Montgomery, Parke, Owen, Wells (Deam).

Economic uses. Wood heavy, hard, weak, close-grained, difficult to split and work, takes a high polish, not durable in the soil, light brown. The principal uses are interior finish, frame material, heading, crating, office furniture and egg cases.

Horticultural value. It is well adapted for shade and ornamental purposes. Transplants well, adapted to a moist or dry soil, grows rapidly, straight, tall and narrow and stands pruning well. Its unique characteristics give it a constant charm. In the eastern states the foliage has been attacked by a fungous disease and this and the litter made by the falling bark and fruit are given as objections to this tree.

No doubt this species could be used to good advantage in reforesting the borders of streams and low ground.

MALACEÆ. THE APPLE FAMILY.

The trees of this family that occur in our area have simple, alternate leaves; perfect, regular flowers, 5-merous calyx and corolla; fruit a more or less fleshy pome.

Flowers in racemes, cavities of mature fruit twice as many as the styles, seeds less than 4 mm. (1/8 inch) long ..... 2 Amelanchier.
Flowers in cymes or corymbs, cavities of mature fruit as many as the styles, seeds more than 4 mm. (1/8 inch) long.
  Fruit green, mature carpels papery ..... 1 Malus.
  Fruit red, orange, blue, black or yellow, mature carpels bony ..... 3 Crataegus.

1. MALUS.* THE APPLES.

There are two marked forms of *Malus coronaria*. One of these has recently been segregated by Mr. Alfred Rehder as *Malus glaucescens*. The Indiana tree is intermediate between these two types as to most of the material seen; and at present it seems best to consider it one species.

Malus augustifolia has been reported from Indiana; but it is a southern species which I have seen no farther north than Cairo, Illinois.

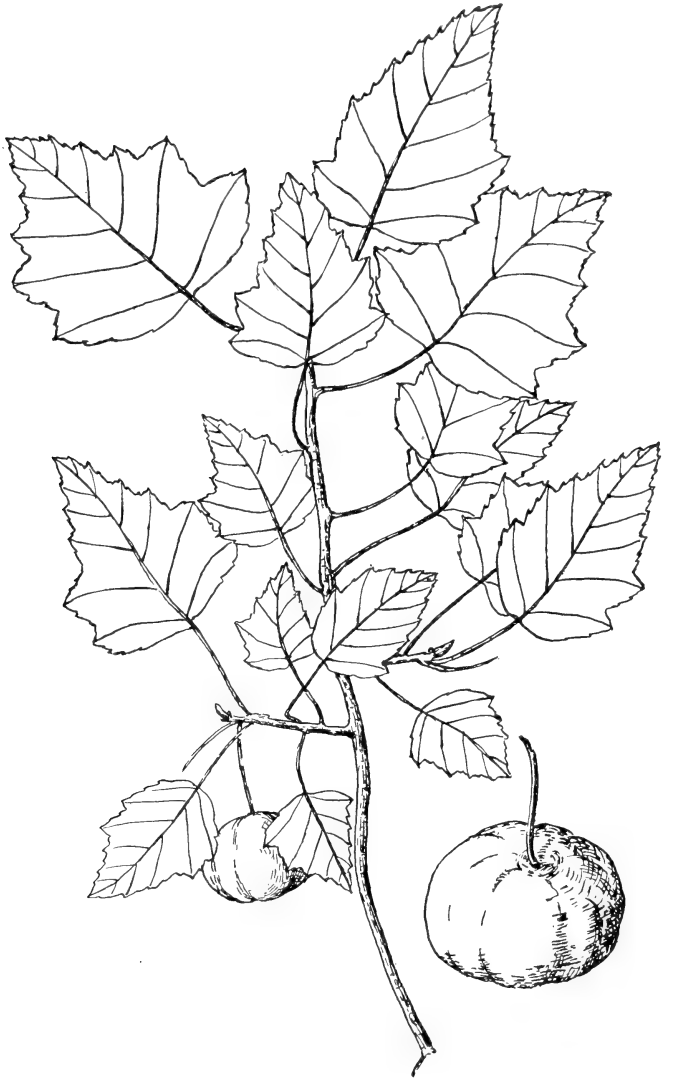
The narrow-leaved form of *Malus coronaria* and also *Malus ioensis* resemble *augustifolia* in leaf-outline and might easily be mistaken for it.

Leaves and petioles glabrous or only slightly pubescent; calyx lobes tomentose inside only; fruit depressed-globose, greenish-yellow ..... 1 M. coronaria.
Leaves (at least the lower surfaces) and petioles densely tomentose; calyx lobes densely tomentose on both sides; fruit subglobose, green ..... 2 M. ioensis.

1. Malus coronaria (Linnæus) Miller. CRAB APPLE. (*M. glaucescens* Rehder). Plates 76 and 77. Bark reddish, fissured and scaly; leaves on glandless petioles, petioles usually 2-4 cm. (¾-1½ inches) long, leaves narrow ovate to almost triangular, those on the lateral branchlets of the ovate type, those of the terminal branchlets and vigorous shoots of the triangular type, 3-8 cm. (1½-3 inches) long, acute at the apex, mostly rounded or somewhat cordate at the

*Contributed by W. W. Eggleston, Bureau of Plant Industry, Washington, D. C.

PLATE 76.



MALUS CORONARIA (Linnæus) Miller. WILD CRAB APPLE. (x ⅓.)
(Fruit, x 1.) (Wide-leaf form.)

PLATE 77.

MALUS CORONARIA (Linnæus) Miller. WILD CRAB APPLE. (x ½.)
(Narrow-leaf form.)

base, sometimes tapering, those of the triangular type usually truncate, margin of the ovate type of leaves more or less sharply serrate, the basal third of the leaf with shallow teeth or entire, margins of the triangular type more deeply serrate to almost lobed, hairy above and below when they expand, becoming smooth both above and below, sometimes a few hairs are found on the veins beneath at maturity, bright green above, paler beneath; flowers appear in May when the leaves are about half grown, usually 5 or 6 in a cluster, white or rose-color, very fragrant, 3-4 cm. (1½-2 inches) broad when fully expanded; calyx lobes lanceolate-acuminate, tomentose on the inside, glabrous outside; fruit depressed-globose, without angles, yellow-green, 2-4.5 cm. (¾-2 inches) thick, 2–2.5 cm. (¾-1 inch) long, very fragrant and covered with a waxy bloom.

Distribution. Central New York, lower peninsula Michigan, western New Jersey to northern Alabama and Missouri. Found in all parts of Indiana. No doubt in the original forest it was rare, but the removal of the large trees has been favorable to its growth until today it is somewhat frequent in moist open woods, along streams and neglected fences. It is most frequent among the hills in southern Indiana, and in all its distribution it is usually found in clumps.

In our area it is a small tree about 1-2 dm. (4-8 inches) in diameter and 4-6 m. (12-18 feet) high, with a spreading crown. However, individuals are found that are strict in habit and attain a height of 10 m. (30 feet).

The published records of the distribution are as follows: Clark (Smith); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Barnes); Knox (Spillman); Kosciusko (Clark) and (Coulter); Marion (Wilson); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Tippecanoe (Coulter); Vermillion (Wright); Vigo (Blatchley).

Additional records are: Floyd (Very); Putnam (Grimes); Tippecanoe (Dorner); Brown, Daviess, Decatur, Delaware, Grant, Kosciusko, Laporte, Morgan, Owen, Starke, Steuben, Warren and Wells (Deam).

Economic uses. The supply is so limited and the trees so small as to be of no economic importance. The pioneers were accustomed to make jelly out of the fruit.

Horticultural uses. Frequently planted for ornamental purposes on account of the profusion and fragrance of its flowers and yellow translucent fruit. Adapted to almost all kinds of soil.

PLATE 78.

MALUS IOENSIS (Wood) Britton. WESTERN CRAB APPLE. (x ½.)

PLATE 79.

AMELANCHIER CANADENSIS (Linnæus) Medicus. JUNEBERRY. (x ½.)

2. Malus ioensis (Wood) Britton. WESTERN CRAB APPLE. IOWA CRAB APPLE. Plate 78. Leaves oblong to ovate-oblong, 4-10 cm. (1½-4 inches) long, 2-8 cm. (¾-3¼ inches) wide, obtuse or acute at the apex, rounded or broadly cuneate at the base, dentate-crenate or doubly so, slightly pubescent above, becoming glabrous, dark green, slightly rugose above, densely white-tomentose below, remaining so at least along the veins; petioles 1.5-4 cm. (½-1½ inches) long, densely white-tomentose; corymbs 2-5 flowered, pedicles pubescent; calyx densely white-tomentose, calyx lobes lanceolate-acuminate, densely tomentose on both sides; flowers similar to those of *Malus coronaria*; fruit subglobose, without angles, green, 2-3.5 cm. (¾-1½ inches) thick, 2-3 cm. (¾-1¼ inches) long.

Distribution. Indiana, central Kentucky, Louisana, Wisconsin, southern Minnesota, eastern Kansas and Texas. A tree, in habit, similar to *Malus coronaria*.

Specimens have been seen from: Putnam (Grimes); Tippecanoe (Dorner). A fragment in the National Museum from New Albany, Floyd County, Ind., collected by C. F. Very, April 1896, No. 254781, may also belong to this species.

This species seems rather uncommon as far east as Illinois, still, no doubt, other stations will be found in Indiana, now that it is known to occur in the State.

2. AMELANCHIER THE SERVICE BERRIES.

Amelanchier canadensis (Linnæus) Medicus. JUNEBERRY. SERVICEBERRY. Plate 79. Bark light reddish-brown; leaves very broadly ovate to oblong, 4-8 cm. (1½-3 inches) long, acute, usually cordate at the base, sometimes rounded, finely serrate with incurved teeth, very hairy and folded together when very young, becoming glabrous above and below at maturity, frequently the under side persistently hairy, thick and firm, dark green above, paler beneath; petioles ¼-2/5 the length of the blade; flowers appear in April or May when the leaves are expanding at the ends of the branches in loose or spreading racemes; fruit ripens in June or July, globose, red or purplish, about 7 mm. (¼ inch) in diameter, sweet and edible.

This tree varies greatly in its size, in the kind of soil and location where it is found, in the shape and pubescence of the leaves, in the size and shape of the petals and in the size and color of the fruit. These variations have led authors to describe several varieties. The accompanying plate is the typical leaf form of the State. The oblong type is seldom seen in the northern part of the State,

but is common in the southern part. The tree is usually 0.5-1 dm. (2-4 inches) in diameter and 5-8 m. (15-25 feet) high.

Distribution. Newfoundland west along the shores of the Great Lakes, south to Florida and west to Minnesota and Kansas. It is frequent in northern Indiana on the wooded dunes bordering Lake Michigan and on the high banks of the lakes and rivers of the northern counties. In the remainder of the State it is usually rare and confined to the slopes of water courses.

The published records of the distribution are as follows: Cass (Benedict and Elrod) and (Hessler); Clark (Smith); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Hamilton (Wilson); Jay (M'Caslin); Jefferson (J. M. Coulter); Kosciusko (Clark); Marion (Douglas); Marshall (Hessler); Monroe (Blatchley); Noble (Van Gorder); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Brown, Clark, DeKalb, Fulton, Jackson, Laporte, Porter, Steuben and Wells (Deam).

Economic uses. Wood very hard, close-grained, strong, reddish-brown. The tree is too rare and small to be of any economic importance. The fruit is greedily devoured by birds and rarely is enough ripe fruit found to justify the gathering.

3. CRATÆGUS.* THORN APPLES. RED HAWS.

Large shrubs or small trees, best at home in a limestone region. This genus has been studied a great deal in this country in the past fifteen years. Much work is still necessary in Indiana since there are a number of other species that belong in this range.

The "knob country" and southwestern Indiana are likely to produce the best results.

A. Leaves not deltoid-cordate; pubescent or glabrous.
  I. Leaves broadest at the middle or the apex, cuneate.
    a. Leaves broadest towards the apex.
      Leaves not impressed-veined above, shining..... I. Crus-Galli.
        1 C. Crus-Galli.
      Leaves impressed-veined above, dull..... II. Punctatæ.
        Fruit ellipsoidal; nutlets usually 3 or 4.
          Leaves bright yellow-green, slightly impressed above; fruit ellipsoidal..... 2 C. cuneiformis.

*Contributed by W. W. Eggleston, Bureau of Plant Industry, Washington, D. C.

Leaves dull gray-green above, strongly impressed-veined; fruit short ellipsoidal..... 3 C. punctata.
Fruit globose..... 4 C. Margaretta.

b. Leaves broadest at the middle.

Leaves impressed-veined..... III. Macracanthæ.
Leaves dark green, glabrous and shining above, coriaceous.
Fruit sometimes 16 mm. (2/3 inch) thick; stamens usually 10; leaves and anthers large..... 5 C. succulenta.
Fruit sometimes 12 mm. (½ inch) thick; stamens 15-20; leaves and anthers small... 6 C. neo-fluvialis.
Leaves gray-green, pubescent and dull above, subcoriaceous..... 7 C. Calpodendron.
Leaves not impressed-veined..... IV. Virides.
Fruit bright red, glaucous, 4-6 mm. (1/6-¼ inch) thick; leaves serrate.. 8 C. viridis.
Fruit dull dark red, 6-8 mm. (¼-1/3 inch) thick; leaves coarsely serrate..... 9 C. nitida.

II. Leaves broadest at the base.

a. Leaves 1½-6 cm. (½-2½ inches) long and wide, membranaceous; calyx lobes usually entire.
Leaves yellow-green, often slightly pubescent; fruit soft at maturity..... V. Tenuifoliæ.
10 C. macrosperma.
Leaves blue-green, glabrous; fruit hard at maturity. VI. Pruinosæ.
Leaves elliptical-ovate.....11 C. Jesupi.
Leaves usually ovate.
Leaves usually cordate...12 C. rugosa.
Leaves usually cuneate.
Leaves deltoid.....13 C. Gattingeri.
Leaves ovate.....14 C. pruinosa.

b. Leaves 3-10 cm. (1-4 inches) long and wide; calyx lobes usually serrate..... VII. Coccineæ.
Mature leaves usually glabrous above; young foliage bronze-green; anthers pink.
Corymbs and fruit glabrous.15 C. coccinoides.
Corymbs and fruit pubescent or tomentose.....16 C. coccinæ.
Mature leaves tomentose above; young foliage yellow-green; anthers yellow.17 C. mollis.

B. Leaves conspicuously deltoid-cordate, glabrous; fruit 4-6 mm. (1/6-¼ inch) thick.....18 C. Phænopyrum.

1. Cratægus Crus-Galli Linnæus. COCK-SPUR THORN. NEWCASTLE THORN. Plate 80. Bark dark gray, scaly; spines many, strong, straight, 3-18 cm. (1-7 inches) long; leaves obovate to elliptical, 2-10 cm. (¾-4 inches) long, 1-4 cm. (¼-1½ inches) wide, sharply serrate, except towards the base, acute or rounded at the apex, cuneate, dark green and shining above, coriaceous, glabrous or occasionally slightly pubescent; petioles slightly winged above, glandless, 1-2 cm. (⅜-¾ inch) long; corymbs glabrous or occasionally pubescent, many flowered; flowers appear in May or June, about 1.5 cm. (2/3 inch) wide, stamens 10-20, anthers usually pink, calyx lobes lanceolate-acuminate, entire, styles and nutlets usually 2; fruit ripens in October, ellipsoidal-ovoid to subglobose about 1 cm. (⅜ inch) thick, greenish to red; flesh hard and dry, rather thin.

Distribution. Northern New York to Ontario, eastern Kansas and south through western Connecticut to Georgia and Texas. Introduced near Montreal, about Lake Champlain and on Nantucket Island. Well distributed in Indiana but apparently more common in the south part of the State.

A small tree, sometimes 10 m. (35 feet) high, with spreading branches and a broad crown; but often a large shrub. This is a variable species and has received many names.

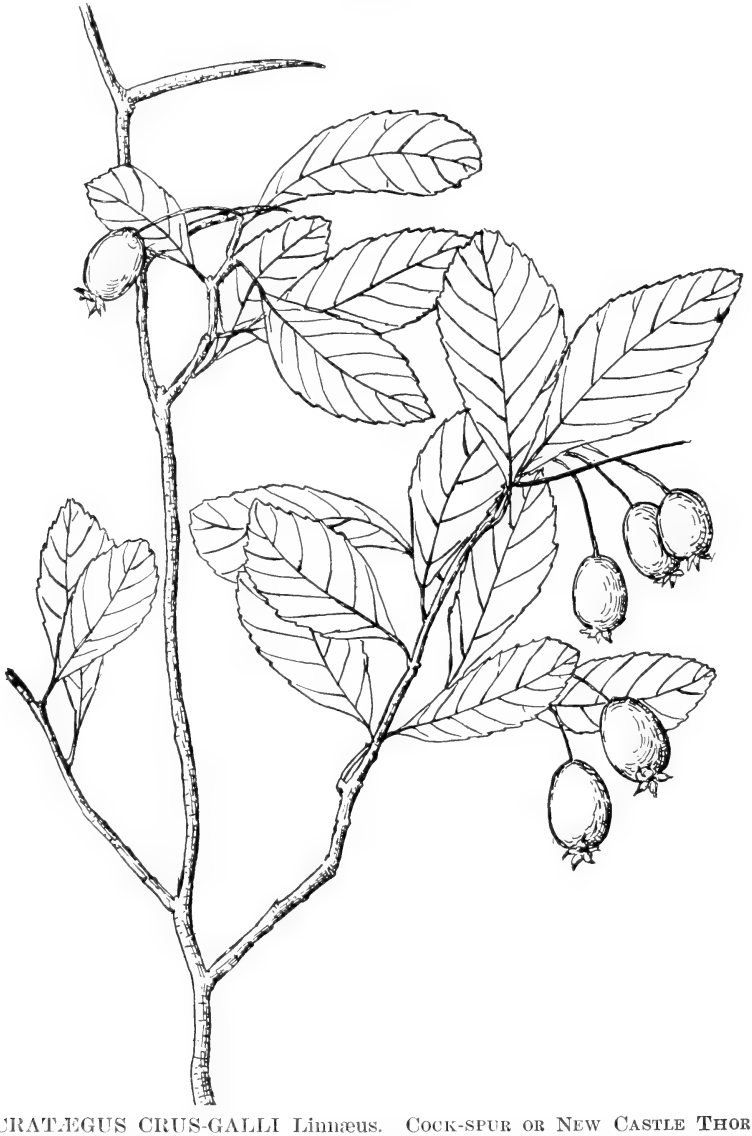
I have seen specimens from the following counties: Crawford (Deam); Decatur (Mrs. C. C. Deam); Gibson (Schneck); Jackson (Deam); Knox (Schneck); Lawrence and Posey (Deam); Owen (Grimes); Vigo (Blatchley); Wells (Deam).

Economic uses. The timber is hard and tough, similar to the ordinary apple, and useful for the same purposes as applewood.

Horticultural uses. Valuable hedge plant, and its shiny, dark green leaves and abundance of white flowers make it also a highly ornamental plant for parks and lawns.

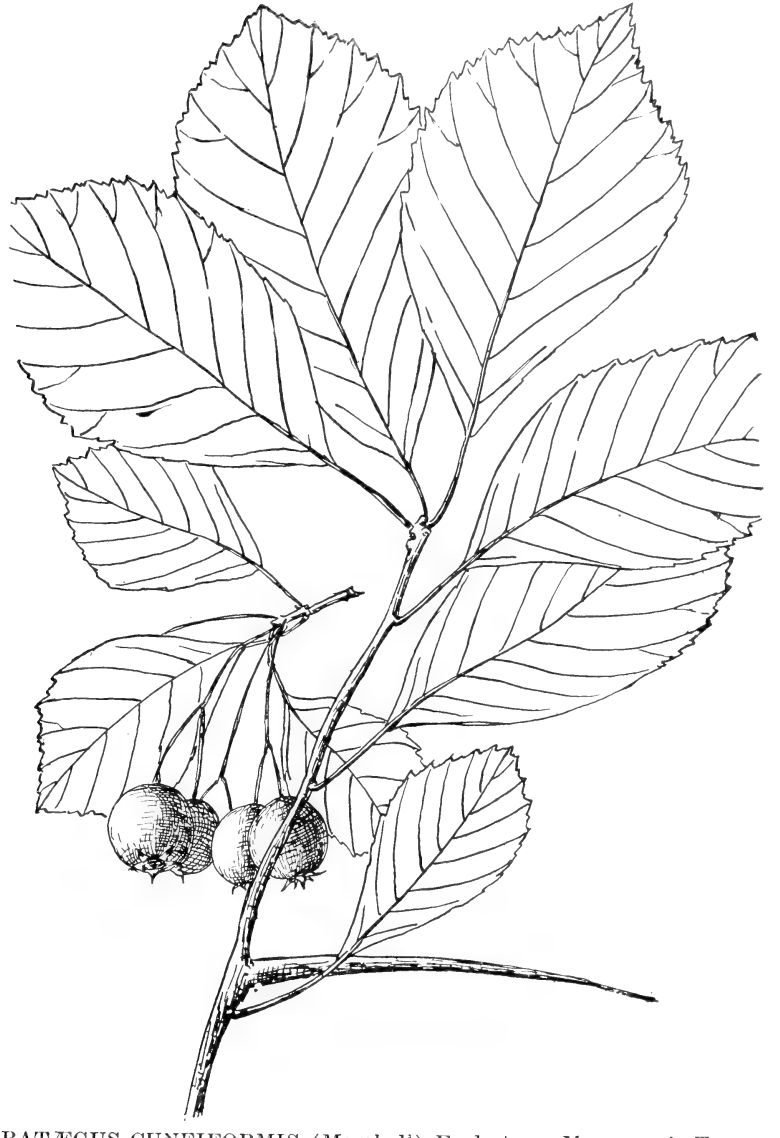
2. Cratægus cuneiformis (Marshall) Eggleston. MARSHALL'S THORN. (*C. pausiaca* Ashe). Plate 81. Bark dark brown, scaly; spines numerous, 2-18 cm. (¾-7 inches) long; leaves oblanceolate-obovate, acute at the apex, cuneate at the base, serrate or doubly serrate, 3-6 cm. (1¼-2½ inches) long, 1.5-4 cm. (½-1½ inches) wide, dark vivid yellow-green, glabrous and impressed-veined above when mature, subcoriaceous; petioles 1-2 cm. (⅜-¾ inch) long, slightly winged above; corymbs usually slightly pubescent, many flowered; flowers appear in May, 1.2-1.5 cm. (½-2/3 inch) wide; stamens 10-15, anthers dark pink, styles and nutlets 2-4, calyx lobes lanceolate-acuminate, entire; fruit ripens in October, ellip-

PLATE 80.



CRATÆGUS CRUS-GALLI Linnæus. COCK-SPUR OR NEW CASTLE THORN. (x 1.)

PLATE 81.



CRATÆGUS CUNEIFORMIS (Marshall) Eggleston. MARSHALL'S THORN.
(x 1.)

[17—28415]

soidal-pyriform, scarlet or dark red, about 8 mm. (3/8 inch) thick, flesh hard, thick.

Distribution. Western New York and Pennsylvania to southwestern Virginia, west to central Illinois.

A small tree sometimes 8 m. (25 feet) high, with spreading branches forming a flat or round crown. This species is intermediate between *Crus-Galli* and *punctata*, and has been found as yet only in a region where both these species are known.

I have seen specimens from the following counties: Clark (Deam); Gibson (Schneck); Hamilton (Mrs. C. C. Deam); Knox (Schneck); Vigo (Blatchley).

3. Cratægus punctata Jacquin. LARGE-FRUITED THORN. DOTTED HAW. Plate 82. Bark grayish-brown, scaly; thorns light gray, 2-5 cm. (3/4-2 inches) long, straight; leaves obovate to oblong, 2-8 cm. (3/4-3 inches) long, 1-5 cm. (1/4-2 inches) broad, dull gray-green and markedly impressed-veined above, pubescent, becoming nearly glabrous above when mature, acute or obtuse at the apex, sharply cuneate at the base; serrate, doubly serrate or lobed at the apex, subcoriaceous; petioles 1-2 cm. (3/8-3/4 inch) long, slightly winged above; corymbs tomentose or canescent, many flowered; flowers appear in June, about 2 cm. (5/6 inch) wide, calyx lobes lanceolate-acuminate, entire, stamens about 20, anthers white or pink, styles and nutlets usually 3 or 4; fruit ripens in October or November, green, yellow or red, short-ellipsoidal, 1.2-2.5 cm. (1/2-1 inch) thick, flesh hard, thick, calyx lobes spreading.

Distribution. Quebec to Pennsylvania, southeastern Minnesota, Iowa, Kentucky and south to the high Alleghenies. Well distributed over Indiana.

A small tree, sometimes 10 m. (35 feet) high, with distinctly horizontal branches and a broad, flat crown.

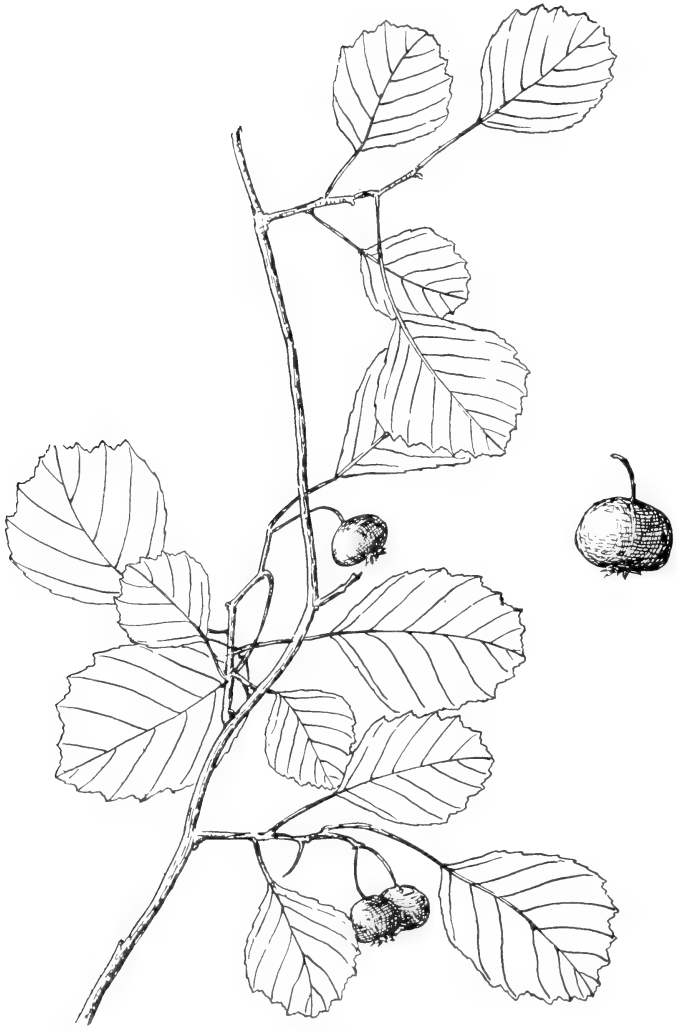
Specimens have been seen from the following counties: Bartholomew, Fulton and Gibson (Deam); Hamilton (Mrs. C. C. Deam); Howard, Jennings and Marion (Deam); Putnam (Grimes); Vigo (Blatchley); Vermillion and Wells (Deam).

4. Cratægus Margaretta Ashe. JUDGE BROWN'S THORN. MRS. ASHE'S THORN. Plate 83. Bark dark grayish-brown; spines curved, 2-4 cm. (3/4-1 1/2 inches) long; leaves oblong-obovate or ovate, sometimes broadly so, 2-6 cm. (3/4-2 1/2 inches) long, 2-4 cm. (3/4-1 1/2 inches) wide, obtuse or acute at the apex, cuneate or rounded at the base, serrate or doubly serrate with 2 or 3 pairs of acute or obtuse lobes towards the apex, glabrous when mature, dark green

PLATE 82.

CRATÆGUS PUNCTATA Jacquin. LARGE-FRUITED THORN. DOTTED HAW (x 1.)

PLATE 83.



CRATÆGUS MARGARETTA Ashe. JUDGE BROWN'S THORN. MRS. ASHE'S THORN. (x $\frac{1}{2}$.) (Fruit x 1.)

above, membranaceous, petioles 1-3 cm. (⅜-1¼ inches) long, slightly winged; corymbs slightly pubescent, becoming glabrous, 5-12 flowered; flowers appear in May, 1.5-2 cm. (½-5/6 inch) wide, stamens about 20, anthers yellow, styles and nutlets usually 2, calyx lobes lanceolate-acuminate, slightly pubescent inside; fruit ripens in October, dull rusty green, yellow or red, compressed-globose to short-ellipsoidal, angular, 8-15 mm. (½-2/3 inch) thick, flesh-yellow, mealy, hard, thick, calyx lobes reflexed, deciduous.

Distribution. Southern Ontario to central Iowa, western Virginia, Tennessee and Missouri. Known in Indiana only from the northern part of the State.

A small tree sometimes 8 m. (25 feet) high, with spreading branches.

Specimens have been seen from the following counties: Cass (Mrs. Ida Jackson); Delaware, Fulton, Steuben and Wells (Deam).

5. Cratægus succulenta Schrader. LONG-SPINED THORN (*C. macracantha* Loddiges). Plate 84. Bark gray; spines numerous, strong, 3-10 cm. (1½-4 inches) long, chestnut-brown; leaves rhombic-ovate to obovate, 3-8 cm. (1¼-3¼ inches) long, 2.5-6 cm. (1-2½ inches) wide, acute at the apex, broadly cuneate at the base, serrate or doubly serrate with fine teeth, often lobed towards the apex, coriaceous, dark shining green above, pubescent along the veins beneath; petioles 1-2 cm. (⅜-¾ inch) long, slightly winged above; corymbs slightly villous, many-flowered; flowers appear in May, about 2 cm. (⅝ inch) broad, stamens 10-20, usually 10, anthers pink or occasionally yellow or white, large, styles and nutlets usually 2 or 3, calyx lobes lanceolate-acuminate, glandular-laciniate, villous; fruit ripens in September, subglobose, 5-15 mm. (¼-2/3 inch) thick, dark red, shining villous, calyx-lobes reflexed, flesh thin, glutinous; nutlets with deep pits on the inner faces.

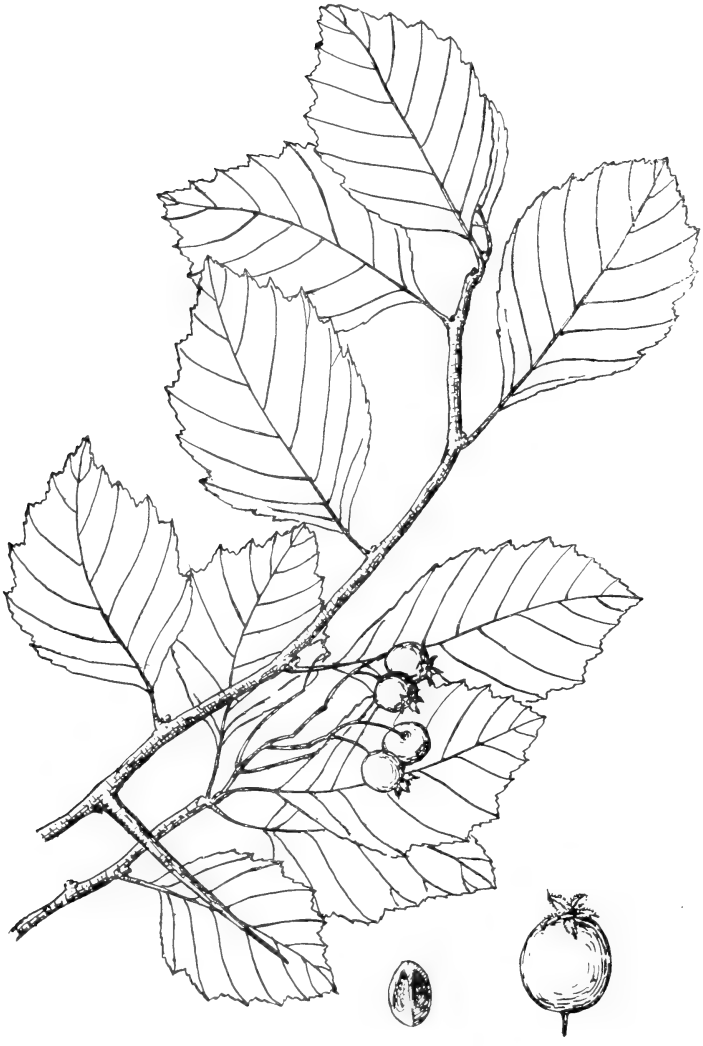
Distribution. Nova Scotia to Minnesota, Nebraska and south in the higher Alleghenies to North Carolina and in the Rocky Mountains to southern Colorado. As yet reported only from northern to central Indiana.

A small tree sometimes 6 m. (20 feet) high, with ascending branches and a broad, irregular crown; more often, however, a large shrub.

Specimens have been seen from the following counties: Cass (Mrs. Ida Jackson); Fulton (Deam); Noble (Van Gorder); Putnam (Grimes); Wells (Deam).

Horticultural uses. Highly ornamental for parks and hedges from the abundant flowers, dark green shining leaves and its dark red shining fruit.

PLATE 84.



CRATÆGUS SUCCULENTA Schrader. LONG-SPINED THORN. (x ½.)
(Fruit and nutlet x 1.)

PLATE 85.

CRATÆGUS NEO-FLUVIALIS Ashe. NEW RIVER THORN. (x ½.)
(Fruit, x 1.)

6. Cratægus neo-fluvialis Ashe. NEW RIVER THORN. Plate 85. Bark grayish; spines numerous, 2.5-8 cm. (1-3 inches) long; leaves elliptical-ovate to obovate, 2.5-8 cm. (1-3 inches) long, 2-6 cm. (¾ 2½ inches) wide, acute or obtuse at the apex, cuneate at the base, sharply and doubly serrate, with obtuse or acute lobes towards the apex, coriaceous, dark green and shining above, pubescent along the veins beneath; petioles 1-2 cm. (⅜-¾ inch) long, slightly winged above; corymbs and calyx-tubes glabrous or slightly villous, many-flowered; flowers appear in May, 1.2-1.6 cm. (½-2/3 inch) broad, stamens 15-20, anthers usually pink, small, styles and nutlets usually 2 or 3, calyx lobes more villous on the inside, lanceolate-acuminate, glandular-laciniate; fruit ripens in September, globose or short ellipsoidal, dark red, 4-12 mm. (¼-½ inch) thick, glabrous or slightly hairy; calyx lobes reflexed, flesh thin, glutinous; nutlets with deep pits on the inner faces.

Distribution. Western Vermont to eastern Wisconsin, Iowa and south in the Alleghenies to North Carolina.

A small tree sometimes 9 m. (30 feet) high, with ascending and spreading branches.

Specimens have been seen from Wells County (Deam).

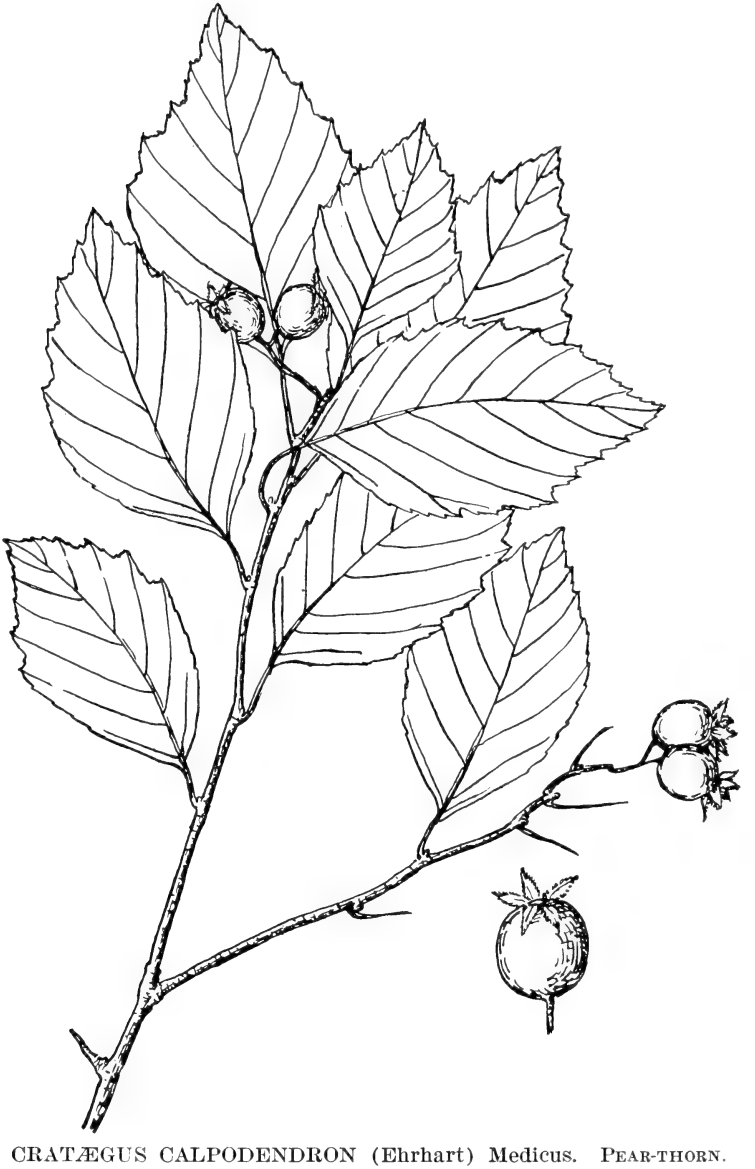
7. Cratægus Calpodendron (Ehrhart) Medicus. PEAR-THORN. PEAR OR RED HAW. Plate 86. Bark pale gray to dark brown, furrowed; spines occasional, slender 3-5 cm. (1¼-2 inches) long; leaves rhombic-ovate, 4-11 cm. (1½-4½ inches) long, 3-8 cm. (1¼-3 inches) wide, acute or acuminate at the apex, finely and doubly serrate, those on the vegetative shoots obtuse and more entire than the others, pubescent on both sides, becoming scabrate above, subcoriaceous, dull green above; petioles about 2 cm. (¾ inch) long, wing margined, glandular hairy; corymbs white-tomentose, many-flowered; flowers appear in June, about 1.5 cm. (2/3 inch) broad, stamens about 20, anthers small, pink, styles and nutlets usually 2 or 3, calyx lobes lanceolate-acuminate, glandular-laciniate; fruit ripens in September, pyriform to ellipsoidal, orange-red or red, 8-10 mm. (1/3 inch) thick; calyx lobes reflexed; flesh glutinous, nutlets with deep pits in their inner faces.

Distribution. Central New York, northeastern New Jersey to Minnesota and Missouri and south in the mountains to northern Georgia.

A large shrub or occasionally a tree 6 m. (20 feet) high, with ascending branches forming a broad crown.

Specimens have been examined from the following counties: Marion and Posey (Deam); Putnam (Grimes); Wells (Deam).

PLATE 86.



CRATÆGUS CALPODENDRON (Ehrhart) Medicus. PEAR-THORN. PEAR OR RED HAW. (x ½.) (Fruit, x 1.)

8. Cratægus viridis Linnæus. SOUTHERN THORN. Plate 87. Bark gray to light orange; spines uncommon, 2-5 cm. (¾-3¼ inches) long; leaves oblong-ovate, 2-8 cm. (¾-3¼ inches) long, 2-5 cm. (½-2 inches) wide, acute, acuminate or even obtuse at the apex, serrate or doubly serrate, often with acute or obtuse lobes towards the apex, dark green, shining and slightly impressed-veined above, sometimes pubescent along the veins beneath; petioles 1-2 cm. (⅜-¾ inch) long, slightly winged above; corymbs glabrous, many flowered; flowers appear in May, 1-1.5 cm. (½-2/3 inch) broad, stamens about 20, anthers usually yellow, sometimes pink, styles and nutlets 4 or 5, calyx lobes lanceolate-acuminate, entire, slightly pubescent inside; fruit ripens in October, globose or compressed-globose, bright red or orange, glaucous, 4-6 mm. (¼ inch) thick, flesh thin, hard, edible.

Distribution. Moist, alluvial soil along streams and lakes, southeastern Virginia to northern Florida and southwestern Indiana to eastern Kansas and Texas.

A tree from 6-11 m. (20-35 feet) high, with ascending branches and a broad crown.

Specimens examined: Gibson and Knox (Schneck); Posey (Deam).

9. Cratægus nitida (Engelmann) Sargent. SHINING THORN. Plate 88. Bark dark and scaly; spines occasional, 3-5 cm. (1-2 inches) long; leaves oblong-ovate to oval, 3-8 cm. (1¼-3 inches) long, 2-6 cm. (¾-2¼ inches) wide, acute at the apex, cuneate at the base, coarsely serrate or twice serrate with acute lobes towards the apex, dark green and shining above, glabrous; petioles 1-2 cm. (⅜-¾ inch) long, slightly winged above, slightly villous when young; corymbs glabrous, many-flowered; flowers appear in May, 1.2-2 cm. (½-¾ inch) broad, stamens about 20, anthers light yellow, styles and nutlets 3-5, calyx lobes lanceolate-acuminate, entire; fruit ripens in October, globose to short-ellipsoidal, dark dull red, 6-9 mm. (¼-½ inch) thick; flesh yellow, mealy, hard.

Distribution. River bottoms southwestern Indiana to southern Illinois. A tree sometimes 9 m. (30 feet) high, with ascending and spreading branches and a broad crown.

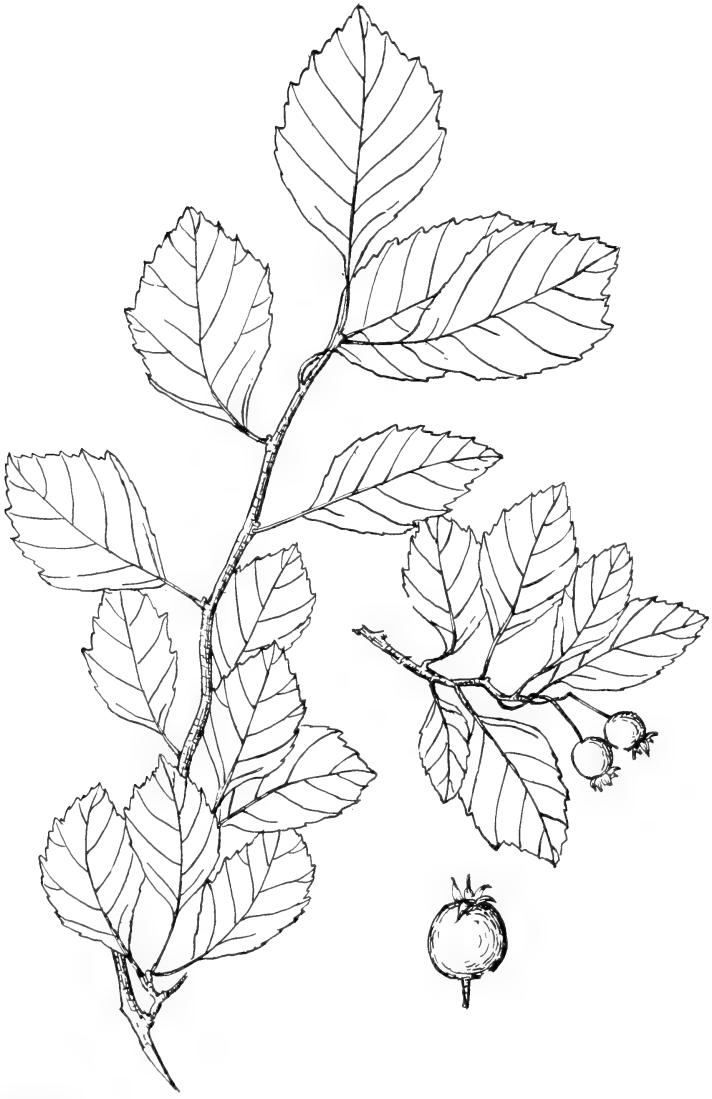
Specimens have been seen from: Gibson (Schneck); Posey (Deam).

10. Cratægus macrosperma Ashe. VARIABLE THORN. Plate 89. Bark brown, scaly; spines numerous, stout, curved, 2-7 cm. (¾-2¾ inches) long; leaves broadly elliptical-ovate to broadly ovate, 2-7 cm. (¾-2¾ inches) long and wide, acute at the apex, rounded, truncate or rarely cordate at the base, serrate or doubly serrate,

PLATE 87.

CRATÆGUS VIRIDIS Linnæus. SOUTHERN THORN. (x $\frac{1}{2}$.)

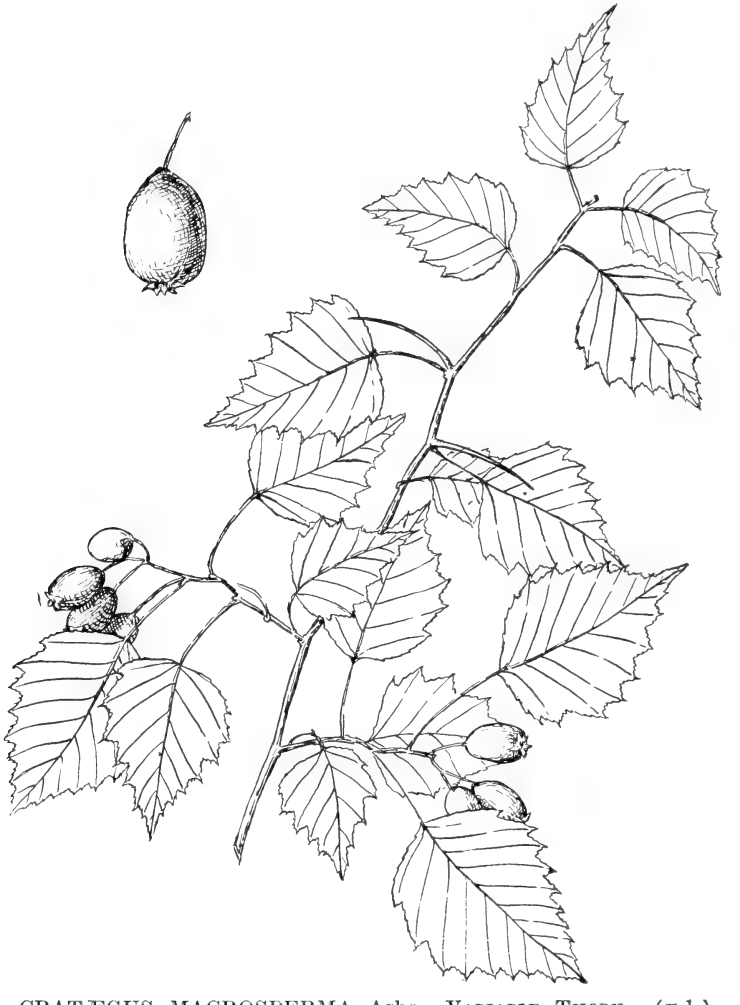
PLATE 88.



CRATÆGUS NITIDA (Engelmann) Sargent. SHINING THORN. (x ½.)
(Fruit, x 1.)

slightly villous, becoming glabrate, dark yellow-green above, membranaceous; petioles slender, 2-3 cm. (½-1¼ inches) long, slightly winged above; corymbs glabrous or slightly villous, many-flowered;

PLATE 89.



CRATÆGUS MACROSPERMA Ashe. VARIABLE THORN. (x ½.)
(Fruit, x 1.)

flowers appear in May, 1.5-2 cm. (½-¾ inch) broad, stamens 5-20, usually 5-10, styles and nutlets usually 3 or 4, calyx lobes lanceolate-acuminate, entire; fruit ripens in August or September, ellipsoidal or pyriform, scarlet to crimson, often glaucous, 1-1.8

cm. (1/3-¾ inch) thick, flesh succulent, edible, calyx lobes persistent, erect or spreading.

Distribution. Nova Scotia and Maine to southeastern Minnesota and south in the mountains to North Carolina and Tennessee.

Usually a large shrub but occasionally a small tree sometimes 8 m. (25 feet) high, with ascending branches.

Specimens have been seen from the following counties: Clark, Fulton, Madison, Porter, Shelby and Wells (Deam).

11. Cratægus Jesupi Sargent. JESUP'S THORN. TWIN MOUNTAIN THORN. Plate 90. Bark grayish-brown; spines stout, straight, 2-4 cm. (¾-1½ inches) long; leaves elliptical-ovate, 3.5-7 cm. (1½-3 inches) long, 2-5.5 cm. (1-2 inches) wide, acute or acuminate at the apex, broadly cuneate to truncate-cordate, serrate or doubly serrate with 4 or 5 pairs of acute lobes, yellow-green above, paler beneath, glabrous; petioles slender, 2-3.5 cm. (¾–1½ inches) long, slightly winged above; corymbs glabrous, many-flowered; flowers appear in May, about 2 cm. (5/6 inch) broad, stamens about 10, anthers dark red, styles and nutlets usually 3 or 4, calyx lobes entire; fruit ripens in October, short-ellipsoidal to pyriform, dark red, slightly angled, lacking bloom when mature, about 1 cm. (⅜ inch) thick, calyx lobes mostly deciduous, flesh yellow, firm.

Distribution. Western Vermont to southwestern Wisconsin and south to Pennsylvania and Owen County, Indiana.

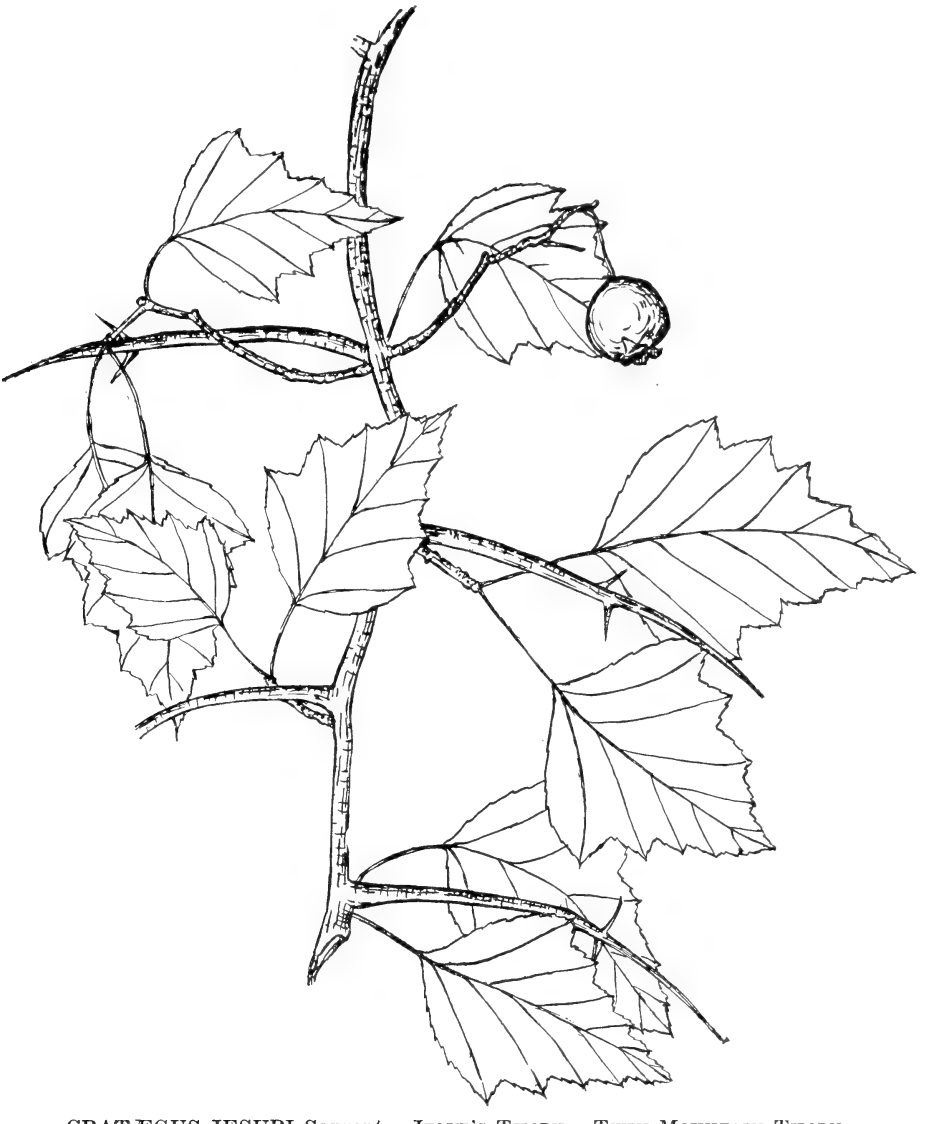
A shrubby tree, sometimes 6 m. (20 feet) high, with ascending branches and a round crown.

Specimens examined: Owen (Mrs. C. C. Deam).

12. Cratægus rugosa Ashe. FRETZ'S THORN. (*C. deltoides* Ashe.) Plate 91. Spines numerous, 3-6 cm. (1¼-2½ inches) long, stout, curved; leaves broadly ovate, 3-7 cm. (1-2¾ inches) long and broad, acute or acuminate at the apex, cordate or truncate at the base, serrate or twice serrate with 4-6 pairs of broad acuminate lobes, glabrous, membranaceous; petioles 1-3 cm. (⅜-1¼ inches) long, glabrous; corymbs many-flowered, glabrous; flowers appear in May, about 2 cm. (5/6 inch) broad, stamens 10-20, anthers pink, styles and nutlets usually 4 or 5, calyx lobes deltoid-acuminate, entire or slightly serrate at the base; fruit ripens in October, depressed-globose, bright red, angular, glabrous, waxy, 1-1.5 cm. (½-2/3 inch) thick, flesh yellow, somewhat succulent, calyx lobes persistent, spreading, the tube rather prominent.

Distribution. Southwestern New England to southern Indiana and the mountains of North Carolina.

PLATE 90.

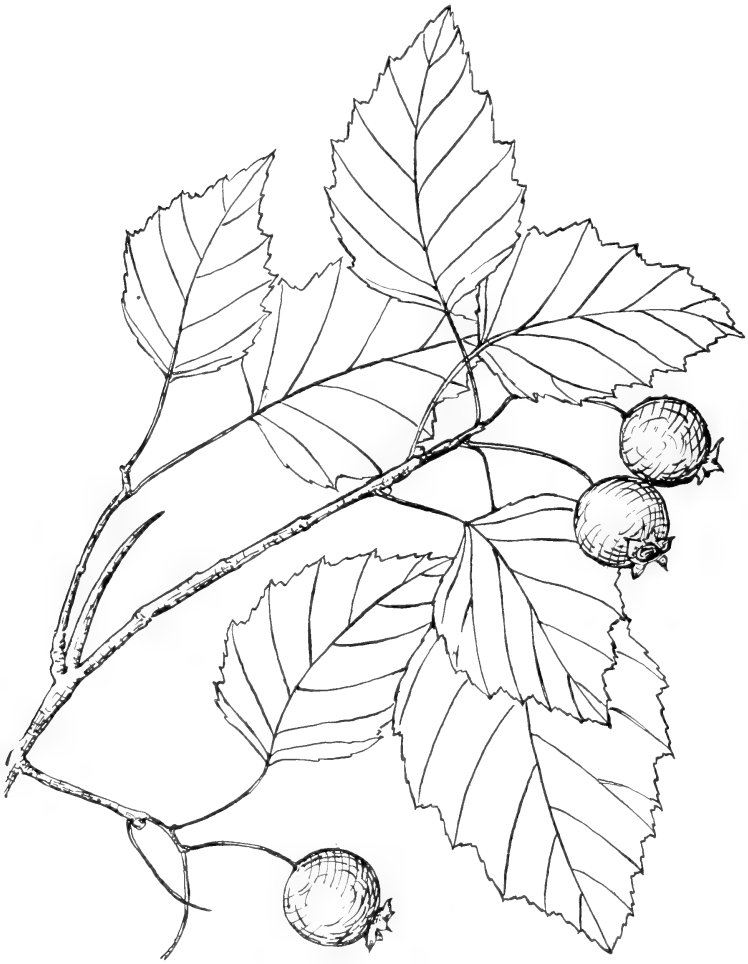


CRATÆGUS JESUPI Sargent. JESUP'S THORN. TWIN MOUNTAIN THORN.
(x 1.)

A shrub or tree sometimes 6 m. (20 feet) high, with ascending branches and an irregular crown.

Specimens examined: Jennings and Owen (Deam).

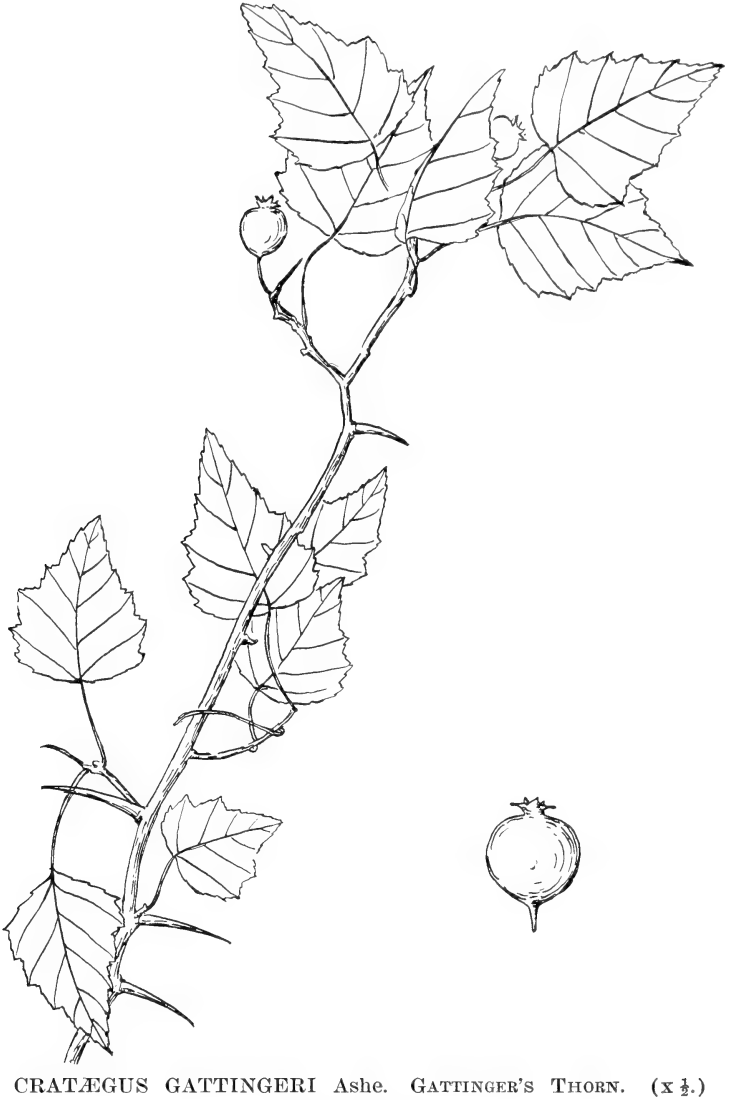
PLATE 91.



CRATÆGUS RUGOSA Ashe. FRETZ'S THORN. (x 1.)

13. Cratægus Gattingeri Ashe. DR. CLAPP'S THORN. GATTINGER'S THORN. (*C. coccinea* var. *oligandra* Torrey and Gray). Plate 92. Spines numerous, 2.5-6 cm. (1-2 inches) long; leaves narrowly ovate to deltoid, 2.5-6 cm. (1-2½ inches) long, 2-5 cm. (¾-2 inches) wide, acuminate at the apex, broadly cuneate or

PLATE 92.



CRATÆGUS GATTINGERI Ashe. GATTINGER'S THORN. (× ½.)
(Fruit, × 1.)

rounded at the base, serrate or doubly serrate, lobed towards the apex, membranaceous, glabrous, dark green above; petioles glabrous, 2-3 cm. (¾-1¼ inches) long; corymbs glabrous, many-flowered; flowers appear in May, about 2 cm. (¾ inch) broad, stamens 10-20, anthers small, pink, styles and nutlets usually 3 or 4; fruit ripens in October, globose, angular, red, slightly waxy, 0.8-1.2 cm. (1/3-½ inch) thick, flesh hard, calyx tube prominent, the lobes triangular, spreading.

Distribution. Southern Pennsylvania and southern Indiana to West Virginia and central Tennessee.

Shrub or small tree sometimes 4.5 m. (15 feet) high, with ascending, irregular branches.

Specimens seen from: Floyd (Dr. Clapp) (Before 1840); Knox (Schneck).

14. Cratægus pruinosa (Wendland) K. Koch. WAXY-FRUITED THORN. Plate 93. Bark dark brown; spines numerous, slender, 3-6 cm. (1¼-2½ inches) long, leaves elliptical-ovate to broadly ovate, 2.5-6 cm. (1-2½ inches) long and wide, acute or acuminate at the apex, abruptly cuneate, rounded or occasionally cordate at the base, serrate or doubly serrate with 3 or 4 pairs of broad acute lobes towards the apex, blue-green, glabrous, membranaceous; petioles 2 or 3 cm. (¾-1¼ inches) long, glabrous; corymbs glabrous, many-flowered; flowers appear in May, about 2 cm. (5/6 inch) broad, stamens 10-20, anthers pink or sometimes yellow or white, styles and nutlets 4 or 5, calyx lobes lanceolate-acuminate, entire, slightly serrate at the base; fruit ripens in October, depressed-globose to short-ellipsoidal, strongly angled, waxy, apple-green, becoming scarlet or purple, 1.2-1.5 cm. (½-2/3 inch) thick, flesh firm, yellow, sweet, calyx tube prominent, the lobes spreading, persistent.

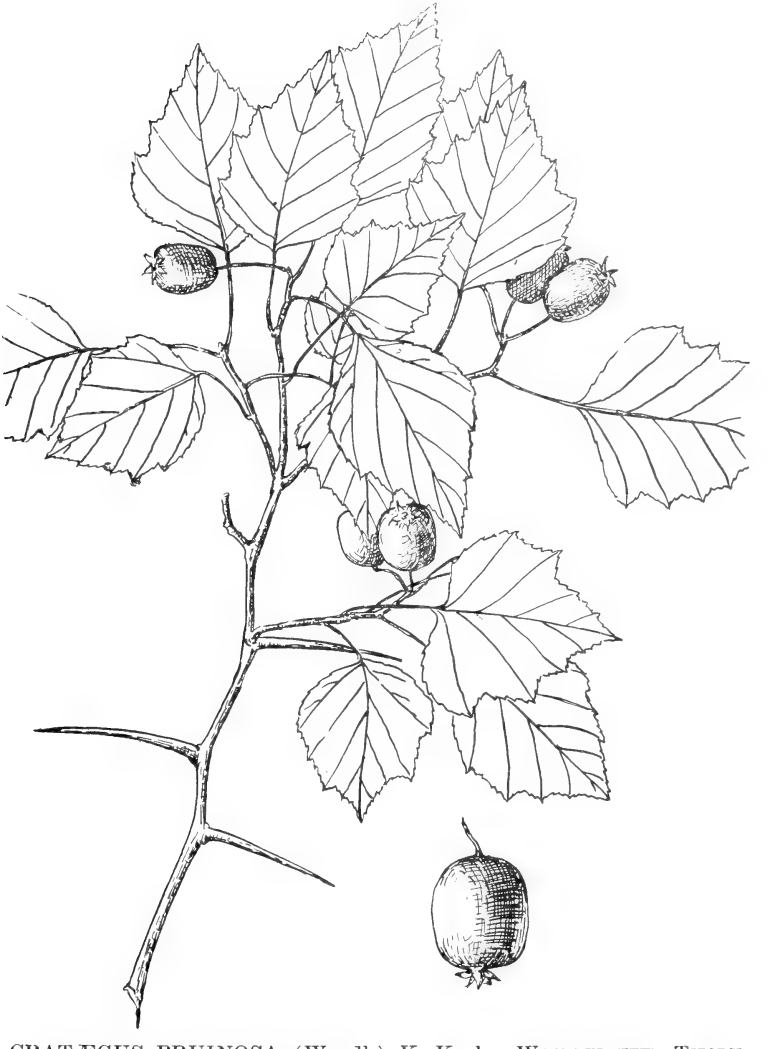
Distribution. Rocky, open woods, western New England to Michigan and south to North Carolina and Missouri. Well distributed in Indiana.

A small shrubby tree, sometimes 6 m. (20 feet) high, with irregular branches and crown.

Specimens have been seen from the following counties: Decatur, Delaware, Gibson, Hamilton, Madison, Steuben, Warren and Wells (Deam); Putnam (Grimes).

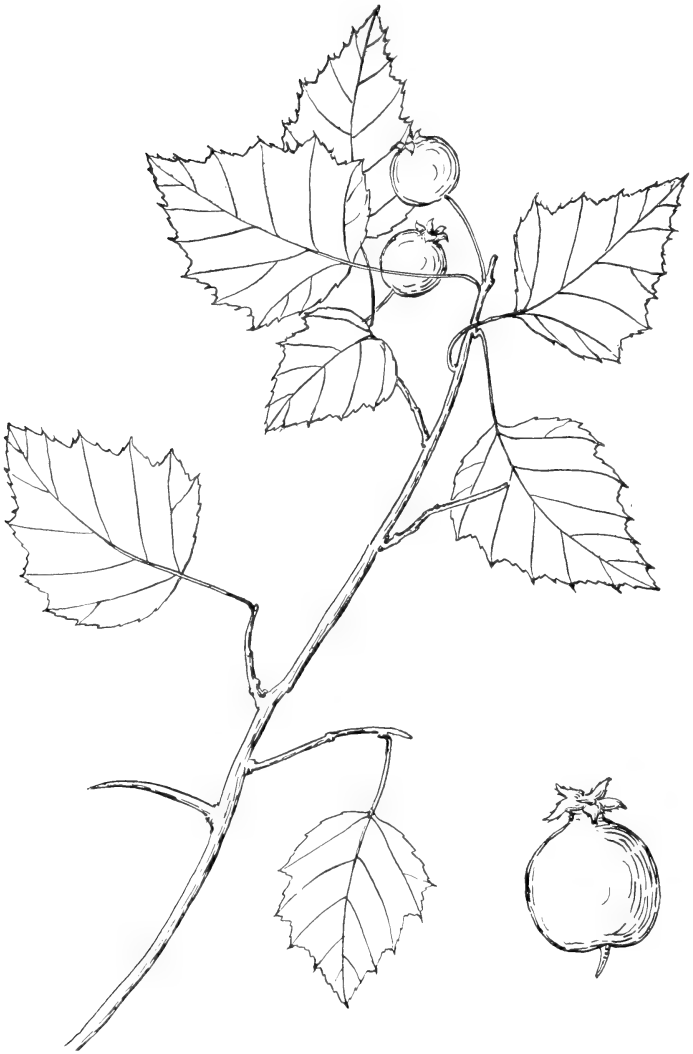
15. Cratægus coccinoides Ashe. EGGERT'S THORN. (*C. Eggertii* Britton). Plate 94. Bark grayish-brown, scaly; spines curved, 2-6 cm. (¾-2½ inches) long; leaves broadly ovate, 4-9 cm. (1½-3½

PLATE 93.



CRATÆGUS PRUINOSA (Wendl.) K. Koch. WAXY-FRUITED THORN.
(x ½.) (Fruit, x 1.)

PLATE 94.



CRATÆGUS COCCINOIDES Ashe. EGGERT'S THORN. (x ½.)
(Fruit, x 1.)

inches) long, 3.5-8 cm. (1¾-3 inches) wide, acute at the apex, rounded or truncate at the base, doubly serrate with several pairs of broad, acute lobes, dark green above, paler and slightly tomentose along the veins beneath, membranaceous; petioles 2 or 3 cm. (¾-1¼ inches) long, slightly pubescent; corymbs glabrous, 5-12 flowered; flowers appear in May, about 2 cm. (5/6 inch) broad, stamens about 20, anthers pink, styles and nutlets usually 4 or 5, calyx lobes ovate, acute, glandular-serrate; fruit ripens in September, subglobose, obtusely angled, 1.5-2 cm. (¾-1 inch) thick; calyx tube prominent, the lobes spreading, flesh reddish, subacid, edible.

Distribution. Montreal Island to Rhode Island and west to eastern Kansas and Missouri.

A small tree sometimes 6 m. (20 feet) high, with ascending and spreading branches and a broad, round-topped crown.

Specimens have been seen from: Floyd (Dr. Clapp) (before 1840); Gibson (Schneck); Marion (Deam); Vigo (Blatchley).

16. Cratægus coccinea Linnæus. SCARLET THORN. RED HAW. (*C. pedicillata* Sargent). Plate 95. Bark light gray; spines stout, curved, 2-6 cm. (¾-2 inches) long; leaves broadly ovate, 3-10 cm. (1¼-4 inches) long, 3-9 cm. (1¼-3½ inches) wide, acute or acuminate at the apex, broadly cuneate to truncate at the base, serrate, doubly serrate or lobed, slightly pubescent becoming scabrous above, nearly glabrous beneath, membranaceous; corymbs glabrous or sometimes slightly villous, many-flowered; flowers appear in May, 1.5-2 cm. (2/3-5/6 inch) broad, stamens 10-20, anthers pink, styles and nutlets 3-5; fruit ripens in September, pyriform to short-ellipsoidal, scarlet or red, glabrous or slightly pubescent, 1.5-2 cm. (¾-5/6 inch) thick; calyx lobes lanceolate-acuminate, glandular-serrate, erect or spreading, rather persistent; flesh thick, dry and mealy.

Distribution. Connecticut to Ontario, Illinois, Delaware and Pennsylvania.

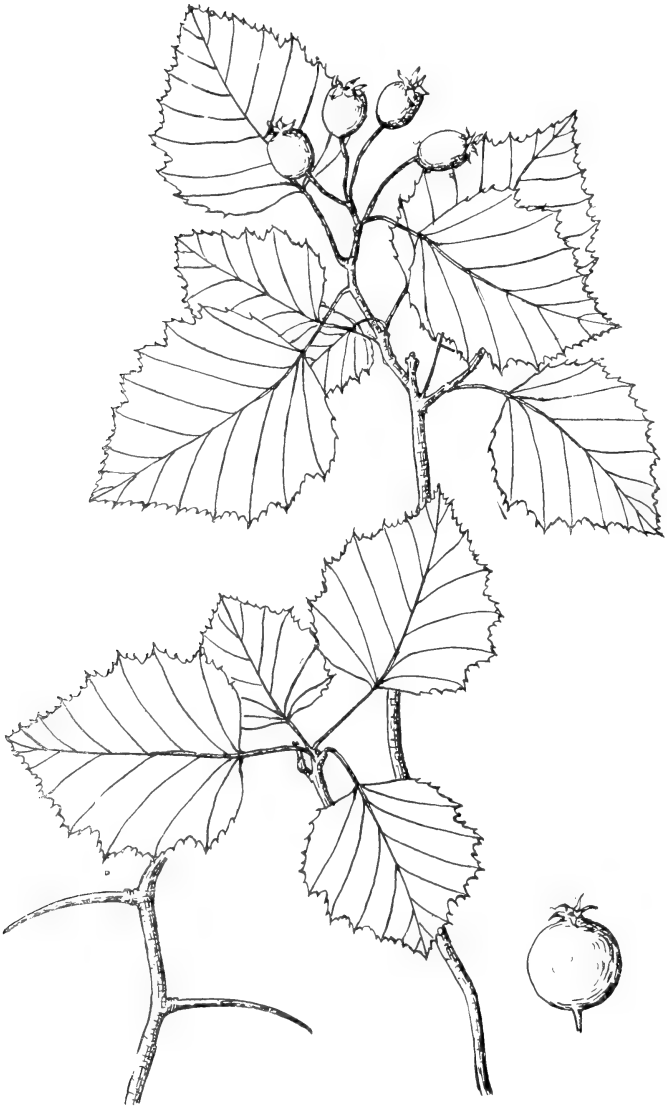
A small tree sometimes 8 m. (25 feet) high, with ascending and spreading branches and a broad, round-topped crown.

Specimens have been seen from the following counties: Floyd (Deam); Noble (Van Gorder); Steuben (Deam).

Horticultural uses. This fine tree has been in the gardner's hands several centuries, there are specimens in the Kew Gardens, England, more than two hundred years old.

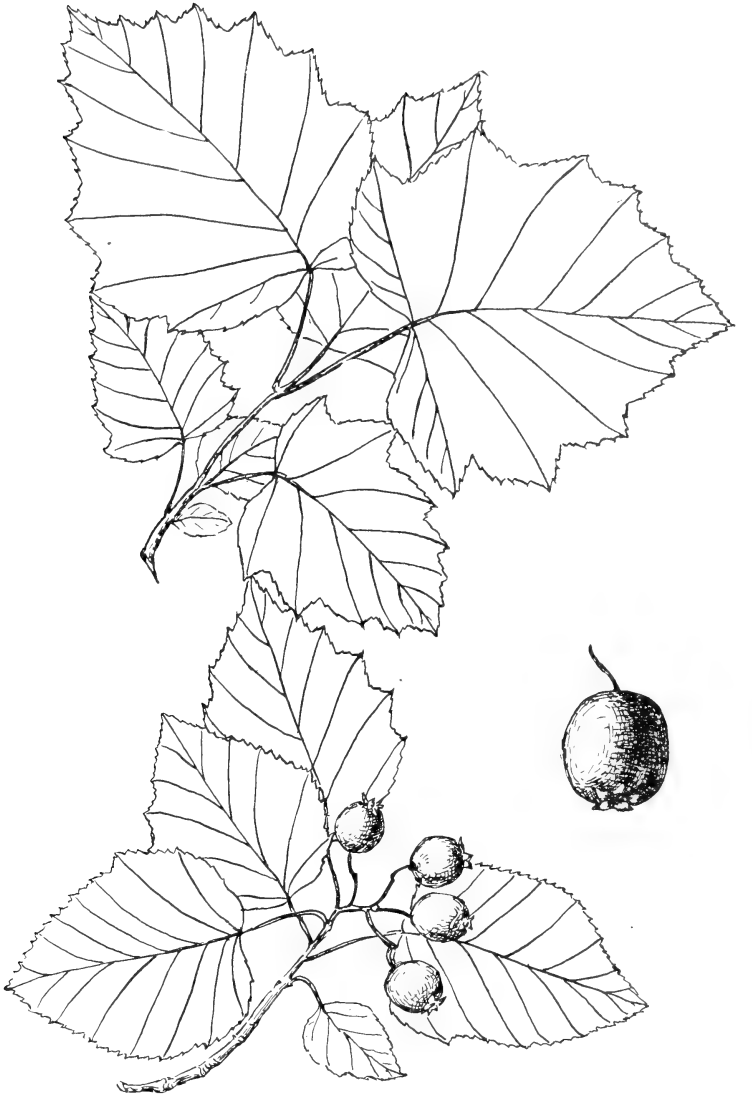
17. Cratægus mollis (Torrey and Gray) Scheele. RED-FRUITED OR DOWNY THORN. RED HAW. Plate 96. Bark grayish-brown, fissured and scaly; spines curved, 3-5 cm. (1-2 inches) long; leaves

PLATE 95.



CRATÆGUS COCCINEA Linnæus. SCARLET THORN. RED HAW. (x ½.)
(Fruit, x 1.)

PLATE 96.



CRATÆGUS MOLLIS (Torrey and Gray) Scheele. RED-FRUITED OR DOWNY THORN. RED HAW. (x ½.) (Fruit, x 1.)

broadly ovate, acute at the apex, cordate to truncate at the base, serrate or twice serrate with narrow acute lobes, 4-13 cm. (1½-5 inches) long, 4-10 cm. (1½-4 inches) wide, slightly rugose, densely tomentose beneath, tomentose above, becoming scabrous, membranaceous; petioles 2-4 cm. (¾-1½ inches) long, tomentose; corymbs tomentose, many-flowered; flowers appear in May, about 2.5 cm. (1 inch) broad, stamens about 20, anthers light yellow; styles and nutlets 4 or 5; fruit ripens in September, short-ellipsoidal to subglobose, scarlet, 1.5-2.5 cm. (½-1 inch) thick, calyx lobes glandular-serrate, swollen, erect or spreading, deciduous, flesh thick, yellow, edible.

Distribution. Southern Ontario to South Dakota, south to central Tennessee and Arkansas. This typical thorn of the central prairie states is best at home on limestone bluffs and is well distributed over Indiana.

A small tree often 13 m. (40 feet) high, with ascending and spreading branches, forming a broad, round-topped crown.

Specimens have been examined from the following counties: Cass (Mrs. Ida Jackson); Gibson and Knox (Schneck); Montgomery and Putnam (Grimes); Decatur, Delaware, Floyd, Henry, Knox, Madison, Marion, Posey, Vermillion and Wells (Deam).

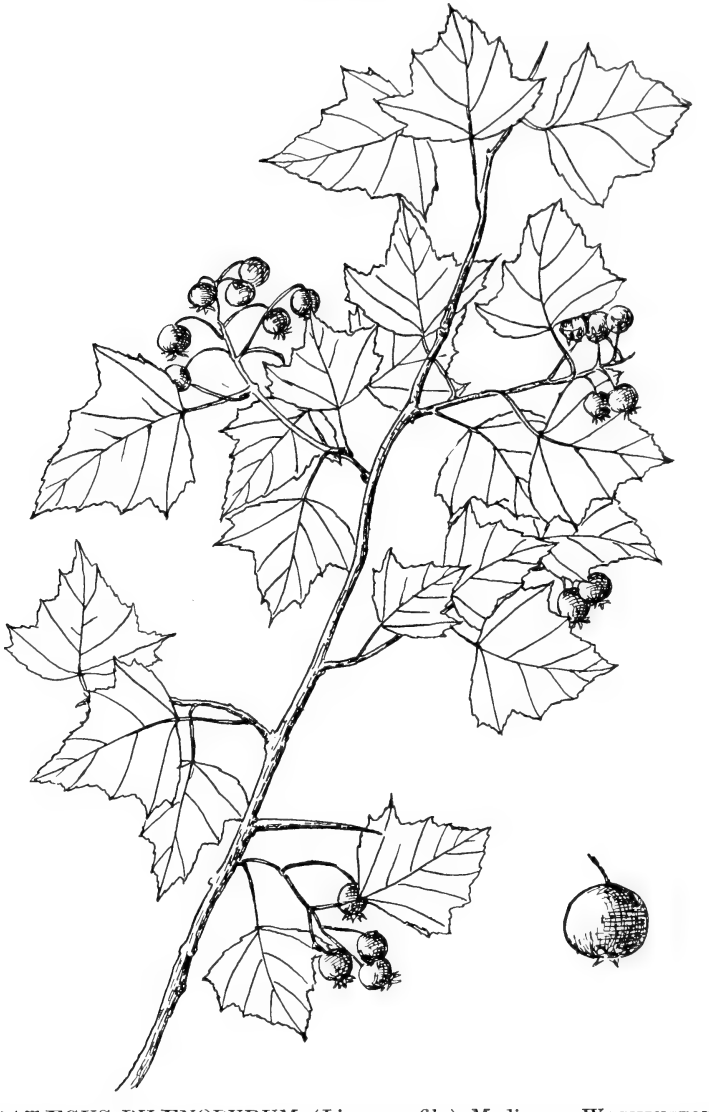
18. Cratægus Phænopyrum (Linnæus fils) Medicus. WASHINGTON THORN. SCARLET HAW. (*C. cordata* Aiton). Plate 97. Bark grayish-brown, scaly; spines numerous, slightly curved, 2-5 cm. (¾-2 inches) long; leaves ovate-triangular, 2-8 cm. (¾-3 inches) long and wide, simply or doubly serrate, often 3-5 lobed, acute at the apex, rounded to cordate at the base, bright green above, glabrous; petioles slender, 1.5-5 cm. (½-2 inches) long, glabrous; corymbs glabrous, many-flowered; flowers appear in June, 8-12 mm. (1/3-½ inch) broad, stamens about 20, anthers pink, styles and nutlets usually 5, calyx lobes deltoid, entire, deciduous; fruit ripens in October or November, depressed-globose, scarlet, 4-6 mm. (1/6-¼ inch) thick, nutlets with a bare apex and smooth back, flesh thin, firm.

Distribution. Virginia to Georgia, Indiana to Arkansas. Moist rich soil. Naturalized to Pennsylvania and New Jersey. Possibly it may be naturalized at the Indiana station. More knowledge of distribution in southern Indiana is needed to settle this question.

A shrubby tree sometimes 9 m. (30 feet) high, with nearly erect branches and an oblong crown.

Specimens have been seen from: Wayne (Deam). It also occurs in the Wabash Valley.

PLATE 97.



CRATÆGUS PHÆNOPYRUM (Linnæus fils) Medicus. WASHINGTON THORN. SCARLET HAW. (x ½.) (Fruit, x 1.)

Horticultural uses. This is one of the most desirable thorns for ornamental planting and hedges. Its scarlet autumn foliage and beautiful little scarlet fruit persist for a long time. It is also one of the American thorns long in cultivation.

According to the treatment of the genus Cratægus in Britton and Brown's Illustrated Flora, 2d Edition, the range of the following species extend into Indiana.

Throughout the State—
- C. Boyntoni.
- C. intricata.
- C. straminea.

In the southern part of the State—
- C. berberifolia.
- C. denaria.
- C. fecunda.
- C. collina.
- C. ovata.

In the northern part of the State—
- C. Brainerdi.
- C. lucorum.
- C. chrysocarpa.
- C. roanensis.
- C. filipes.
- C. beata.
- C. villipes.
- C. Pringlei.
- C. albicans.

AMYGDALÀCEÆ. THE PLUM FAMILY.

Leaves alternate, simple, rather thick, usually serrate, stalked, stipules early fugacious; flowers regular, perfect, calyx and corolla 5-merous; fruit a 1-seeded drupe. The trees of this family exude a gum when wounded, and those that occur in our area bear edible fruit.

Flowers corymbose, appearing before or with the leaves on branchlets of the previous year..... 1 Prunus.
Flowers racemose, appearing after the leaves on branchlets of the year..... 2 Padus.

PRÙNUS. THE PLUMS AND CHERRIES.

(From *prunus*, the Latin word for plum.)

Cherries, leaves shiny above; flowers small, petals mostly 4-6 mm. (¼ inch) long; stone of fruit globose..... 1 P. pennsylvanica.
Plums, leaves dull above; petals 7-12 mm. (1/3-½ inch) long; stone of fruit flattened.
- Teeth of leaves sharp pointed and ending in a callous tip; calyx lobes without glands..... 2 P. americana.
- Teeth of leaves rounded and the vein ending in the center tipped by a gland; calyx lobes glandular..... 3 P. nigra.

1. Prunus pennsylvánica Linnæus fils. WILD RED CHERRY. Plate 98. Bark of trunk reddish-brown, redder than that of the common wild cherry; leaves oblong-lanceolate, 4-10 cm. (1½-4 inches) long, thin, usually long taper-pointed, tapering or rounded at the base, serrate, sometimes doubly serrate, many of the teeth

PLATE 98.

PRUNUS PENNSYLVANICA Linnæus fils. WILD RED CHERRY. (x ½.)
(Flower, x 2.)

gland-tipped, yellow-green at maturity, smooth or nearly so when they unfold, becoming smooth both above and below at maturity; flowers appear with the leaves in April or May, in axillary clusters of 2-8, pedicels 1-2 cm. (⅜-¾ inch) long in the flowering stage, calyx greenish-white and smooth; fruit ripens in June or July, globose, about 5 mm. (3/16 inch) in diameter, bright red, flesh thin and sour; stone rounded at the base, pointed at the apex, slightly ridged on one edge.

Distribution. Newfoundland, British Columbia, south to Pennsylvania, northern Indiana and Illinois, and central Iowa; also on the eastern slopes of the Rocky Mountains, and in the high mountains of North Carolina and Tennessee. In Indiana it is found only in the northern part of the State. It is locally more or less frequent on the wooded sand dunes along Lake Michigan. If found in other stations it must be regarded as rare and local. Along Lake Michigan it is a small sized tree, usually associated with the common wild cherry, June-berry and black oak.

The published records of the distribution are as follows: Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Kosciusko (Chipman); Lake and Porter (Blatchley).

Additional records are: Porter (Deam).

2. Prunus americàna Marshall. WILD PLUM. Plate 99. Bark on the trunk of old trees dark reddish-brown, separating into thin persisting plates; twigs at first smooth or hairy, light green, becoming reddish-brown and smooth or some remaining densely hairy until the end of the season; winter buds very small, sharp-pointed, a light or dark brown; leaves oval or slightly obovate, 4-9 cm. (1½-3½ inches) long, rather thin or thick, narrowed or rounded at the base, taper-pointed at the apex, sharply serrated with teeth projecting forward and inward, at maturity smooth and a yellow or dark green above, paler and more or less pubescent beneath especially along the prominent veins; petioles 1-2 cm. (⅜-¾ inch) long, sometimes with 1 or 2 glands near the base of the blade; flowers appear in April or May before or with the leaves, white, about 2 cm. (¾ inch) across, 2-5 in a cluster; calyx lobes lanceolate, entire or more frequently lacerated at least near the apex, or only forked at the apex, the lacerations ending in callous tips, lobes smooth or pubescent both within and without, usually pubescent at least within; fruit ripens in July or September, globular or somewhat oblong, about 2 cm. (¾ inch) long. red at maturity, flesh yellow and tart; stone about 1.5 cm. (½ inch) long, double convex, oval to nearly orbicular in out-

PLATE 99.

PRUNUS AMERICANA Marshall. WILD RED PLUM. (x ½.)
(Stone, x 1.) (Calyx lobes, x 3.)

line, about half as wide as long or wider, one side having a groove on each face near the edge. This species is extremely variable and it is hoped some one can give it a detailed study.

Distribution. New York to Montana, south to Florida and west to Texas. Found throughout Indiana, usually along the banks of streams, and the sides of ravines. It generally occurs in open places and at present is more or less frequent along unkept fences. Although general in its distribution it is more or less rare in our area. It is a small tree and is usually found growing in clumps.

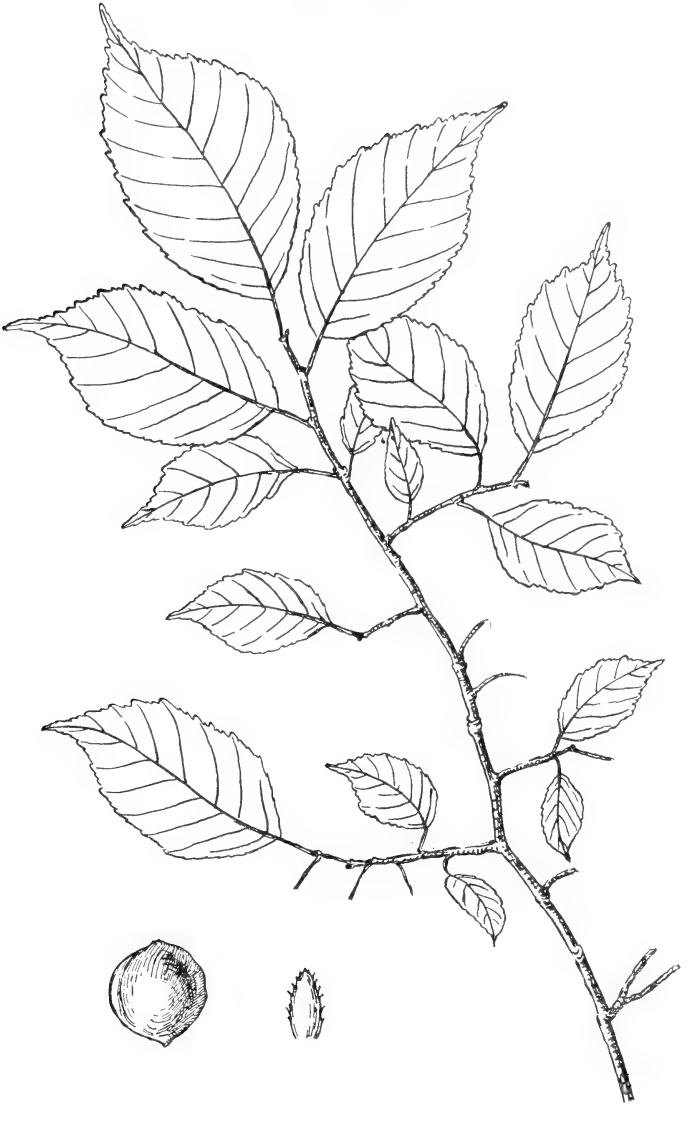
The published records of the distribution are as follows: Cass (Hessler); Clark (Smith); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Barnes), (Coulter) and (Young); Knox (Ridgway); Kosciusko (Chipman), (Coulter) and (Scott); Lake (Blatchley); Marion (Blatchley) and (Wilson); Marshall (Hessler); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Porter (Blatchley); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Grimes); Tippecanoe (Coulter); Blackford, Clark, Dearborn, Delaware, Harrison, Lawrence, Marion, Starke, Vermillion, Warren and Wells (Deam).

Economic uses. Tree too small and rare to be of any economic importance.

3. Prunus nìgra Aiton. WILD PLUM. Plate 100. Bark brown, separating and rolling back from one edge; twigs at first green and smooth or hairy, becoming smooth and reddish-brown; winter buds brown, acute, scales blunt and more or less fringed with hairs; leaves oval to obovate, 4-10 cm. (1½-4 inches) long, rounded or slightly narrowed at the base, taper-pointed at the apex, margins with rounded teeth ending in a gland, sparingly hairy on both surfaces when they expand, becoming at maturity a dull dark green above, paler beneath, slightly pubescent both above and below, or sometimes almost glabrous; petioles 0.5-2 cm. (¼-¾ inch) long, usually bearing 1 or 2 glands near the base of the blade, the channel pubescent; flowers appear in April before the leaves, 2-3 together, about 1.5 cm. (½ inch) across, white turning pinkish; calyx lobes ovate and blunt, sometimes narrower, the margins minutely serrate and tipped with dark red glands, smooth or nearly so on both surfaces, usually with a border of hairs at the base within; fruit ripens

PLATE 100



PRUNUS NIGRA Aiton. WILD OR CANADA PLUM. (x ½.) (Stone, x 1.) (Calyx lobe, x 3.)

in June or July, oval and red; stone double convex, about 1.5 cm. (½ inch) long, half as thick, oval in outline, one side having a groove on each face near the edge.

Distribution. Newfoundland throughout the valley of the St. Lawrence, west to Manitoba, south to Massachusetts, Indiana and Minnesota. In Indiana it has been noted only in Wells County where it was found in two stations about 6 miles apart in wet woods. In one location it was a shrub and in the other it was a small tree about 1 dm. (4 inches) in diameter. The distribution of the species is to the north and its appearance in this State is exceptional.

The published records of the distribution are: Wells (Deam).

Economic uses. Too rare to be of any importance.

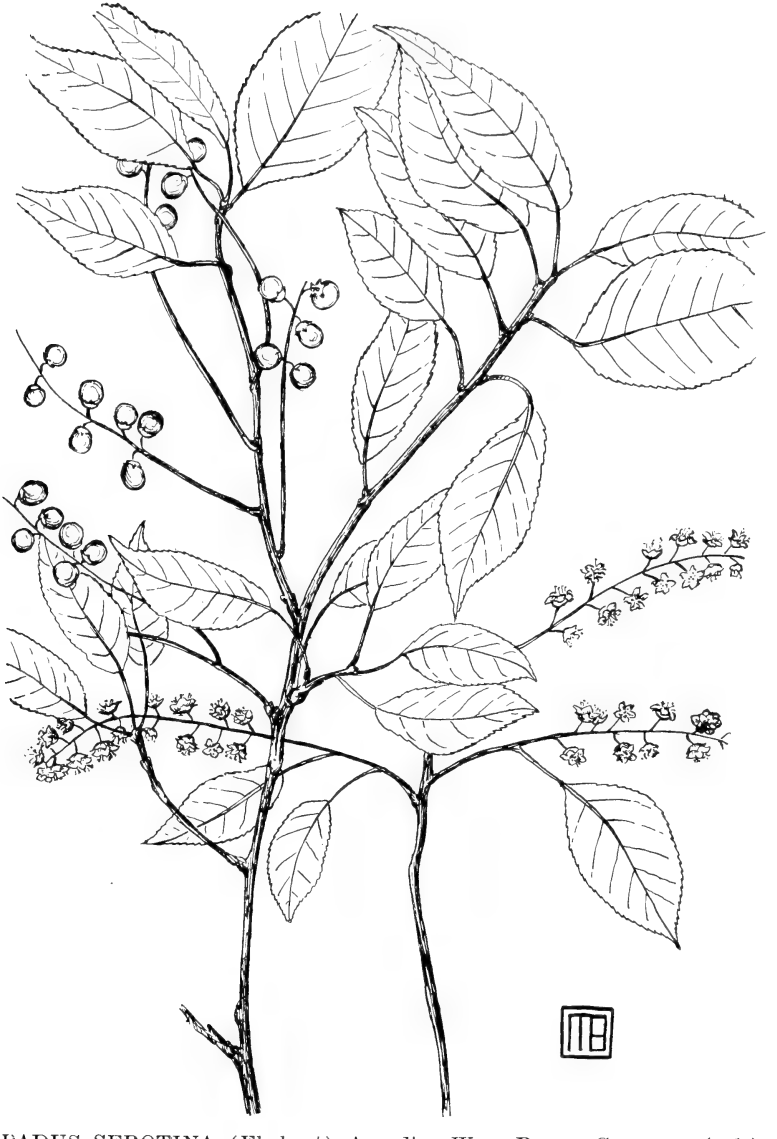
2. PADUS. THE WILD CHERRIES.

Pàdus serótina (Ehrhart) Agardh. WILD CHERRY. WILD BLACK CHERRY. CHERRY. (*Prunus serotina* Ehrhart). Plate 101. Bark on young trees smooth, becoming on old trees irregularly fissured and separating in small scaly plates, dark reddish-brown; branchlets slender, pale green at first, becoming a gray or reddish-brown; winter buds conic, acute, smooth, scales about the color of the branches or redder; leaves oval to lanceolate-oblong, 6-12 cm. (2½-5 inches) long, generally drawn to a long point at the apex, wedge-shaped or rarely rounded at the base, finely serrated with incurved glandular teeth, hairy below when they unfold, becoming at maturity firm, smooth and dark green above, somewhat paler and smooth beneath, becoming a yellow-green before falling; petioles 1-2 cm. (⅜-¾ inch) long, usually bearing from 1-5 glands; flowers in racemes about 1 dm. (4 inches) long, appearing in May when the leaves are half grown; fruit ripens in July and August, globose, about 8 mm. (⅜ inch) in diameter, dark purple or black.

Distribution. Nova Scotia and South Dakota south to Florida and west to Texas. It is well distributed throughout Indiana. In the original forest it was rather infrequent, but has become frequent along fences, outnumbered only by the black walnut. In the original forest it grew to be a very tall and generally quite a large tree but frequently with a somewhat crooked trunk. It prefers a rather moist, rich and porous soil, although it adapts itself well to all kinds of soil and conditions which may be seen from its distribution along fences. It is most commonly associated with beech, sugar maple, white ash and linn.

The published records of the distribution are: Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Daviess (Clem-

PLATE 101.



PADUS SEROTINA (Ehrhart) Agardh. WILD BLACK CHERRY. (X ½.)

ents); Decatur (Ballard); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (J. M. Coulter) and (Young); Knox (Ridgway); Kosciusko (Chipman) and (Coulter); Lake (Blatchley) and (Clark); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Porter (Blatchley); Posey (Schneck); Putnam (MacDougal); Shelby (Ballard); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter) and (Dorner); Adams, Allen, Brown, Clark, Dearborn, Delaware, Dubois, Hamilton, Jennings, Marshall, Montgomery, Morgan, Noble, Porter, Posey, Steuben, Vermillion, Washington and Wells (Deam).

Economic uses. Wood strong, hard, close-grained and reddish-brown. Used principally for furniture, office and store fixtures and for the backing of electrotypes. The bark is used in medicine. The fruit is often combined with other fruit to impart a flavor.

Horticultural value. It is hardy but is somewhat difficult to transplant, grows rapidly in the open while young, does not grow tall but develops a wide oval crown. It has not been used much for ornamental planting and can scarcely be recommended because it is subject to the San Jose scale and tent-caterpillar. It might be permitted to grow along fences because the fruit is an attraction for the birds and if the trees could not be utilized for anything else they could be worked into fence posts.

CÆSALPINIÀCEÆ. THE SENNA FAMILY.

Leaves simple; flowers pink or rose; seed pod papery.... 1 Cercis.
Leaves compound; flowers not pink; seed pod woody or leathery.
  Trees with thorns; stamens 3-5, longer than the corolla; pods flat and leathery; seeds about 1 cm. (½ inch) long..... 2 Gleditsia.
  Trees without thorns; stamens 10, shorter than the corolla; pods swollen, woody; seeds about 2 cm. (1 inch) long..... 3 Gymnocladus.

1. CÉRCIS. THE REDBUDS.

(From *kerkis*, a name given by Theophrastus to a tree supposed to be the modern Cercis).

Cercis canadénsis Linnæus. REDBUD. FISH BLOSSOM. Plate 102. Bark of trunk on old trees fissured and sometimes dark

PLATE 102.

CERCIS CANADENSIS Linnæus. REDBUD. (x ½.)

reddish-brown, shreddy, smooth on the branches; twigs glabrous, shining, light brown, becoming gray-brown; leaves alternate, broadly ovate, short-pointed, truncate or cordate at the base, 8-12 cm. (3-5 inches) long; flowers appear in April or May before the leaves in clusters of 4-8 on the branches of the previous season, pink or rose color; pods 5-9 cm. (2-3½ inches) long, hairy.

Distribution. Southern Ontario, east to the valley of the Delaware River, south to the Gulf States and west to eastern Nebraska and Texas. Generally found in all parts of Indiana. In the northern part of the State it is usually found in rich soil on the borders of streams where it occurs frequently. In the vicinity of Lake Michigan it is rare or wanting. In the southern part of the State it is quite generally distributed. It is frequent to common throughout this part; on the limestone and sandstone hills it is commonly a shrub, while in the valleys it reaches its greatest size. Commonly a small tree, 1-2 dm. (4-8 inches) in diameter and 6-10 m. (20-33 feet) in height.

The published records of the distribution are as follows: Carroll (Thompson); Clark (Baird and Taylor) and (Smith); Daviess (Clements); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Barnes), (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Coulter); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Cook) and (Grimes); Tippecanoe (Coulter); Bartholomew, Blackford, Clark, Crawford, Decatur, Fountain, Franklin, Fulton, Hancock, Harrison, Johnson, Knox, Madison, Marion, Montgomery, Parke, Owen, Posey, Putnam, Shelby, Starke, Vermillion, Warren and Wells (Deam).

Economic uses. Wood heavy, hard, weak, sap wood light color, heart wood a rich brown color, takes a good polish. Not of sufficient size and abundance to be of any economic importance. In the forest it is generally regarded as a weed tree and is removed.

Horticultural value. It is frequently recommended for ornamental planting where a small tree is required. Adapted to a moist rich soil; grows rapidly; shade enduring, for which reason it can be used under taller trees in landscape work.

2. GLEDÍTSIA. THE HONEY LOCUSTS.

(Named in honor of John Gottlieb Gleditsch, a German botanist.)

Leaflets lanceolate-oblong; thorns many, long and usually forked; pods linear, seeds in a sweet pulp..... 1 G. triacanthos.
Leaflets ovate-oblong; thorns few and usually simple; pods oval, pulpless, 1 or 2 seeded..... 2 G. aquatica.

1. Gleditsia triacánthos Linnæus. HONEY LOCUST. THORN TREE. Plate 103. Bark fissured, gray brown to almost black; twigs reddish to greenish-brown, armed with stout spines; leaves pinnate or twice pinnate, hairy when expanding, practically glabrous at maturity; flowers appear in May when the leaves are about half grown, inconspicuous, greenish-yellow, the staminate in clustered racemes, the pistillate usually in few-flowered racemes, rich in honey, and their appearance will be announced by the hum the swarm of insects make visiting them; fruit a flat, linear twisted pod, 20-40 cm. (8-16 inches) long, with several seeds.

Distribution. Southern Ontario east to the Alleghany mountains, south to northern Alabama and Mississippi and west to eastern Nebraska, Kansas and Texas. It is found in sparing numbers in all parts of the State. In the northern part it is confined generally to the borders of streams, while in the southern part of the State it is frequently found on the top of the wooded hills. In Gibson, Knox and Posey Counties it is generally frequent or common on the borders of ponds and sloughs. It is usually a tree of medium size, though in the southern part of the State it grows to be a large tree.

The published records of the distribution are as follows: Cass (Hessler); Clark (Baird and Taylor) and (Smith); Daviess (Clements); Dearborn (Collins); Decatur (Ballard); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Barnes), (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Coulter); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Coulter); Vigo (Blatchley); Wayne (Petry and Markle).

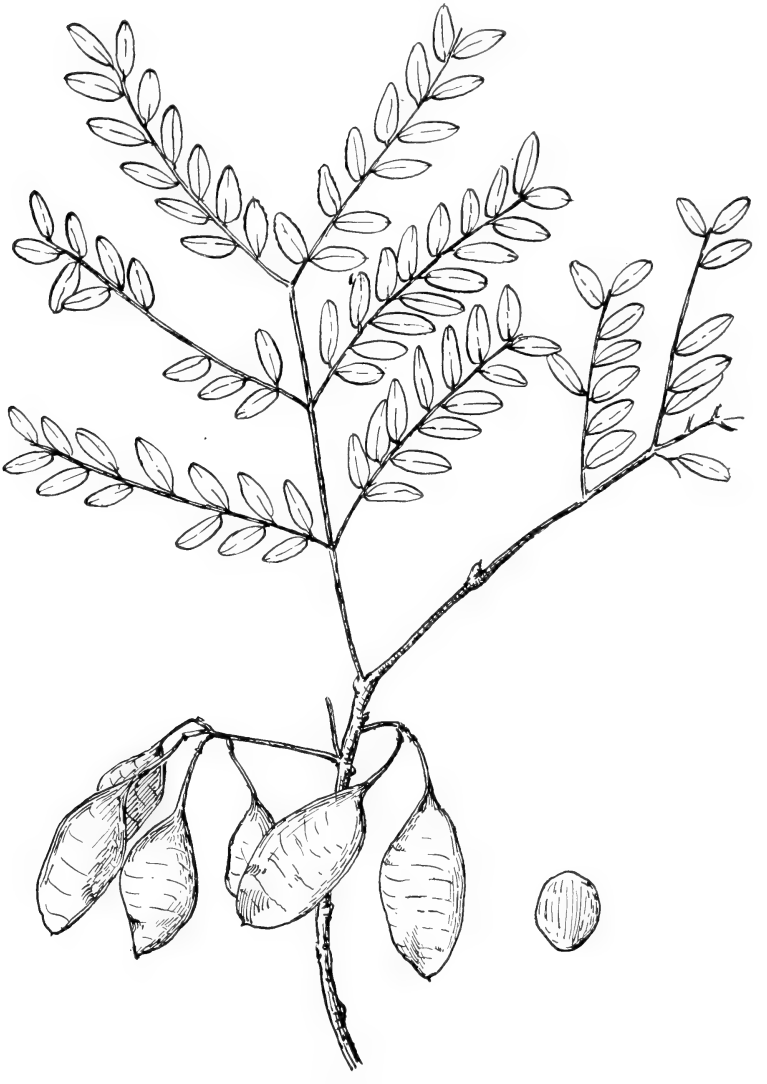
Additional records are: Knox (Schneck); Montgomery (Evans); Tippecanoe (Dorner); Fountain, Posey, Vermillion and Wells (Deam).

Economic uses. Wood heavy, hard, strong, coarse-grained, takes a good polish, reddish-brown. It is claimed to be very dur-

PLATE 103.

GLEDITSIA TRIACANTHOS Linnæus. HONEY LOCUST. (x ½.)
(Fruit, x ¼.) (Seed, x 1.)

PLATE 104.



GLEDITSIA AQUATICA Marshall. WATER HONEY LOCUST. (x ½.)
(Seed, x 1.)

able in the ground, but experience proves that the heart wood is about as durable as white oak, while the sap wood decays very rapidly. Used for fence posts.

Horticultural value. It is frequently used for ornamental planting. It is adapted to all kinds of soil, although its preference is for a moist soil, grows rapidly and is free from disease. Nurserymen now offer a thornless variety which is preferred to the native tree.

2. Gleditsia aquática Marshall. HONEY LOCUST. THORN TREE. Plate 104. Bark smoothish, dull gray; twigs yellowish-brown turning to a gray or reddish-brown, thorns simple or with one or two short branches; leaves pinnate or twice pinnate; flowers similar to the preceding species; fruit 3-5 cm. (1¼-2 inches) long and 1.5-2 cm. (¾-1 inch) wide, one seeded, rarely two.

Distribution. Southern Illinois and Indiana, south to the Gulf States and west to Texas. Rare and local in its general distribution and in Indiana confined to a few localities in the extreme southwestern counties where it is found in sloughs and cypress swamps.

The published records of the distribution are as follows: Gibson (Schneck); Knox (Ridgway) and (Thomas); Miami (Gorby);* Posey (Schneck).

Additional records are: Knox (Schneck).

Economic uses. Too rare to be of any economic importance.

3. GYMNÓCLADUS. THE COFFEE TREE.

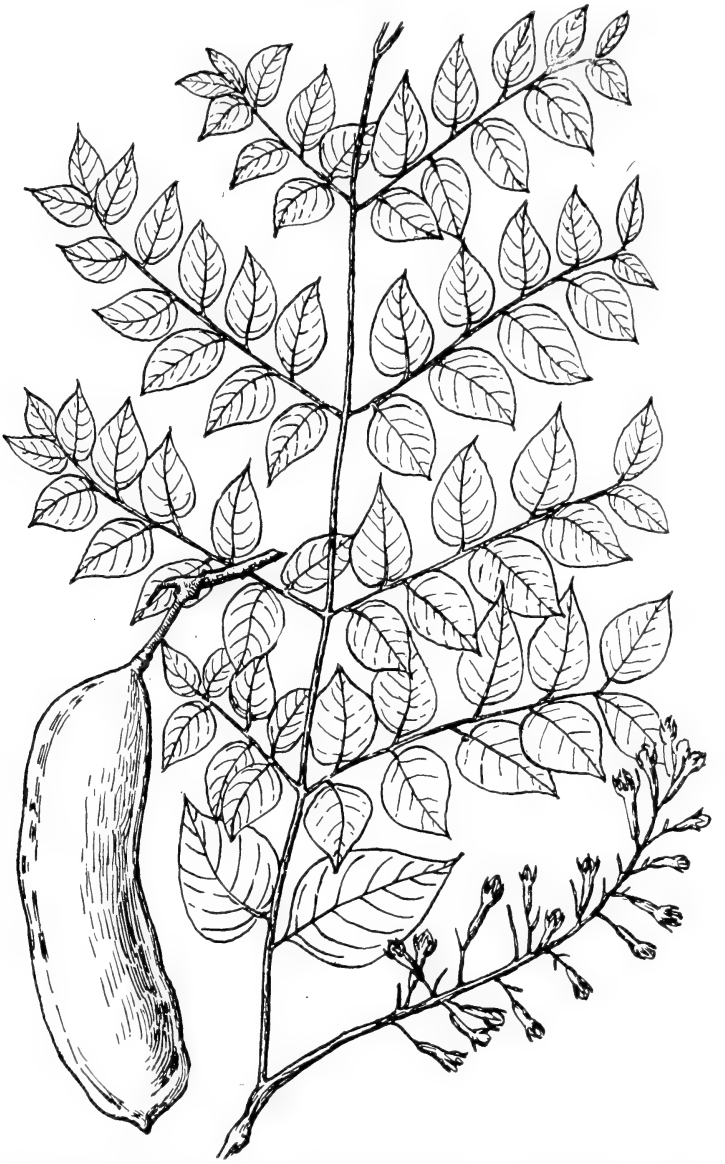
(From the Greek, *gymnos*, naked, *klados*, branch; in reference to the naked appearance of the tree in the winter condition).

Gymnocladus dioíca (Linnæus) Koch. COFFEENUT TREE. Plate 105. Bark of the trunk deeply fissured, dark gray; twigs at first hairy, at length smooth, brown or gray, splotched with brown; leaves twice pinnate, 3-9 dm. (12-36 inches) long, 4-6 dm. (16-24 inches) wide; leaflets ovate, 3-6 cm. (1¼-2¼ inches) long; flowers appear in May, in whitish terminal racemes, the staminate in clusters, 7-10 cm. (2¾-4 inches) long, the pistillate in racemes 2-3 dm. (4-12 inches) long; fruit a pod about 1.5 dm. (6 inches) long, seeds imbedded in a dark-colored sweet pulp.

Distribution. Southern Ontario and central New York, south to Tennessee and west to eastern Nebraska and Oklahoma. No doubt

*This record is evidently an error.

PLATE 105.



GYMNOCLADUS DIOICA (Linnæus) Koch. COFFEENUT. (x ½.)

this tree occurs in all parts of Indiana. It is rare in the northern part and increases in frequency toward the south. It is most abundant in rich soil near streams and just back of the flood plain. In the southern part of the State it is found in patches, where it is sometimes the principal species on areas of an acre or more. In the northern part of the State it is commonly a medium sized tree, 8-15 m. (25-50 feet) high and 3-5 dm. (12-20 inches) in diameter. In the southern part of the State it is usually somewhat larger.

The published records of the distribution are as follows: Cass (Hessler); Clark (Baird and Taylor); Dearborn (Collins); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Barnes) and (Coulter); Knox (Ridgway) and (Thomas); Kosciusko and Laporte (Coulter); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Hancock, Orange, Vermillion, Wells (Deam).

Economic uses. Wood heavy, not hard, strong, coarse-grained, checks on drying, works easily, takes a high polish, sap wood consisting of 5 or 6 years' growth, light colored, heart wood light brown with a tinge of red. It is said to be durable in contact with the soil, although this is disputed by a majority of those who have tried it. The pioneers used the roasted nuts as a substitute for coffee to some extent, which gave the tree its common name. The bruised leaves covered with sweetened water were used as a fly poison.

Horticultural value. It is occasionally planted as an ornamental tree. It is not a rapidly growing tree, leaves appear late and fall early. The absence of small branches make it unattractive in the winter condition and when used it is no doubt to satisfy a desire for variety.

FABÀCEÆ. THE PEA FAMILY.

ROBINIA THE LOCUST.

Robínia Pseùdo-Acàcia Linnæus. LOCUST. BLACK LOCUST. YELLOW LOCUST. Plate 106. Bark deeply furrowed, dark brown; twigs slender, zigzag, green and hairy when young, becoming smooth and reddish-brown, older branches armed with pairs of short and

PLATE 106.

ROBINIA PSEUDO—ACACIA Linnæus. BLACK LOCUST. (x ½.)

sharp spines; leaves odd-pinnate, 1.5-3 dm. (6-12 inches) long; flowers in loose racemes, white, very fragrant, flowering season May or June; fruit a pod about 7 cm. (3 inches) long, smooth.

Distribution. Along the mountains from Pennsylvania south to Georgia and again appearing in the Ozark Mountains in Missouri. It is doubtful if it was native to the State.* It has been cultivated and has escaped in all parts of Indiana. A medium sized tree, sometimes attaining a height of 25 m. (80 feet) and a meter (39 inches) in diameter.

The published records of the distribution are as follows: Clark (Baird and Taylor); Daviess (Clements) and (Hessler); Dearborn (Collins); Decatur (Ballard); Delaware, Jay, Randolph and Wayne (Phinney); Franklin (Meyncke); Gibson (Schneck); Jefferson (Coulter) and (Young); Knox (Thomas); Marion (Douglas); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Shelby (Ballard); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans) and (Thompson); Putnam (Grimes) and (Lewis and Bridges); Tippecanoe (Coulter) and (Dorner); Bartholomew, Franklin, Hamilton, Johnson, Laporte, Montgomery, Steuben and Wells (Deam).

Economic uses. Wood heavy, very hard, close-grained, takes a good polish, sap wood yellow, heart wood light brown and very durable in contact with the soil. Used principally for fence posts and crossties.

Horticultural value. This tree was formerly extensively used for ornamental planting. The homes of many of the pioneers have a row of these trees from a half to a meter (19-39 inches) in diameter growing in front of their door. Groups of these trees in fields and along roadsides mark the location of the cabins of the old pioneers. The chief charm of the tree is the fragrance of its blossoms. The ornamental value is much lessened by the late appearance and the early falling of the leaves.

The tree is now used principally in forestry planting. It is adapted to all kinds of soil except a muck soil. It grows rapidly in a sandy and well drained soil. It is one of the most resistant to drought of any of our trees and for this reason is recommended for reforesting the steep and rocky hillsides of southern Indiana. It shows a rapid and healthy growth where many other species are not able

*"We had gazed at the majestic beech of this country (near Rising Sun) three feet in diameter; we had seen the honey locust, the black walnut, a buckeye of equal magnitude; and then we saw with surprise, the black locust almost a rival in stature." (Thomas' Western Travels, page 111, published in 1819).

to grow. It is propagated either from the seed or from seedlings. Where the ground can not be cultivated it is recommended that the trees be spaced 4x4 to 5x5 feet, and where the trees are to be cultivated they should be planted about 7x7 feet, and undercropped with corn for two or three years. The locust is not a shade enduring tree, so natural pruning is effective. However, it is recommended that the trees be gone over annually for three to five years and that very strong lateral branches be removed, and if the tree forks, that one part be removed. Wounds on the locust heal readily. Under good conditions the trees will attain a single post size in about 4 to 6 years, depending on the quality of the soil and the distance apart the trees are planted. This tree has a mortal enemy in the locust borer, and the planting of the tree for commercial purposes should be confined to the southern counties where it is not seriously damaged by this pest.

SIMAROUBÀCEÆ. THE QUASSIA FAMILY.

AILÁNTHUS. TREE OF HEAVEN.

Ailanthus glandulòsa Desfontaines. STINK TREE. TREE OF HEAVEN. Plate 107. Bark gray, thin, rough or fissured on old trees, smooth on the branches and young trees; twigs very robust, at the end of season a glossy light brown; leaves spiral on the branches, odd-pinnate, 3-10 dm. (12-40 inches) long; leaflets 13-41, margins entire or with few teeth, drawn to a long point; flowers appear in June, in large terminal panicles, the staminate flowers emit an offensive odor; fruit numerous, twisted and broadly winged, about 1 cm. (⅜ inch) wide and 4 cm. (1½ inches) long, the single seed near the center.

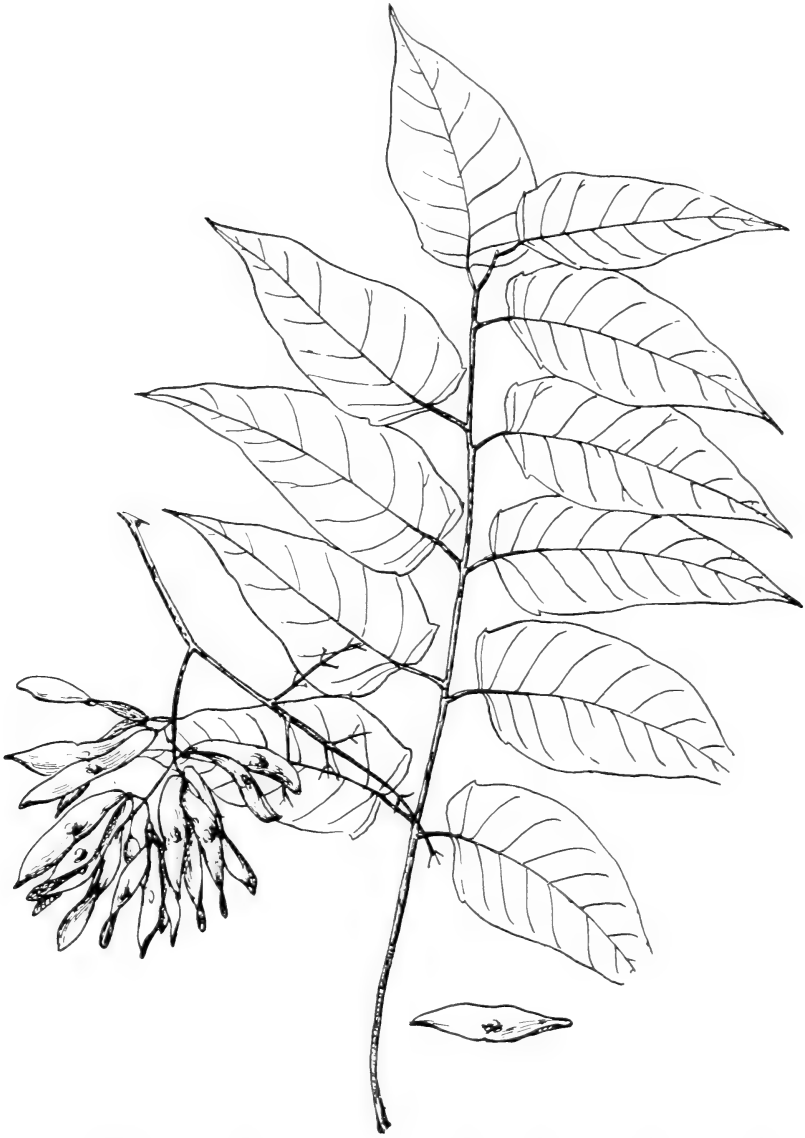
Distribution. Introduced from Asia. Now well established in many parts of Indiana. It is generally regarded as a weed tree on account of the rapidity and certainty with which it spreads from the seed scattered by the wind.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Franklin (Meyncke); Hamilton (Wilson); Jefferson (J. M. Coulter), (S. Coulter) and (Young); Kosciusko (Chipman); Marion (Wilson); Monroe (Blatchley); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Decatur and Wells (Deam).

Horticultural value. Adapted to all kinds of soils and all kinds of conditions. No tree will endure more abuse. Very ornamental

PLATE 107.



AILANTHUS GLANDULOSA Desfontaines. TREE OF HEAVEN. (x ½.)

on account of its large compound, dark glossy green leaves, and later because of the rich color of its winged fruit. It is little used on account of the unpleasant odor of the staminate flowers and its disposition to spread by suckers.

AQUIFOLIÀCEÆ. THE HOLLY FAMILY.

ÌLEX. THE HOLLIES.

Ilex decídua Walter. Plate 108. Bark light brown and warty; branchlets yellow gray; leaves alternate, simple, obovate to lanceolate, leaf-blades 3-8 cm. (1-3 inches) long, usually long taper-pointed, sometimes rounded or notched, taper-pointed at the base, margins remotely shallow toothed, yellow green and smooth above, paler and somewhat pubescent beneath; flowers appear soon after the leaves begin to unfold on slender pedicels, usually in May; fruit ripening early in the fall and persisting on the branches during the winter, berry like, about 7 mm. (¼ inch) in diameter, orange or orange-scarlet, usually containing 3-4 nutlets which are ribbed on the back.

Distribution. Virginia and southern Indiana south to Florida and west to Texas. In Indiana it is found only in the southwestern counties. It is rare and restricted to the borders of ponds and sloughs near the water courses. Where found it frequently forms dense thickets, and rarely reaches tree size.

The published records of the distribution are as follows: Gibson and Posey (Schneck); Knox (Ridgway); Monroe* (Barnes Catalogue of Indiana Plants).

Additional records are: Posey (Deam).

ACERÀCEÆ. THE MAPLE FAMILY.

ÀCER. THE MAPLES.

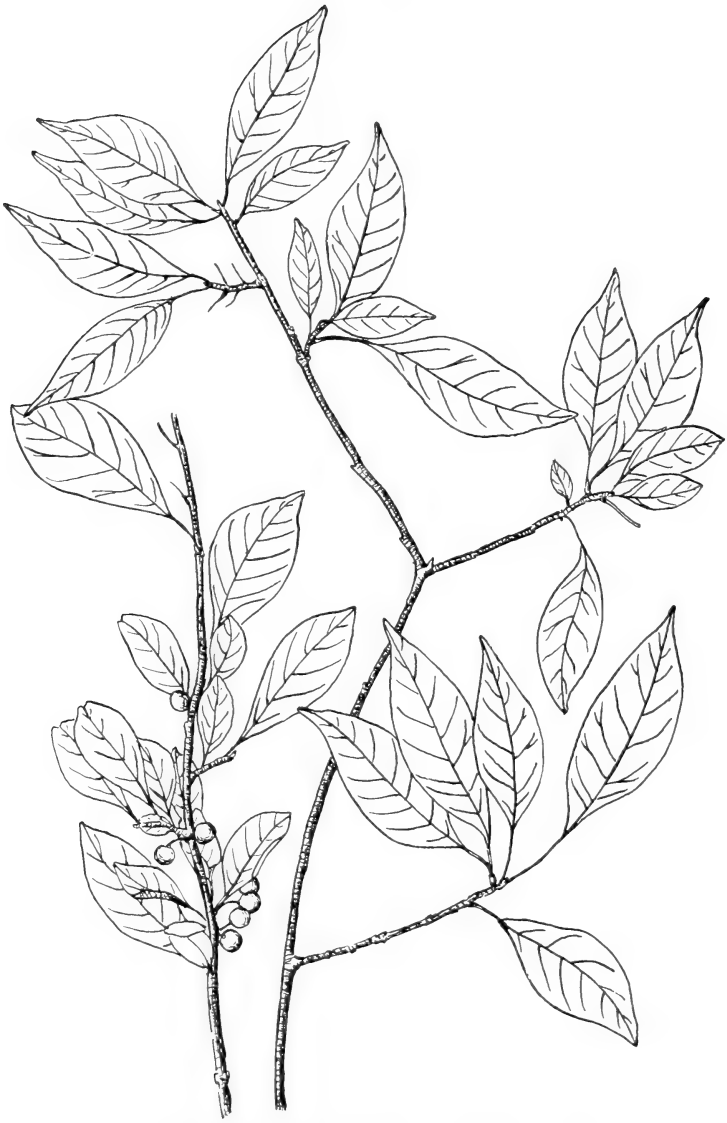
(From the Latin, *acer*, sharp or hard; refers to the hardness of the wood which was used in the making of spears).

Trees with terete branches; scaly buds; leaves opposite, long-petioled; fruit consists of two long-winged samaras. The sap of some of the species when concentrated yields the maple sugar and sirup of commerce.

Twigs greenish or purplish; leaves pinnate or trifoliate.. 1 A. Negundo.
Twigs reddish-brown; leaves simple, palmately-lobed.

*This is undoubtedly an error.

PLATE 108.



ILEX DECIDUA Walter. HOLLY. (x ½.)

Winter buds blunt, exposed scales 6-8, reddish, tomentose ciliate; flowers appearing before the leaves.
Sides of the V-shaped notches of the leaves straight, lobes of the leaves usually 3; flowers with petals, on pedicels; young fruit glabrous ..... 2 A. rubrum.
Sides of the V-shaped notches of the leaves concave, lobes of the leaves usually 5; flowers without petals, sub-sessile; young fruit tomentose ..... 3 A. saccharinum.
Winter buds acute, exposed scales 8-16, usually 12-16, brown to nearly black, usually with a silky pubescence; flowers appear after the leaves.
Bark usually gray; leaves whitish or glaucous beneath, glabrous at maturity, appendages at the base of the petioles wanting ..... 4 A. saccharum.
Bark dark brown to nearly black; leaves green beneath, pubescent at least on the veins beneath at maturity, and with two appendages at the base of the petioles ..... 5 A. nigrum.

1. Acer Negúndo Linnæus. BOX ELDER. Plate 109. Bark on young trees gray and smooth, on old trees thick, light to dark brown and deeply fissured, very much resembling the bark of *Fraxinus pennsylvanica*; twigs smooth, light green, sometimes purplish and glaucous; leaves usually with 3 leaflets, sometimes with 5, leaflets thin, varying from ovate to oval or obovate, acute at the apex, rounded or wedge-shaped at the base, margin entire, coarsely serrate or rarely 3-lobed, pubescent on both sides when young, becoming smooth or nearly so at maturity, 5-10 cm. (2-4 inches) long; flowers appear with the leaves in clusters borne on the twigs of the past season, the staminate and pistillate in different clusters on different trees or sometimes on the same tree, flowering period April, May or June; fruit ripens in early summer, the samaras smooth or slightly pubescent, 2-4 cm. (¾-1½ inches) long.

Distribution. Western Vermont south to Florida and west to the Rocky Mountains. Rare east of the Appalachian Mountains. Rare to infrequent in northern Indiana, increasing in numbers in the southern counties where it is sometimes frequent, or sometimes common along streams. It is generally found near streams, lakes and swamps. It is usually a medium sized tree, attaining its greatest size in the southwestern counties.

The published records of the distribution are as follows: Carroll (Thompson); Cass (Hessler); Clark (Baird and Taylor); Daviess (Clements); Dearborn (Collins); Delaware (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Barnes), (Coulter) and (Young);

PLATE 109.

ACER NEGUNDO Linnæus. BOX ELDER. (x $\frac{1}{2}$.)

Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Coulter); Marion (Wilson); Marshall (Hessler); Miami (Gorby); Monroe Blatchley); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Shelby (Ballard); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Grimes); Bartholomew, Decatur, Delaware, Hamilton, Hancock, Lagrange, Madison, Morgan, Owen, Posey, Putnam, Vermillion and Wells (Deam).

Economic uses. Wood light, soft, weak, creamy-white, close-grained. Too rare and small to be of much economic value.

Horticultural value. Adapted to a moist rich soil; grows rapidly; easily transplanted; crown oval; leaf period short. The pale green of the twigs makes it attractive in the winter condition. Frequently used for ornamental and shade tree purposes. The tree is subject to the attack of both fungous diseases and insects which discourage its use.

2. Acer rùbrum Linnæus. SOFT MAPLE. RED MAPLE. SWAMP MAPLE. Plate 110. Bark on young trees and the branches smooth and light gray, becoming on old trees dark gray and scaly; young twigs smooth and reddish, becoming gray; leaves 3-5 lobed, 5-12 cm. (2-4¾ inches) long, truncate or more or less cordate at the base, the middle lobe longer than the others, its base with parallel or with pyramidal sides, irregularly serrate or toothed, hairy when young, glabrous above and more or less hairy beneath at maturity, medium green above, whitish beneath; flowering period March or April; flowers scarlet, red or rarely yellow, in dense clusters in the axils of the leaves of the previous year, the staminate and pistillate in separate clusters on the same or different trees; fruit on long drooping pedicels, ripens in the spring or early summer, red or scarlet, sometimes tinged with green, varying from 2-3.5 cm. (¾-1¾ inches) in length, wings converging at first, divergent at maturity.

Distribution. Quebec to Ontario south to Florida and west to Iowa and Texas. Frequent to common in all parts of Indiana in low wet soil, and in the southern part of the State it is as frequently found on the slopes and tops of hills. Most abundant in low ground bordering lakes and swamps. A medium to large sized tree of rapid growth.

The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Decatur (Ballard); Delaware (Phinney); Dela

PLATE 110.

ACER RUBRUM Linnæus. RED MAPLE. (x ½.)

ware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Barnes), (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Scott); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Montgomery (Evans); Putnam (Grimes); Tippecanoe (Coulter); Allen, Clark, Porter, Posey, Putnam, Scott, Steuben and Wells (Deam).

Economic uses. Wood heavy, light or reddish-brown, not strong, close-grained. Used for frame lumber, furniture, staves and heading.

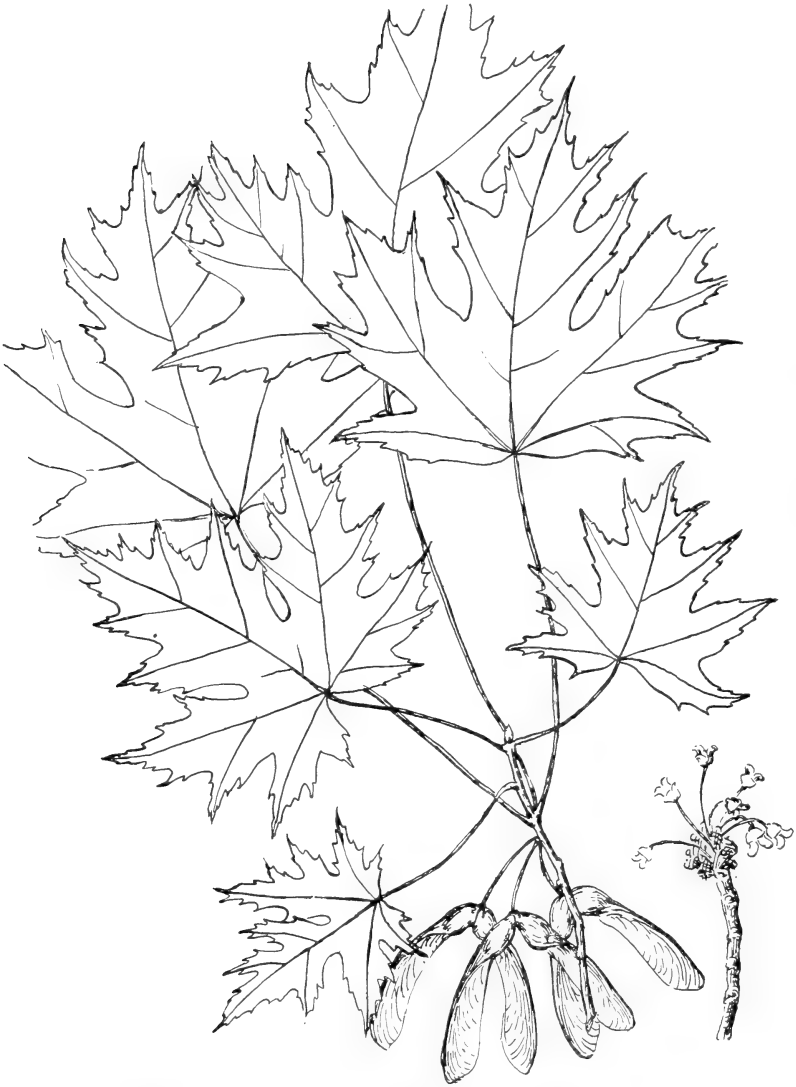
Horticultural value. Adapted to a moist rich soil, grows rapidly, transplants easily, crown oval, when crowded the branches grow long and are easily broken off, leaf period long. It is frequently used for ornamental shade purposes. The use of the red and silver maple has been discouraged by the appearance of the maple borer, cottony maple scale and tussock moth. The soft maples are more frequently attacked by the borers than the hard maples.

3. Acer saccharìnum Linnæus. SOFT MAPLE. SILVER MAPLE. WHITE MAPLE. Plate 111. Bark of young trees and branches smooth and gray, becoming on older trunks reddish-brown, freely splitting into thin scales; twigs brownish to red, turning up at the end; leaves truncate or somewhat heart-shaped at the base, deeply 5-lobed, the middle lobe frequently 3-lobed, the lobes pointed and sharply toothed, 6-14 cm. (2½-5½ inches) long, hairy beneath when young, smooth on both surfaces at maturity, medium green above, whitish beneath, petioles long; flowering period March or April; flowers greenish, in clusters in the axils of the leaves of the previous year, the staminate and pistillate in separate clusters on the same or different trees; fruit matures in late spring, green, smooth and more or less divergent at maturity, 4-7 cm. (1½-2¾ inches) long.

Distribution. New Brunswick, southern Ontario, South Dakota to Florida. Rare on the Atlantic coast. Frequent to common in all parts of Indiana in wet ground. Grows in situations similar to that of the red maple.

The published records of the distribution are as follows: Carrol (Thompson); Cass (Benedict and Elrod); Clark (Baird and Tay-

PLATE 111.



ACER SACCHARINUM Linnæus. SILVER MAPLE. (x ½.)

lor); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Decatur (Ballard); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Barnes), (Coulter) and (Young); Knox (Ridgway), (Spillman) and (Thomas); Kosciusko (Clark), (Coulter) and (Youse); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Shelby (Ballard); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Posey and Wells (Deam).

Economic uses. Wood hard, close-grained, strong, brittle, pale brown. Uses same as those of the red maple. Lumber dealers put the red and silver maple into one class and designate them as soft maple. On drying the soft maples do not warp as much as the hard maple.

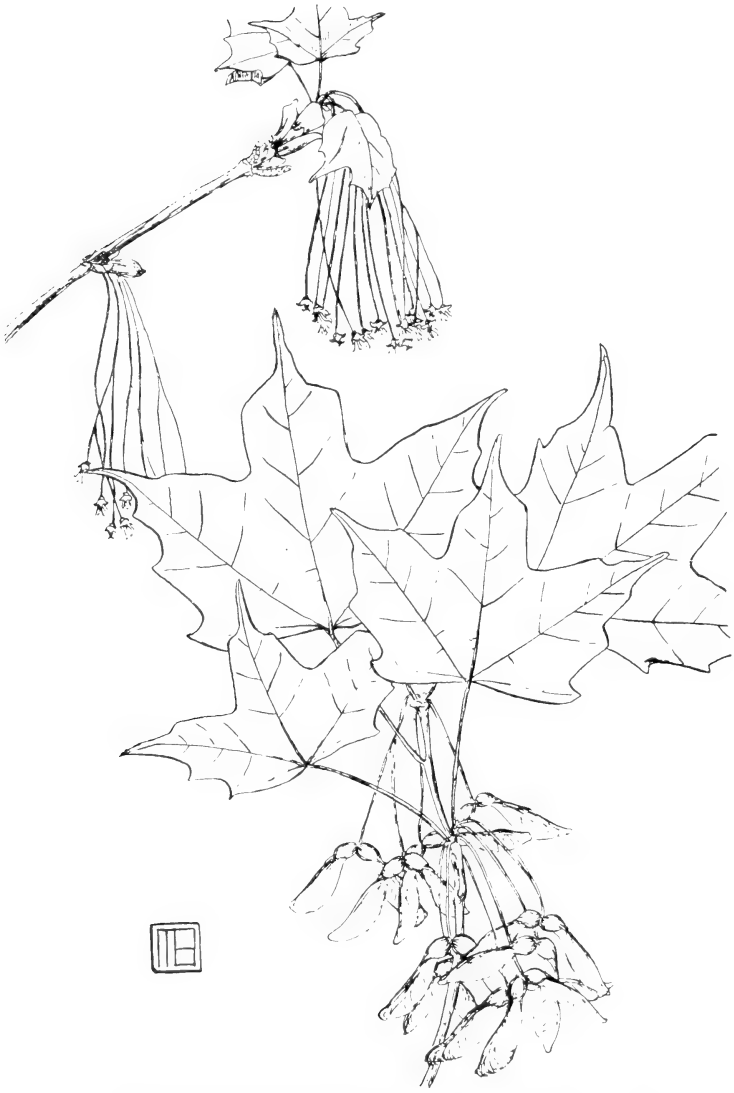
Horticultural value. Same as the preceding.

4. Acer sáccharum Marshall. SUGAR MAPLE. SUGAR TREE. HARD MAPLE. ROCK MAPLE. Plate 112. Bark of young trees and branches light brown, smooth or rough, becoming on old trees a gray or dark brown, fissured, tardily separating into rather thick scales, which turn up at the side; twigs reddish or gray, mostly glossy, ridge of leaf scars slightly pubescent; leaves more or less cordate at the base, usually 3-lobed, sometimes 5-lobed, 6-12 cm. (2¼-4¾ inches) long, hairy beneath when young, becoming smooth at maturity, rarely remaining pubescent, dark green above, whitish beneath; flowering period April, May or June, flowers on pedicels 4-6 cm. (1½-2½ inches) long which are usually hairy, the staminate and pistillate in separate clusters on the same or on different trees, rarely both kinds of flowers in the same cluster, the staminate usually on undeveloped naked branches with leaves at the base, greenish yellow; fruit ripens late in the summer or early autumn, glabrous, 2-3 cm. (¾-1¼ inches) long, wings diverging.

Distribution. Newfoundland south to Georgia and west to Manitoba, Nebraska and Texas. Frequent to common in all parts of Indiana in rich and well drained uplands. It is usually associated with the beech and black maple.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fount-

PLATE 112.



ACER SACCHARUM Marshall. SUGAR MAPLE. (X $\frac{1}{2}$.)

ain (Brown); Franklin (Haymond); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway) and (Thomas); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Wayne (Petry and Markle).

Additional records are: Vicinity of New Albany (Clapp); Putnam (Grimes) and (MacDougal); Tippecanoe (Coulter); Fulton, Harrison, Hendricks, Jennings, Laporte, Madison, Posey, Steuben, Vermillion, Warren and Wells (Deam).

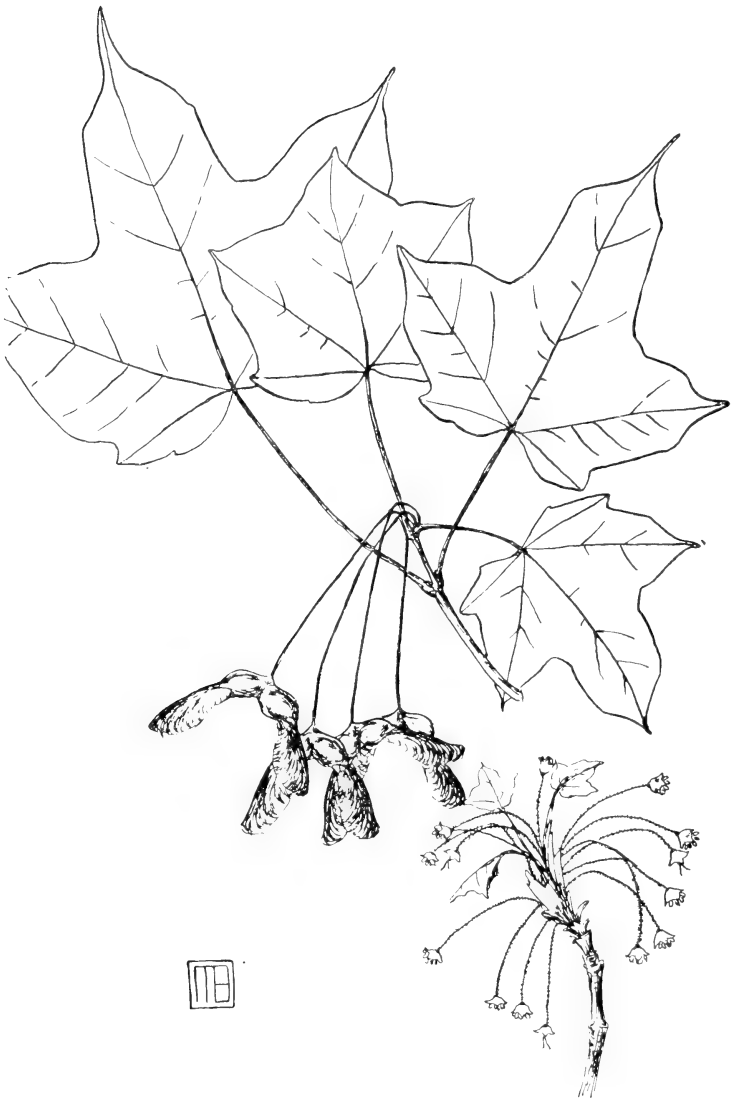
Economic uses. Wood heavy, hard, strong, close-grained, takes a good polish, sap wood light, heart wood light brown, air dries well but warps badly in the kiln. Used in building for frame material and flooring, axles, neck yokes, bolsters, sand-boards, nibs for scythe and cradle snaths. One of our best woods for fuel.

The maple sugar and sirup of commerce is made principally from this species. The amount and sweetness of the sap depends upon the season and the tree. On an average it takes from 3 to 4 gallons of sap to make a pound of sugar, and an average sized tree will usually yield about 3-4 pounds of sugar. In 1900 Indiana ranked third in the production of maple sirup, making 179,576 gallons and 51,900 pounds of sugar. Formerly there were many "sugar camps" but they are becoming rarer each year.

Horticultural value. It is adapted to a moderately dry rich soil; transplants with some difficulty if trees are removed from the forest, nursery stock doing much better; grows slowly, but is hardy and long lived; leaf period long. It is one of the most desirable and most used of our native trees for ornamental and shade tree purposes. It has enemies in the maple borer, tussock moth and cottony maple scale.

5. Acer nigrum Michaux. BLACK SUGAR. BLACK MAPLE. Plate 113. Bark of young trees and the branches smooth and gray, becoming on older trees thick, deeply furrowed, very tight and not exfoliating, usually dark brown to nearly black; branchlets light orange color; ridges of leaf scars prominently pubescent; leaves usually about as wide as long, 6-15 cm. (2¼-6 inches) long, 3-lobed, sometimes 5-lobed, the lobes acute, more or less cordate at the base, hairy beneath when young, becoming at maturity dark green and glabrous above, a yellow green and remaining somewhat hairy beneath, petioles hairy when young, becoming glabrous or nearly so at maturity, usually showing some hairs around the swollen base which later develop a scale-like appendage on each side; flowers

PLATE 113.



ACER NIGRUM Michaux. BLACK SUGAR MAPLE. (x ½.)

yellow on more or less hairy pedicels, the staminate and pistillate in different clusters, sometimes on the same or different trees, flowering period April or May; fruit ripens late in the summer, glabrous, wings diverging slightly more than those of the preceding species. This tree so closely resembles the preceding that by some authors it is regarded as only a variety of it. It can usually be easily distinguished from the sugar maple by its tighter bark, somewhat larger and more drooping leaves which are a shade darker, and by the yellow green color of the under surface of the leaves. The under surface of the leaves of the sugar maple in our area is whitish or glaucous. The sides of the leaves of the black maple droop and the bases of the petioles of especially the last pair of leaves develop two scales which by the end of the season are conspicuous and resemble stipules.

Distribution. Quebec south to Georgia and west to South Dakota, Kansas and Louisana. In Indiana it is widely distributed. It is more or less frequent in all the area where it is found. It is usually found associated with the sugar maple, which it resembles in size and appearance. It prefers a moist rich soil, where it is often more frequent than the sugar maple.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware (Phinney); Gibson (Schneck); Hamilton (Wilson); Kosciusko (Coulter); Marion (Wilson); Monroe (Blatchley); Posey (Schneck); Putnam (MacDougal); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter) and (Dorner); Delaware, Jefferson, Jennings, Montgomery, Vermillion and Wells (Deam).

Economic uses. Same as the preceding species. It is claimed that the sap of this species is the sweetest of any of the maples.

ÆSCULÀCEÆ. THE BUCKEYE FAMILY.

ÆSCULUS. THE BUCKEYES.

Trees with brown or ashy-gray, scaly bark; twigs stout; buds large; leaves opposite, palmately divided into 5-9 ovate to oblong divisions, the divisions serrate, hairy when young, glabrous at maturity except a few hairs along the veins beneath; flowers appearing when the leaves are half grown in terminal panicles; fruit a yellowish-green, three-lobed capsule, generally with one seed, sometimes

two, rich dark brown, 2-4 cm. (¾-1½ inches) broad. The fruit is poisonous to stock, although it seldom proves fatal.

Anthers protruding from the flower; fruit warty..... 1 A. glabra.
Anthers included in flower, fruit smooth..... 2 A. octandra.

1. Æsculus glàbra Willdenow. BUCKEYE. Plate 114. Branchlets at first covered with hairs which soon disappear, orange brown becoming a reddish-brown; terminal bud sharp-pointed, about 1.5 cm. (½ inch) long, scales of bud nearly triangular; flowers appear in May, pale yellow green.

Distribution. Pennsylvania to Iowa, south to Alabama and west to Kansas. Probably native to every county of Indiana, although scarce at present because it has been destroyed on account of the poisonous character of its fruit. It is rare in the extreme northern, northwestern and southwestern counties. In the other parts of the State it is locally frequent in moist rich soil, usually along streams. In the greater part of the State it is frequently associated with sugar maple and beech.

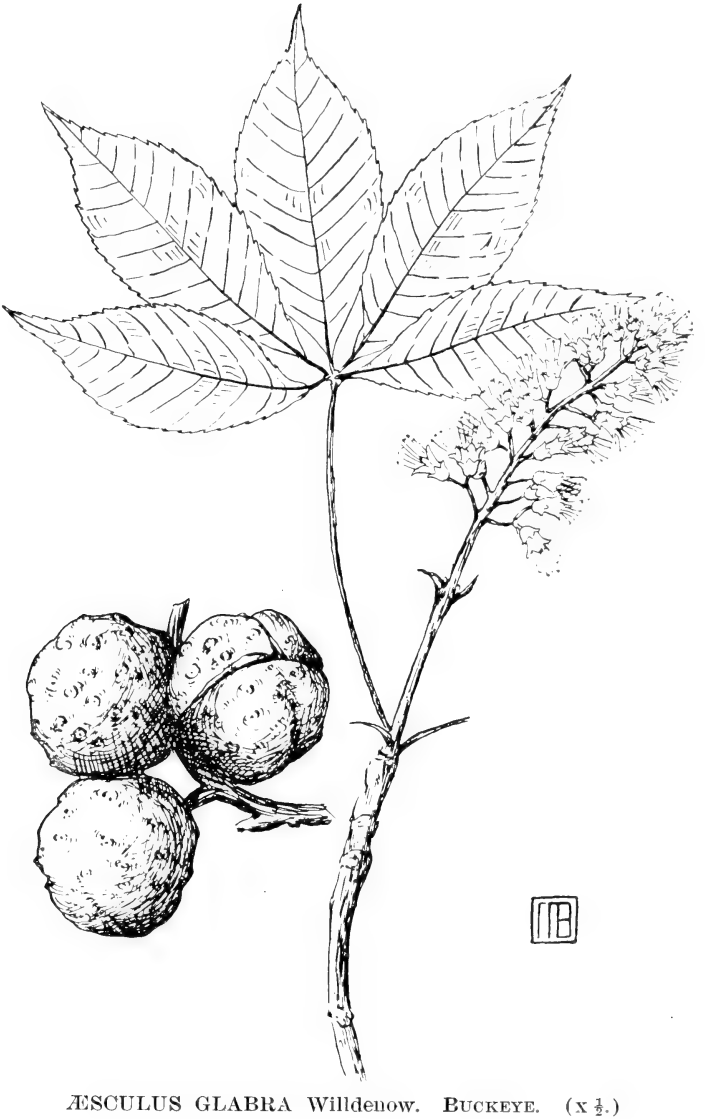
The published records of the distribution are as follows: Boone (Coulter); Clark (Baird and Taylor); Clinton (Coulter); Dearborn (Collins); Decatur (Ballard); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Hendricks (Trucksess); Jay (M'Caslin); Jefferson (Barnes), (Coulter) and (Young); Knox (Thomas); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Shelby (Ballard); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Crawford (Schneck); Montgomery (Evans); Putnam (Grimes); Tippecanoe (Coulter) and (Dorner); Bartholomew, Crawford, Dekalb, Delaware, Franklin, Hamilton, Hancock, Henry, Howard, Jennings, Madison, Marion, Montgomery, Putnam, Shelby, Spencer, Vermillion, Wabash and Wells (Deam).

Economic uses. Wood white, soft, not strong, rather tough. Used for pulp. The fact that the wood is of little commercial value and that the fruit is poisonous to stock has caused it to be cut until at present only isolated trees remain. For ornamental use it has been supplanted by the horse-chestnut.

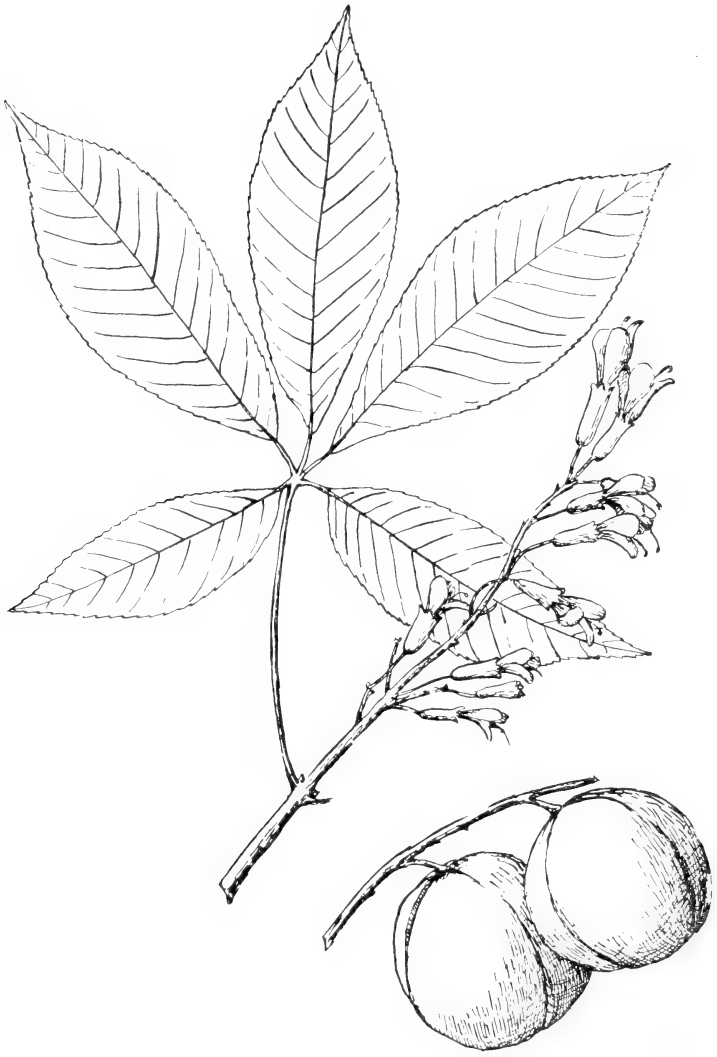
2. Æsculus octándra Marshall. BUCKEYE. Plate 115. Branchlets orange-brown, hairy when young, soon becoming glabrous and

PLATE 114.



ÆSCULUS GLABRA Willdenow. BUCKEYE. (x ½.)

PLATE 115.



ÆSCULUS OCTANDRA Marshall. SWEET BUCKEYE. (x ½.)

turning a pale brown; terminal buds blunt, 2-2.5 cm. (¾-1 inch) long, scales ovate; leaflets irregularly serrate; flowers appear in May, yellow or purplish.

Distribution. Western Pennsylvania, west along the Ohio River to Missouri and south to northern Alabama. Very rare in Indiana and found only in a few counties along the Ohio River. It is the largest tree of the genus in our area.

The published records of the distribution are as follows: Clark (Baird and Taylor); Dearborn (Collins); Delaware (Phinney); Jay (M'Caslin); Jefferson (Coulter) and (Young); vicinity of New Albany (Clapp).

Economic value. Too rare to be of any economic importance.

TILIÀCEÆ. THE LINDEN FAMILY.

TILIA. THE BASSWOODS.

Trees with medium sized twigs; leaves alternate, mostly taper-pointed, oblique cordate or truncate at the base, serrate; flowers in axillary or terminal cymes, white or yellow, fragrant, peduncles of the cymes with a leaf-like bract adhering to about half their length; fruit nut-like, woody, 1-celled.

Leaves smooth or nearly so beneath..... 1 T. americana.
Leaves densely white or gray pubescent beneath..... 2 T. heterophylla.

1. Tília americàna Linnæus. LINN. BASSWOOD. LINDEN. Plate 116. Bark of old trees deeply furrowed, dark gray brown; twigs at the end of the season gray, brown or reddish-brown, when chewed somewhat mucilaginous; buds ovoid, pointed, dark reddish-brown; leaves ovate to orbicular, long-pointed or sometimes rounded at the apex, dark green above, a lighter green beneath, leaf blades 5-15 cm. (2-6 inches) long, smooth above and beneath at maturity, or with scattered hairs and tufts of brown hairs in the axils of the veins beneath, sharply toothed, the teeth ending in a gland; petioles 1/3 to ½ as long as the blades; flowers appear when the leaves are almost mature, June or July; bracts of the peduncles very variable, adhering to the peduncle for about half their length, about 8 cm. (3 inches) long and 1-3 cm. (⅜-1 inch) wide, rounded at the apex, wedge-shaped or rounded at the base, smooth above and below; fruit woolly, globose, about 6 mm. (¼ inch) in diameter.

Distribution. New Brunswick west to Manitoba and south to Georgia and Texas. More or less frequent to common in rich soil

PLATE 116.

TILIA AMERICANA Linnæus. LINN OR BASSWOOD. (x ½.

in all parts of Indiana. It is usually a large and tall tree and is found associated with beech, sugar maple, white ash and red elm.

The published records of the distribution are as follows: Carroll (Thompson); Clark (Baird and Taylor) and (Smith); Daviess (Clements); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Young); Knox (Thomas); Kosciusko (Clark); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Grimes); Tippecanoe (Coulter) and (Dorner); Clark, Decatur, Delaware, Floyd, Fulton, Hamilton, Hancock, Knox, Laporte, Montgomery, Morgan, Noble, Owen, Parke, Porter, Posey, Starke, Warren and Wells (Deam).

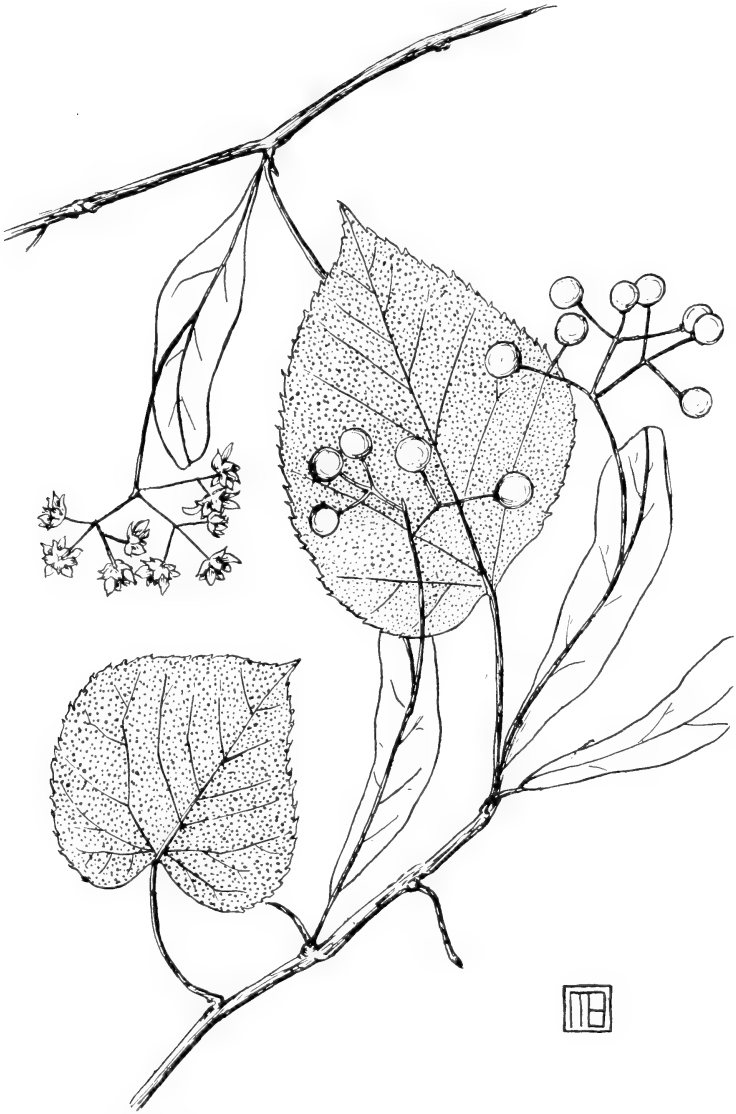
Economic uses. Wood soft, light, straight and close-grained, light brown, easily worked. The principal uses are for lumber, heading and excelsior. The supply of the wood in this State is almost exhausted because of its use for special purposes for which no satisfactory substitute for it has been found. The inner bark is very tough, and was commonly used by the pioneers for tying the shocks of corn.

Horticultural value. Adapted to a moist rich soil and grows rapidly; transplants fairly well, numerous and vigorous shoots appear from the stumps; flowers contain a nectar from which bees make the choicest honey; frequently planted as a shade tree and for ornamental purposes. It has not been tried for forestry purposes in Indiana, although it reaches its greatest development in our area. Since it is certain that there will be a demand in the future for this wood, it is evident that its culture is worthy a trial.

2. Tilia heterophylla Ventenat. LINN. Plate 117. Bark, twigs and buds similar to the preceding species; leaves usually larger, a dark yellow-green above, densely white or gray pubescent beneath, leaf stalks 1/3 to ½ the length of the blade; bracts on the peduncles usually hairy above similar to the under surface of the leaves; flowers appear in June or July.

Distribution. New York south along the mountains to Alabama, west to southern Indiana and Illinois, and central Tennessee. In Indiana it is found in a few counties adjacent to the Ohio River. Dr. Schneck says he noted one tree near the mouth of White River.

PLATE 117.



TILIA HETEROPHYLLA Ventenat. WHITE BASSWOOD. (x ½.)

In the vicinity of Madison it was the only species of Tilia noted. It is said to occur as far north as Vernon in Jennings County.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware (Phinney)*; Gibson (Schneck); Jefferson (J. M. Coulter).

Additional records are: Clark, Dearborn and Jefferson (Deam).

CORNÀCEÆ. THE DOGWOOD FAMILY.

Trees or shrubs, leaves alternate, opposite or whorled; fruit mostly a drupe, 1 or 2 seeded.

Leaves alternate; flowers of two kinds, the staminate in heads, 5-parted; stigmas lateral	1 Nyssa.
Leaves mostly opposite; flowers perfect, 4-parted, stigmas terminal.	
Flowers in open cymes, not subtended by a large involucre	2 Cornus.
Flowers in heads subtended by a large involucre	3 Cynoxylon.

1. NYSSA. THE TUPELOS.

1. Nyssa sylvática Marshall. GUM. BLACK GUM. SOUR GUM. PEPPERIDGE. Plate 118. Bark of old trees thick, deeply and irregularly furrowed, from a light to a very dark brown, branches smooth and brown; twigs slender; winter buds obtuse about 5 mm. (¼ inch) long, leaves entire or sometimes angular toothed, oval obovate or oblong, 5-12 cm. (2-5 inches) long, more or less acute at the apex, wedge-shaped or rounded at the base, hairy when expanding, glabrous and shiny at maturity, or with some pubescence beneath along the veins, a glossy dark green above; flowers appear with the leaves in April or May, small greenish-white, the pistillate and staminate usually on different trees, the pistillate 2-8 or solitary, the staminate numerous; fruit a fleshy drupe, ovoid, blue-black, sour and astringent, ripens in September and October, usually in clusters of 3; stone generally cylindric with 10-12 indistinct ribs.

Distribution. Maine and central Michigan south to the Gulf States and west to Texas. It is well distributed in Indiana. Not frequent in the northern counties, rare in the central part and frequent in the southern half of the State. In the northern part of the State it is found associated with the swamp white and burr oaks. In the southern part of the State it is frequently found in

*Reported by Phinney as occuring in central-eastern Indiana. Reference to Phinney's botany, which is now in the Indianapolis Public Library, in which he kept a record of the plants noted by marking them with an X, shows this species was not marked, so this reference should be dropped.

PLATE 118.

NYSSA SYLVATICA Marshall. BLACK GUM. (x ½.)

drier situations and is generally associated with white oak, red oak and sweet gum. In our area it is usually a tall medium sized tree, although it sometimes attains a circumference of 5 m. (16 feet).

The published records of the distribution are as follows: Clark (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Franklin (Meyncke); Gibson (Schneck); Hamilton(Doane); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Kosciusko (Clark) and (Youse); Lake (Babcock) and (Blatchley); Marshall (Scovell); Monroe (Blatchley); Noble (Van Gorder); Parke (Hobbs); Porter (Blatchley); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Vigo (Blatchley).

Additional records are: Monroe (Mottier); Putnam (Grimes); Tippecanoe (Coulter); Allen, Brown, Clark, Crawford, Decatur, Gibson, Harrison, Johnson, Laporte, Marshall, Montgomery, Porter, Posey, Steuben (Deam).

Economic uses. Wood heavy, soft, rough, sap wood yellowish, heart wood light brown, difficult to split. Used principally for building material, heading, boxes and by the pioneers for ox-yokes.

2. CÓRNUS. The Cornels.

Cornus alternifòlia Linnæus. Dogwood. Swamp Dogwood. Plate 119. Bark gray to dark brown, sometimes the bark of small trees is a glossy yellow green, smooth, warty, or with shallow fissures; twigs at the end of the season green, tinged with brown; buds brown, small and acute; leaves clustered at the ends of the branches, oval or ovate, taper-pointed, narrow or rounded at the base, 6-10 cm. (2½-4 inches) long, margin mostly entire with a few shallow indentations, bright green above, paler beneath, both surfaces hairy when expanding, at maturity the upper side is usually smooth and the lower whitish with appressed hairs; flowers appear in May, in cymes about 5 cm. (2 inches) broad on shoots of the season, cream color, about 3 mm. (⅛ inch) long; fruit dark blue-black, sub-globose, about 8 mm. (1/3 inch) in diameter; stone obovoid, pointed at the base, longitudinally many grooved.

Distribution. Eastern Quebec west to northern Minnesota and south to northern Alabama and Georgia. Throughout Indiana in wet woods and along the borders of streams and lakes. Its distribution has not been determined, although it is believed to be rather rare; favorable conditions for its growth appear to be local. It is found along the Tippecanoe River in Fulton County and asso-

PLATE 119.

CORNUS ALTERNIFOLIA Linnæus. SWAMP DOGWOOD. (x ½.)

ciated with the white elm and black willow. In our area it rarely attains tree size and is of no economic importance.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jefferson (Barnes) and (Coulter); Kosciusko (Clark); Marion (Douglas); Monroe (Blatchley); Posey (Schneck); Steuben (Bradner); St. Joseph (Rothert); Tippecanoe (Cunningham); Vigo (Blatchley).

Additional records are: Montgomery (Evans); Putnam (Grimes), (MacDougal) and (Wilson); Fulton, Hamilton, Johnson, Laporte, Monroe, Montgomery, Porter, Washington and Wells (Deam).

3. CYNÒXYLON. THE DOGWOODS.

(From the Greek, *cynos*, dog and *xylon*, wood).

Cynoxylon flóridum (Linnæus) Rafinesque. DOGWOOD. FLOWERING DOGWOOD. (*Cornus florida* Linnæus). Plate 120. Bark of old trees reddish-brown, usually deeply fissured and divided into short oblong scales; twigs slender, round, turning up at the ends; terminal winter buds oblong, covered with two opposite scales, flowering buds sub-globose, grayish, covered with 4 scales which later develop into the flowering bracts; leaves ovate to elliptic, 5-14 cm. (2-5½ inches) long and 3-7 cm. (1¼-2¾ inches) wide, taper-pointed at the apex, narrowed or rounded at the base, margin entire or with a few shallow indentations, more or less hairy both above and below, bright green above, lighter or whitish beneath, turning scarlet in autumn; flowering heads surrounded by an involucre of 4 large white or pinkish bracts, the mature bracts obovate, 3-6 cm. (1¼-2½ inches) long, notched and thicker at the apex, the apex is a grayish brown, being the part that encloses the flower buds; flowers small, greenish, appearing in April or May; fruit ripens in September and October, scarlet red, the ovoid drupe about 1 cm. (⅜ inch) long with a thin acrid pulp and a large elliptic stone; stone pointed at both ends.

Distribution. Southern Maine, Ontario and southern Minnesota south to Florida and west to Texas. In Indiana it is frequent in all parts of the State that are favorable to its growth. It prefers a moist rich soil and is usually associated with beech, sugar maple and white oak. It is a small tree with a short trunk, usually about 7 m. (23 feet) high with a diameter of about 13 cm. (5 inches).

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Daviess (Clements); Dearborn

PLATE 120.

CYNOXYLON FLORIDUM (Linnæus) Rafinesque. DOGWOOD. (x ½.)

(Collins); Delaware (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway); Kosciusko (Clark) and (Scott); Lake (Higley and Radden); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Wayne (Petry and Markle).

Additional records are: Monroe (Blatchley); Montgomery (Evans); Posey (MacDougal and Wright); Putnam (Cook), (Grimes) and (Lewis and Bridges); Tippecanoe (Coulter) and (Dorner); Blackford, Clark, Decatur, Delaware, Harrison, Huntington, Jackson, Madison, Marion, Morgan, Parke, Putnam, Ripley, Scott, Steuben, Shelby, Wells (Deam).

Economic uses. Wood heavy, hard, tough, strong, close-grained, brown, takes a high polish. It was used by the pioneers for wedges, mallets, handles for tools and for fuel. No place was found in Indiana where it is now bought for commercial purposes. The bark of the root is used in medicine and the fruit is freely eaten by some species of birds.

Horticultural value. It is adapted to a moist rich soil; is not easily transplanted; crown depressed hemispheric. In flower it is the most showy of our native trees and for this reason it is much desired for ornamental planting. Several horticultural varieties have been developed, but they are not as hardy as the type. It is used in the planting of borders and because it is shade enduring is well adapted for planting between large trees.

EBENÀCEÆ. THE EBONY FAMILY.

DIOSPYROS.

(From the Greek, *dios*, Jupiter, and *pyros*, fruit: meaning heavenly fruit).

Diospyros virginiàna Linnæus. PERSIMMON. Plate 121. Bark dark reddish-brown to black, deeply and irregularly fissured; buds acute with lustrous purplish scales; leaves alternate, entire, oval, short pointed at apex, narrowed, rounded or cordate at the base, hairy when young, smooth at maturity, at least above, 8-16 cm. (3-6 inches) long and 5-8 cm. (2-3 inches) wide; flowers appear in May or June when the leaves are half grown, greenish yellow, the staminate on one tree and the pistillate on another; fruit depressed globose to oval in shape, 2-3 cm. (¾-1¼ inches) in diameter, reddish-brown or yellow, matures late in the fall, flesh very astringent when immature, sweet when ripe. The fruit varies greatly in

PLATE 121.

DIOSPYROS VIRGINIANA Linnæus. PERSIMMON. (x ½.)

quality and shape and in the number of the seeds. From the fact that it is the favorite food of the opossum it is frequently called the "possum" fruit.

Distribution. Southern Connecticut west to southeastern Iowa and eastern Kansas, south to the Gulf. In Indiana it is confined principally to the southern part of the State, and is rarely found north of Indianapolis. Prof. Stanley Coulter reports three large trees growing in Tippecanoe County in situations such as to indicate that they are native. It is usually a small, sometimes a medium sized tree, 8-15 m. (25-50 feet) high. Generally found in dry soil in woods, fields and along fences. Frequently in the southern part of the State waste and old worn out fields become thickly covered with persimmon sprouts and in cultivated fields it is often a task for the farmer to subdue the persimmon and sassafras sprouts. In Posey County it is found on both high and low situations. In the Wabash bottoms it is found on the borders of swamps and one specimen was noted growing with *Cephalanthus* and *Saururus,* which was 2.5 dm. (10 inches) in diameter.

The published records of the distribution are as follows: Clark (Baird and Taylor) and (Smith); Floyd (Clapp); Franklin (Meyncke); Gibson (Schneck); Jefferson (Coulter) and (Young); Knox (Ridgway) and (Thomas); Marion (Douglas); Miami (Gorby); Monroe (Blatchley); vicinity of New Albany (Clapp); Orange (Troop); Posey (Schneck); Tippecanoe (Coulter); Vigo (Blatchley).

Additional records are: Posey (Wright); Putnam (Grimes); Clark, Dubois, Knox, Posey (Deam).

Economic uses. Wood heavy, hard, strong, fine-grained, takes a high polish; sap wood light brown, heart wood dark brown to nearly black in very old trees. The supply is so limited in this State as to be of no economic importance.

Horticultural value. While the tree is interesting and the flowers and foliage attractive, it can scarcely be recommended for ornamental planting on account of its slow growth. It is hardy in all parts of the State and since the fruit is relished by many people, the planting at least of horticultural varieties should be encouraged.

OLEÀCEÆ. THE OLIVE FAMILY.

Leaves compound; fruit dry, a samara..... 1 Fraxinus.
Leaves simple; fruit fleshy, a drupe..... 2 Forestiera.

1. FRÁXINUS. THE ASHES.

Trees with furrowed bark; opposite, compound leaves; flowers appear in April or May in clusters from the axils of the last year's leaves, the staminate and pistillate on different, or sometimes on the same tree; fruit a samara.

Bark of mature trees deeply fissured; fruit not winged to the base.
- Wing of fruit rarely extending down on the body more than 1/3 of its length; body of fruit robust, round and rather abruptly passing into the wing.
  - Shoots and main axis of the leaf smooth ..... 1 F. americana.
  - Shoots and main axis of the leaf velvety pubescent .. 2 F. biltmoreana.
- Wing of fruit generally extending down on the body more than 1/3 of its length; body of fruit flattened and gradually passing into the wing.
  - Body of samara less than 3 mm. (1/8 inch) in diameter just below the wing, usually 1.5-2 mm. (1/16 inch); generally 3-4.5 cm. (1¼-1¾ inches) long ..... 3 F. pennsylvanica.
  - Body of samara more than 3 mm. (1/8 inch) in diameter just below the wing, usually 4-5 mm. (¼ inch); samara generally 4-6 cm. (1⅝-2⅜ inches) long ..... 4 F. Michauxii.

Bark of mature trees scaly or flaky; fruit winged to the base.
- Ridges connecting leaf scars usually present; twigs usually 4-angled and more or less pubescent; buds gray; leaflets stalked ..... 5 F. quadrangulata.
- Ridges connecting leaf scars usually absent; twigs round and smooth; buds a very dark brown or black; leaflets sessile ..... 6 F. nigra.

1. Fraxinus americàna Linnæus. WHITE ASH. GRAY ASH. Plate 122. Bark on the trunks of mature trees gray, deeply fissured, forming numerous diamond-shaped cavities, bark on the smaller branches smooth and grayish-green; the season's shoots at first green, becoming gray or light brown by the end of the season, smooth and often coated with a bloom; winter buds broadly ovate, obtuse, with 4 pairs of scales, appearing rusty-pubescent or reddish-brown; leaves 2-3 dm. (8-12 inches) long, main axis smooth, leaflets on stalks 0.3-2.5 cm. (1/8-1 inch) long, the stalk of the terminal one 2-3 times as long, leaflets 5-9, usually 7, 5-13 cm. (2-5 inches) long, ovate to narrow-oblong, entire or somewhat toothed, the teeth rarely extending to the base, base rounded, acute or oblique, acute at the apex, usually long taper-pointed, sometimes short taper-pointed, deep green and smooth above, paler beneath, usually silvery, smooth or with hairs along the veins; calyx persisting on the fruit; fruit ripens in early fall, varies greatly on different trees in size and shape, the fruit of each tree is however quite uniform in

PLATE 122.

FRAXINUS AMERICANA Marshall. WHITE ASH. (x ½.)

size and shape, spatulate to linear, 3-5 cm. (1¼-2 inches) long, body round and plump, the wing somewhat wider and 2-3 times as long as the body.

Distribution. Nova Scotia, Ontario and Minnesota south to Florida. Frequent to common in all parts of Indiana. It is the most abundant in the northern two-thirds of the State, where it is associated with the hard maple, beech, linn and slippery elm. In several localities in southern Indiana it is called black ash to distinguish it from its associate, the blue ash, which has a whiter bark. In the hilly part of the State it is found principally near the water courses and rarely on the white and black oak ridges.

In the forest it is a tall straight tree, averaging 0.5-1 m. (19-39 inches) in diameter and 20-30 m. (65-100 feet) in height, with usually few side branches below the main branches of the crown.

The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor) and (Smith); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Kosciusko (Clark) and (Youse); Knox (Ridgway); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Knox (Schneck); Putnam (MacDougal); Tippecanoe (Coulter); Union (Rose); Brown, Clark, Decatur, Delaware, Floyd, Hamilton, Jefferson, Jennings, Laporte, Lawrence, Porter, Posey, Starke, Steuben, Vermillion, Warren, Washington and Wells (Deam).

Economic uses. Wood heavy, hard, strong, tough, close-grained, sap wood light, heart wood light brown. The wood of this tree is one of the most valuable of the Indiana hardwoods. It has numerous uses among which the following are the most important: Handle stock, street car stock, agricultural implements, heading for butter tubs, house finishing, furniture, boxes, crating and vehicle stock.

Horticultural value. Hardy, grows in nearly all kinds of soil, though it prefers a moist rich soil; transplants easily; grows rapidly; bears pruning well; erect in its habit of growth and easily trained to grow tall and straight. It is a desirable tree for street and landscape planting. The results of the cultivation of this species at the forest experimental station indicate that it is one of the best

for forest planting in Indiana. It grows rapidly, transplants successfully and is easily managed. It is propagated by planting the seed in the fall and transplanting the seedlings when they are 1 or 2 years old. If the trees are planted in rows they should be given from 16 to 64 square feet of space. Results indicate that when a pure planting is attempted the trees should be spaced 4x4 feet or 5x5 feet. The ash will do well either in a pure or mixed stand, provided the associated trees do not over-top it. It is light demanding, consequently natural pruning is effective.

2. Fraxinus biltmoreàna Beadle. WHITE ASH. GRAY ASH. Bark and buds similar to those of the preceding; shoots velvety pubescent, remaining so during the season or becoming somewhat smooth, but never glabrous; leaves 2-3, 5 dm. (8-14 inches) long, main axis pubescent, leaflets on stalks 0.3-3 cm. (1/8-1 3/4 inches) long, the terminal about twice as long; leaflets 5-11, generally 9, 5-13 cm. (2-5 inches) long, ovate to narrow oblong, usually entire, sometimes toothed, rounded, acute at the apex, dark green and smooth above, paler and pubescent beneath, at least with numerous hairs along the veins; fruit similar to that of the preceding.

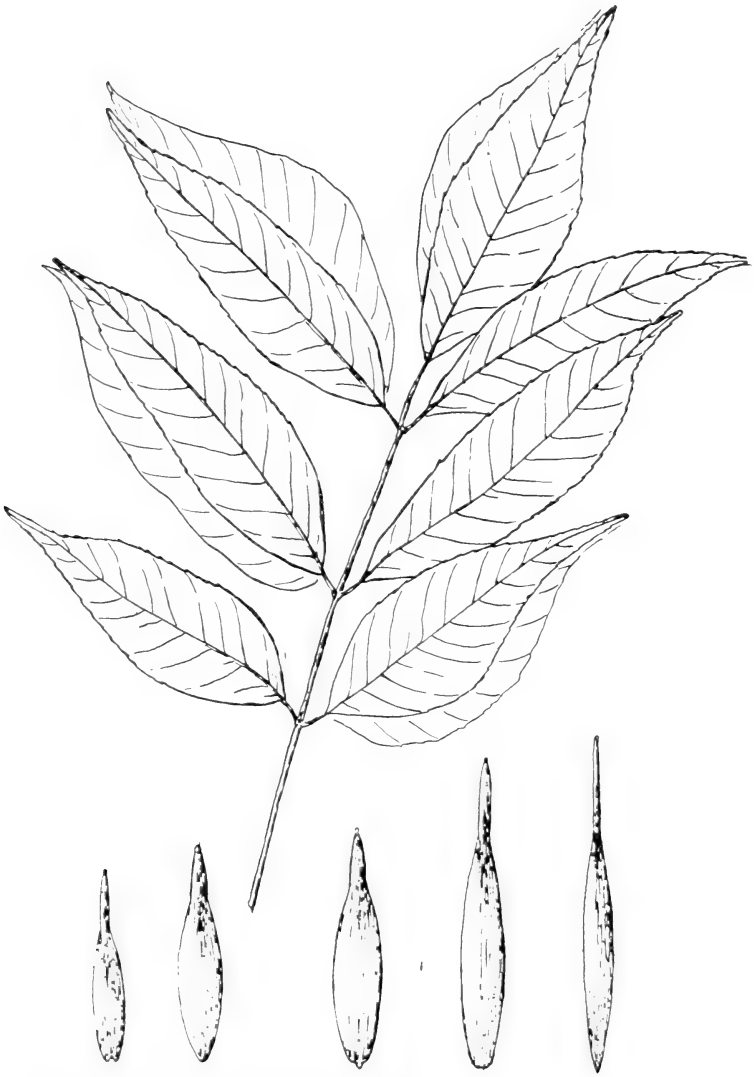
Distribution. Pennsylvania and southern Indiana south to Georgia. In Indiana it occurs only in the southern half of the State. It is found in situations similar to those of the preceding species and under drier conditions. It is associated with *Fraxinus americana* and is equally abundant.

It has been found in the following counties: Brown, Clark, Jefferson, Jennings, Lawrence, Owen and Washington (Deam).

Economic uses. Similar to those of the preceding species.

3. Fraxinus pennsylvánica Marshall. WHITE ASH. GRAY ASH. BLACK ASH. Plate 123. Bark similar to that of the preceding species but with closer and more shallow furrows and darker in color; the year's shoots greenish-gray, smooth or hairy, generally smaller than those of the other species that occur in the State; buds smaller and blacker than those of the preceding species; leaves 2-3 dm. (8-12 inches) long, petioles smooth or pubescent; leaflets 5-9, usually 7, the lateral on stalks from 2-12 mm. (1/10-3/5 inch) long, the stalk of the terminal 2 or 3 times as long, margins entire or serrate; acute or rounded at the base, generally long taper-pointed at the apex, yellow green on both sides or sometimes paler beneath, smooth or more or less pubescent beneath; flowers appear in April or May as the leaves unfold; fruit ripens early in the fall, 2.5-5 cm. (1-2 inches) long, linear to spatulate, the base sur-

PLATE 123.



FRAXINUS PENNSYLVANICA Marshall. RED OR GREEN ASH. (x ½.)
(Showing variation of fruit from different trees.) (x 1.)
(Variation of leaflets indicated by secondary leaf margins.)

PLATE 124.

FRAXINUS MICHAUXII Britton. SWELL-BUTT ASH.

[22—28415]

rounded by the persistent calyx, the end of the body gradually tapering into a wing which is 1-5 times as long as the body and which extends down along the body to the middle or below.

Distribution. New Brunswick, Southern Ontario and Nebraska south to Florida. In Indiana it is a medium sized tree, found more or less frequently in all parts of the State along water courses and on the borders of lakes and swamps. It is usually found in situations intermediate between those of *Fraxinus americana* and *Fraxinus nigra.* The bark of the trunk is usually darker than that of the preceding species and for this reason it is often called black ash. Books and nurserymen call this species green or red ash, but no millman or farmer was found who applied either of these names to any of the ashes of the State.

The published records of the distribution are as follows: Franklin (Meyncke); Gibson (Schneck); Knox (Ridgway); Lake (Higley and Radden); Posey (Schneck); Tippecanoe (Cunningham).

Additional records are: Knox (Schneck); Putnam (Grimes); Tippecanoe (Coulter); Bartholomew, Delaware, Gibson, Hancock, Hendricks, Jackson, Jefferson, Marion, Montgomery, Parke, Porter, Posey, Starke, Steuben, Vermillion, Warren and Wells (Deam).

Economic uses. Wood heavy, hard, rather strong, sap wood thick and of a light color, heart wood light brown. Commercially not separated from *Fraxinus americana,* which however, is a superior wood.

Horticultural value. It is hardy in our area, transplants easily, grows rapidly, and when grown in the open develops a wide spreading crown. If a medium sized ash tree is desired, this is the species that should be chosen.

4. Fraxinus Michauxii Britton. SWELL-BUTT ASH. CHURN-BUTT ASH. Plate 124. Bark rather deeply fissured, light or dark gray, similar in appearance to that of *Fraxinus pennsylvanica;* season's shoots densely velvety pubescent, remaining so during the season, becoming gray or brown by the end of the season; leaves 2-4 dm. (8-16 inches) long, main axis generally densely pubescent; stalks on the lateral leaflets 0.2-1.5 cm. (1/16-¾ inch) long, the terminal stalk 2-4 times as long as those of the upper pair of leaflets; leaflets 5-9, generally 7, frequently 9, ovate-lanceolate or oval-oblong, 7-15 cm. (3-6 inches) long, round or acute at the base, usually long taper-pointed at the apex, thick, margins entire or with a few small teeth, dark green and smooth above at maturity, paler and usually densely pubescent beneath; fruit ripens early in the fall a few weeks

before *Fraxinus pennsylvanica;* samara large, generally 4-6 cm. (1⅝-2⅜ inches) long, frequently falcate, the wing generally 8-9 mm. (¼ inch) wide in the middle, commonly obtuse and notched at the apex, body heavy, about 2/3 as long as the wings.

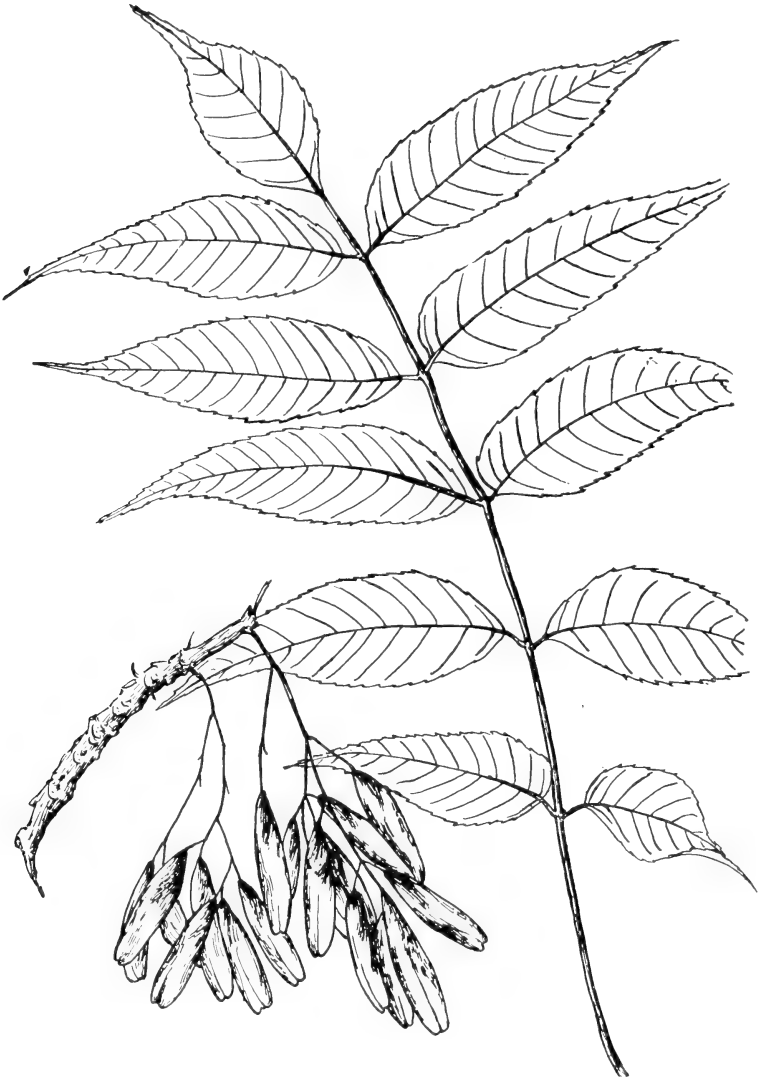
Distribution. New York south to North Carolina and Louisiana and west to Missouri. In Indiana it is found in a few counties in the southwestern part of the State. It grows in swamps which are inundated for several months during the year. A characteristic of the tree is to develop a swelled base. An average sized tree measured as follows: 6 dm. (2 feet) above the ground, 36 dm. (141 inches) in circumference; 12.5 dm. (4½ feet) above the ground, 28 dm. (113 inches) in circumference; 18 dm. (6 feet) above the ground, the top of the swelled base 23.5 dm. (94 inches) in circumference.

There are no published records of the distribution of this species in Indiana. It has been taken in Gibson, Marion and Posey Counties by Deam. Although it has been known for years to be a member of our flora both by Dr. J. Schneck and Robert Ridgway, it has never been published. Dr. Schneck's specimens were labeled *Fraxinus profunda* Beadle. The specimen taken in Marion County was from a medium sized tree in moist soil along a roadside. In appearance it resembles *Fraxinus americana.* The existence of this tree in this locality is puzzling and additional study may show that the species has a wider range than indicated and that it may be found in drier situations than inundated swamps.

Economic uses. Similar to that of the white ash. Millmen who are acquainted with the tree say it is rarely ever hollow at the swelled base.

5. Fraxinus quadrangulàta Michaux. BLUE ASH. Plate 125. Bark of mature trees light gray, separating in large thin plates, usually curling up at the side; shoots green, gradually turning gray, 4-angled, or vigorous shoots developing 4 wings about 2 mm. (1/16 inch) high, smooth; leaves 2-3 dm. (8-12 inches) long, petioles more or less pubescent, usually somewhat winged at the base, not deeply grooved; leaflets 7-11, ovate oblong to lanceolate, long taper-pointed at the apex, unequal at the base, rounded or wedge-shaped, margins usually with a few shallow teeth, sometimes sharply serrate or entire, the lateral leaflets on stalks 2-12 mm. (1/10-3/5 inch) long, the terminal one on a stalk 2 or 3 times as long, hairy beneath when they unfold, smooth or somewhat hairy at maturity, glabrous above, yellow-green both above and below; flowers appear before

PLATE 125.



FRAXINUS QUADRANGULATA Michaux. BLUE ASH. (x ½.)

the leaves in April or May, perfect, that is there are stamens and pistils in the same flower, petals wanting, calyx in mature fruit obsolete or a mere ring; fruit maturing late in summer; linear-oblong, 2-4 cm. (1-2 inches) long, about 1 cm. (½ inch) wide, flat, winged all around, blunt and notched at the apex, as viewed from apex twisted to the right 20-40 degrees.

Distribution. Southern Ontario and Minnesota south to Tennessee, Alabama and Arkansas. In the northern part of Indiana it is rare to infrequent, becoming more frequent southward until the hills of southern Indiana are reached where it is more uniform in its distribution. In several localities in the southern part of the State it is known as "white" ash on account of the light color of the bark to distinguish it from the other species of the neighborhood, all of which have a darker colored bark. In these localities *Fraxinus nigra* is not found. Where the sugar maple and beech are the prevailing species it is commonly quite frequent. Throughout its distribution it is found in dry well drained soil and its constant associate is the sugar maple. Usually a medium sized tree in both diameter and height, occasionally a tree of large diameter. Frequently the bark of the mature trees of the hard maple and blue ash very much resemble each other in color and exfoliation.

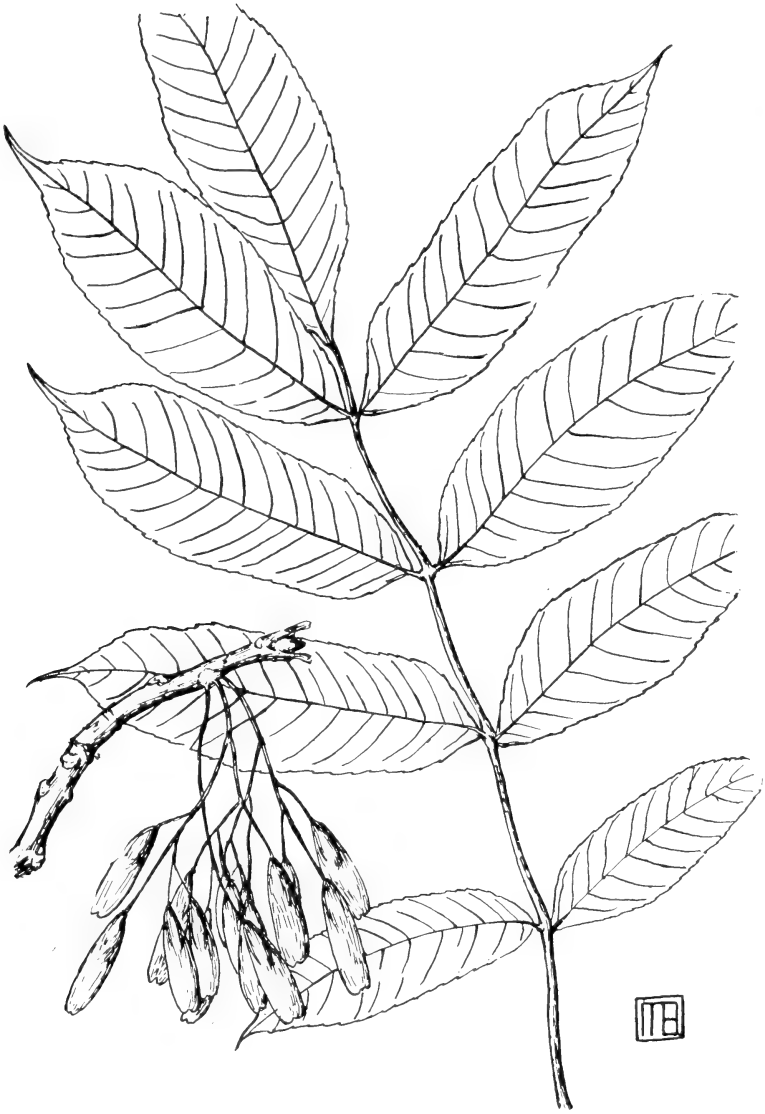
The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor); Dearborn (Collins); Delaware (Phinney); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Haymond) and (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway); Marion (Wilson); Miami (Gorby); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod); Wayne (Petry and Markle).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Dearborn, Delaware, Harrison, Jefferson, Montgomery and Wells (Deam).

Economic uses. Wood heavy, hard, close-grained and rather brittle. Commercially it is usually graded as white ash. It was a favorite wood with the pioneers for making the puncheons of their log cabins.

6. Fraxinus nigra Marshall. WATER ASH. SWAMP ASH. BLACK ASH. HOOP ASH. Plate 126. Bark light gray, fissures short and shallow, separating in short thin scales; small branches light gray, rather tough; the season's shoots at first olive green, becoming smooth and gray; leaf-scars shield shape, ridges connecting them

PLATE 126.



FRAXINUS NIGRA Marshall. WATER OR BLACK ASH. (x $\frac{1}{2}$.)

usually absent, plane of leaf-scar usually parallel to the branch; winter buds robust, about 5 mm. (¼ inch) long, broadly ovate, roundish pointed, with 3 pairs of scales, velvety black; leaves 3-4 dm. (12-16 inches) long, petioles smooth and grooved, leaflets 7-13 usually 9, variable in outline, 6-10 cm. (2½-4 inches) long and 3-4 cm. (1¼-1¾ inches) wide, wedge-shaped at the base, sometimes rounded, taper-pointed, sharply serrate, lateral leaflets sessile, the terminal one stalked, dark green above, paler beneath, glabrous on both sides at maturity except a few clusters of brown hairs in the axils of the veins beneath; flowers appear before the leaves in April or May, calyx and petals wanting; fruit ripens late in the summer, linear-oblong, broadest above the middle, 2-3 cm. (¾-1¼ inches) long, round at both ends, flat or slightly twisted.

Distribution. Newfoundland and Manitoba south to Virginia, southern Illinois and Arkansas. Found in most parts of Indiana. Infrequent to rare in the extreme southern part, and it is doubted if it occurs at all in a few of the southeastern counties. It is more or less frequent in all of the northern counties in wet woods, on the borders of swamps, lakes and streams. It is usually associated with the water elm, burr and swamp white oaks, soft maples, linn, cottonwood, aspens and tamarack. In some of the wet woods of the northern part of the State it sometimes composes one-third to one-half of the stand. It is a medium sized tree, growing very tall and straight. Usually about 3-4 dm. (12-16 inches) in diameter and 20-25 m. (60-80 feet) in height.

The published records of the distribution are as follows: Cass (Benedict and Elrod); Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Coulter); Knox (Ridgway); Marion (Wilson); Miami (Gorby); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Steuben (Bradner); Vigo (Blatchley); Wabash (Benedict and Elrod).

Additional records are: Putnam (Grimes); Tippecanoe (Coulter); Union (Rose); Blackford, Delaware, Knox, Madison, Porter, Steuben and Wells (Deam).

Economic uses. Wood heavy, rather soft, coarse-grained, not strong, sap wood light, heart wood brown, very brash if grown where it is wet, rather tough if grown in drier situations. Readily separating into thin layers if pounded, hence its use in the manufacture of hoops and baskets. Used for fuel, and by the pioneers for rails and pieces from the buttressed bases for hames.

2. FORESTIÈRA.

Forestiera acuminàta (Michaux) Poiret. POND BRUSH. CROOKED BRUSH. Plate 127. Bark on small trees smooth, becoming rough or fissured on larger trees, the ridges short and broken, light to dark gray; branches slender, numerous and somewhat spiny; winter buds ovoid, smooth or sometimes a few of the scales with ciliate margins, much lighter in color than the twigs; leaves ovate to elliptic-ovate, 3-9 cm. (1¼-3½ inches) long, long taper-pointed at the apex, generally about as long pointed at the base, leaves on vigorous shoots the largest and with a shorter tapering base, margins with shallow rounded teeth to below the middle, rarely entire, a light green and smooth both above and beneath; petioles about 1 cm. (⅜ inch) long; flowers appear in March or April before the leaves, the staminate in small sessile clusters along the small branches, the pistillate in short panicles; fruit a dark purple drupe, oblong, about 15 mm. (½ inch) long; stone with many longitudinal ribs.

Distribution. Southwestern Indiana and southern Illinois south to Georgia and Texas. In Indiana it occurs only in a few counties in the southwestern part of the State where it is found in swamps, borders of ponds and low river banks. It is very tolerant of shade and is frequently found growing in a thick stand of tall trees. It is generally associated with *Cephalanthus* (Button Bush), *Taxodium* (Cypress), *Salix nigra* (Willow), *Betula nigra* (Birch), *Populus heterophylla* (Cottonwood) and *Fraxinus Michauxii* (Swell-butt Ash). In our area it is usually shrub-like and in some places it forms almost impenetrable thickets. It sometimes reaches a height of 8 m. (25 feet) and a diameter of 1.5 dm. (6 inches). The common name given in books for this species is "swamp privet" but no one was found who knew it by that name. In Gibson and Posey Counties it is commonly called "pond brush" and "crooked brush".

The published records of the distribution are as follows: Gibson and Posey (Schneck); Knox (Ridgway).

Additional records are: Gibson and Posey (Deam).

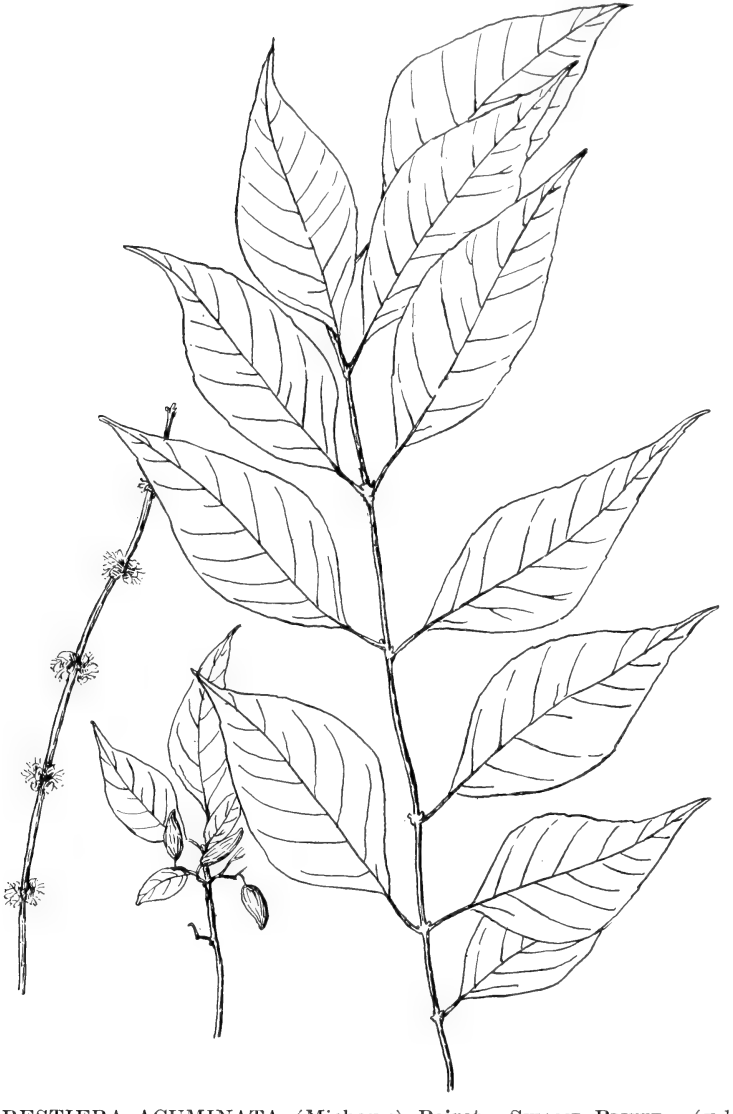
Economic uses. Too small and the supply too limited to be of any economic value.

BIGNONIÀCEÆ. THE TRUMPET CREEPER FAMILY.

CATÁLPA. THE CATALPAS.

Leaves simple, opposite or whorled, with long petioles; flowers in terminal panicles or corymbs; fruit a long round pod which splits into halves; seeds many, flat, papery, with a tuft of long hairs at each

PLATE 127.



FORESTIERA ACUMINATA (Michaux) Poiret. SWAMP PRIVET. (x $\frac{1}{2}$.)

end. The word catalpa is of Indian origin, and the meaning of the word, doubtful. The genus is composed of seven species of trees and shrubs, native to North America and Asia.

Bark of old trees separating in thin flat scales; flowers numerous in dense panicles; flowers about 3 cm. (1¼ inches) wide; calyx glabrous; lower lobe of corolla entire ..... 1 Catalpa Catalpa.

Bark of old trees deeply fissured, not scaly; flowers in loose panicles; flowers about 5 cm. (2 inches) wide; calyx usually pubescent; lower lobe of corolla notched at the apex ..... 2 Catalpa speciosa.

1. Catalpa Catálpa (Linnæus) Karsten. CATALPA. (*Catalpa bignonioides* Walter). Plate 128. Bark of old trees grayish-brown, flaky, separating in thin scales, 6-8 mm. (¼ inch) thick; leaves broadly ovate or narrower, cordate at the base, taper-pointed, entire, or with 1 or 2 lateral lobes, blades 15 cm. (6 inches) long and 12 cm. (5 inches) wide, at maturity light green and smooth above, paler and hairy beneath, fetid when bruised; flowering period May or June; flowers white, marked on the lower inner surface by 2 rows of yellow blotches, the lower lobes marked with purple spots, the lower lobe entire or nearly so, the upper lobe about half enclosing the other lobes when expanding; tube of flower bell-shaped, wide as long; fruit chestnut brown, grooves of pod shallow or usually wanting, 1.5-3.5 dm. (6-14 inches) long, usually about 8 mm. (1/3 inch) thick, walls of pod thin, becoming flat after opening, each panicle of flowers usually maturing 4-10 pods; seeds 1.5-2.5 cm. (¾-1¼ inches) long and about 5 or 6 mm. (¼ inch) wide, silvery gray, with the tuft of hairs on the end of the seed coming to a point, and longer than the body of the seed.

Distribution. Supposed to be native to parts of Florida, Georgia, Alabama, and Mississippi. It has been introduced and naturalized throughout the whole of the eastern United States. In Indiana it has been used for years as an ornamental and shade tree, although in fact, it has few qualities to recommend it. In some of the parks where it has been planted it is being removed because the mature pods make such a litter when they fall.

2. Catalpa speciòsa Warder. CATALPA. HARDY CATALPA. CATALFA. Plate 129. Bark of old trees grayish-brown, furrowed, at last slightly flaky; leaves broadly to oblong-ovate, 1-3 dm. (4-12 inches) long, heart-shaped at the base, long taper-pointed, entire or with 1 or 2 lateral lobes, at maturity dark green and smooth above, lighter and hairy beneath, not ill-scented when bruised, with clusters of dark glands in the axils of the veins beneath; flow-

PLATE 128.

CATALPA CATALPA (Linnæus) Karsten. CATALPA. (×½.)

PLATE 129.

CATALPA SPECIOSA Warder. CATALPA. (x ½.)

ers appear in May or June about 2 weeks later than the preceding species, white, inconspicuously spotted with yellow and purple, lower lobe notched, the upper lobe enclosing the other lobes when expanding, tube of flower conical, longer than wide; fruit dark brown, strongly grooved, 2-5 dm. (8-20 inches) long, and about 1.5 cm. (¾ inch) thick, usually 1 or 2 and seldom as many as 3 pods of the panicle maturing, walls of the pod thick, the valves remaining semi-terete after separating; seeds light brown, 2-3 cm. (¾-1 inch) long, and about 1 cm. (⅜ inch) wide, with a fringe of light brown and parallel hairs at each end nearly as long as the body.

It is now known that the several species of catalpa freely hybridize and it is difficult to obtain pure strains of either species. It appears to be almost impossible, or at least with a great risk of being mistaken, to separate this species from the preceding when they are very young. Mature trees are frequently difficult to distinguish because there are so many hybrids. Sometimes trees that have the appearance of speciosa will have the flowers or seed of *Catalpa Catalpa*. Mr. E. S. Antisdale in the Botanical Gazette, Vol. 8, page 171, says, "the stigmas of *Catalpa speciosa* close in a few seconds after being irritated." Thos. Meehan in the Botanical Gazette, Vol. 8, page 191, says, "it takes about 45 seconds for the stigmas of *Catalpa Catalpa* to close after being irritated."

Distribution. Found in the valley of the lower Wabash, along the valley of the Ohio River through Illinois, in the southeastern part of Missouri and the northeastern part of Arkansas. In Indiana it was found along the valley of the Ohio River as far east as Rockport and in the valley of the Wabash as far north as Vigo County. The mass of its distribution was west of a line connecting Terre Haute and Rockport. An old pioneer living near Austin, Scott County, said it was native in the Muscatatuck bottoms. This citation has not been verified. Another pioneer said it was native along the Ohio River as far up as New Albany. It was rather frequent in low, well drained soil near streams but has now become very scarce.

In the original forest it was a medium sized tree, usually about 5-7 dm. (20-28 inches) in diameter and 15-25 m. (49-81 feet) high. In the forest conditions it grew tall and straight, although it can scarcely be said of it that it grows as straight and as tall as other trees of equal size. Information obtained from the pioneers who were familiar with the original forests, say that the tree was only medium sized and seldom made more than 3 or 4 post lengths below the branches; that the lower branches did not shade off early and that the trees would seldom make good saw timber on account

of the many knots. Some persons who are interested in selling catalpa trees have exaggerated the tendency of the catalpa to grow tall and straight. The catalpa does not form a terminal bud and each year's growth is marked by a more or less visible crook.

The published records of the distribution are as follows: Delaware, Jay, Randolph and Wayne* (Phinney); Gibson (Schneck); Knox (Ridgway); Posey (Schneck); Tippecanoe* (Coulter); Vigo (Blatchley).

Additional records are: Gibson, Knox and Posey (Deam).

Economic uses. Fence posts, poles and crossties. It is believed that the average life of a forest grown split catalpa post is from 15 to 25 years. That the life of a round post that has been grown in the open and has large annual rings will not average more than 10-15 years. The lasting qualities of the catalpa post have been exaggerated. In the vicinity where the catalpa was indigenous it was used extensively for post purposes, not entirely on account of its lasting qualities, but because it worked easily and was not valuable for other purposes.

Horticultural value. The catalpa transplants easily, grows rapidly, is adapted to a well drained loam soil, forms a rather narrow and open crown, leaf period begins late and lasts until killing frosts. It has been rather extensively used for ornamental and shade tree purposes on account of its large green leaves and large panicles of flowers. The objections to this tree are the litter the fruiting pods make, and the danger of being defoliated by the catalpa sphinx.

It has been recommended and extensively used for forest planting. It has also been recommended for reinforcing the wood lot, that is to plant between other trees to thicken up the stand. The catalpa is not shade enduring and when planted in the woods among other trees it is usually suppressed.

It is adapted to a rich, moist and well drained loam soil. When planted on clay or gravelly soil it grows very slowly. In forest planting if a pure stand is desired the trees should be planted 5x5 to 8x8 feet depending upon the quality of the soil, and how quickly it is desired to mature the crop. If the trees are planted close together they will not grow so rapidly. It should be borne in mind that the lasting qualities of the timber is increased by slow growth.

In forest planting seedlings 12-18 inches long are the most desirable size to use. The best results are obtained by cultivating and undercropping with corn for the first year or two. Deep cultivation should not be attempted because the catalpa is a surface

*From cultivated trees.

rooting tree, and cultivation should cease when it would be a damage to the root system.

The catalpa sphinx has appeared in many of the catalpa plantings in the southern part of the State and the trees are twice defoliated each year, and as a consequence the trees make but little growth.

In forest planting in Indiana where the locust can not be grown successfully it appears that the catalpa is the most suitable tree to plant as a temporary tree between trees that are intended for a permanent stand.

The last year's growth of the catalpa in our area is frequently winter killed until the tree becomes 4-6 years old. During mild winters the ends only of the shoots may be killed, while during severe winters young trees may be killed back to the ground. In case only the end of the shoots are killed it is advised to wait until the buds begin to swell and then cut it back to a strong bud. If the tree is killed back to, or near the ground, cut it off about an inch above the ground.

CAPRIFOLIÀCEÆ. THE HONEYSUCKLE FAMILY.

VIBÚRNUM. THE VIBURNUMS.

(From the Latin, meaning the wayfaring).

Trees or shrubs with opposite, simple, entire, toothed or lobed leaves; flowers in the axils or in terminal cymes; fruit a drupe with one flat, oval stone.

Leaf-blades drawn to a long point, petioles winged..... 1 V. Lentago.
Leaf-blades merely acute or obtuse, petioles usually wingless..... 2 V. prunifolium.

1. Viburnum Lentàgo Linnæus. SHEEPBERRY. BLACK HAW. Plate 130. Bark of old trees reddish-brown, broken into thick plates; leaves varying from narrow-ovate to broadly oval, 3-9 cm. (1-3½ inches) long, apex sharply pointed, base wedge-shaped or rounded, sharply serrate with incurved teeth, smooth above and below, sometimes a few hairs along the veins below, lower surface with brown resinous dots; flowers appear in May or June, when the leaves are almost full grown; fruit bluish-black, covered with a bloom, oval, about 10 mm. (⅜ inch) long.

Distribution. Quebec to Manitoba, south to Georgia and Kansas. Infrequent, in rich soil in all parts of Indiana, usually near lake sor streams. Usually a shrub, sometimes attaining a diameter of 1 dm. (4 inches) and a height of 5-6 m. (16-19 feet).

PLATE 130.

VIBURNUM LENTAGO Linnæus. SHEEPBERRY. (x $\frac{1}{2}$.)

PLATE 131.

VIBURNUM PRUNIFOLIUM Linnæus. BLACK HAW. (x ½.)

[23—28415]

The published records for the distribution are as follows: Clark (Baird and Taylor); Gibson (Schneck); Jefferson (J. M. Coulter); Kosciusko (Clark) and (Coulter); Monroe (Blatchley); Noble (Van Gorder); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Vigo (Blatchley).

Additional records are: Putnam (Grimes); Steuben and Wells (Deam).

Economic uses. Not of sufficient size and abundance to be of any economic importance. Frequently used for ornamental planting.

2. **Viburnum prunifòlium** Linnæus. BLACK HAW. Plate 131. Bark of old trees reddish-brown, broken into irregular scales; twigs at the end of the season ash gray or reddish-brown; leaves oval, ovate or obovate, blades 3-8 cm. (1-3 inches) long, acute or obtuse at apex, wedge-shaped or rounded at base, remotely or finely serrate, glabrous at maturity; flowers white, appearing in April or May; fruit ripening in September and October, oval, about 1 cm. (3/8 inch) long, dark blue, covered with a bloom, edible, persisting on the branches until late in the fall. The variety **globosum** Nash has smaller and almost globose fruit.

Distribution. Connecticut south along the montains to Georgia, west to Michigan and Missouri. More or less frequent in rich damp woods in all parts of Indiana.

The published records of the distribution are as follows: Clark (Baird and Taylor); Delaware, Jay, Randolph and Wayne (Phinney); Fayette (Hessler); Fountain (Brown); Franklin (Meyncke); Gibson (Schneck); Hamilton (Wilson); Jay (M'Caslin); Jefferson (Barnes); (Coulter) and (Young)); Knox (Ridgway) and (Spillman); Kosciusko (Scott) and (Youse); Marion (Wilson); Miami (Gorby); Monroe (Blatchley); vicinity of New Albany (Clapp); Noble (Van Gorder); Parke (Hobbs); Posey (Schneck); Putnam (MacDougal); Steuben (Bradner); Tippecanoe (Cunningham); Vigo (Blatchley); Wayne (Petry and Markle).

Additional records are: Montgomery (Evans); Putnam (Grimes); Tippecanoe (Miller); Blackford, Crawford, Decatur, Dekalb, Delaware, Franklin, Gibson, Jackson, Knox, Madison, Marion, Parke, Shelby and Wells (Deam).

Variety **globosum**: Brown and Marion (Deam).

Economic uses. It is a small tree and seldom reaches a diameter of more than 1 dm. (4 inches) and a height of 5 m. (16 feet). It is too small to be of any economic importance. The inner bark of the trunk is used in medicine. It is sometimes used for ornamental planting.

TABLE OF MEASUREMENTS OF THE LARGEST TREES OF SOME SPECIES THAT OCCUR IN INDIANA.

Authority.	County.	Name.	Circumference.			Clear Bole.		Total Height.	
			cm.	ft.	in.	dm.	ft.	dm.	ft.
Deam	Laporte	Pinus Strobus (White Pine)	267	8	8	...	...	229	75
Deam	Lake	Pinus Banksiana (Jack Pine)	116	3	11	...	...	168	55
Schneck	L. W. V.*	Taxodium distichum (Cypress)	562	18	9	226	74	445	146
Ridgway	L. W. V.	Salix nigra (Black Willow)	305	10	..	...	...	268	88
Schneck	L. W. V.	Populus deltoides (Cottonwood)	671	22	..	229	75	518	170
Ridgway	L. W. V.	Populus grandidentata (Quaking Asp)	112	3	8	...	...	217	71
Ridgway	Knox	Populus heterophylla (Cottonwood)	229	7	6	156	51	281	92
Deam	Marshall	Populus tremuloides (Quaking Asp)	121	4	..	...	...	168	55
Schneck	L. W. V.	Juglans nigra (Black Walnut)	671	22	..	226	74	473	155
Schneck	L. W. V.	Hicoria alba (White Hickory)	315	10	4	168	55	342	112
Ridgway	L. W. V.	Hicoria glabra (Black Hickory)	229	7	6	...	...	351	115
Ridgway	L. W. V.	Hicoria microcarpa (Small fruited Hickory)	294	10	..	213	70	409	134
Schneck	L. W. V.	Hicoria Pecan (Pecan)	488	16	..	275	90	534	175
Deam	Madison	Ostrya virginiana (Ironwood)	117	3	10	...	...	122	40
Ridgway	Knox	Carpinus caroliniana (Blue Beech)	107	3	6	21	7	98	32
Deam	Porter	Betula papyrifera (Paper Birch)	63	2	1	...	...	183	60
Deam	Porter	Alnus incana (Tag Alder)	42	1	5	...	...	92	30
Schneck	L. W. V.	Fagus grandifolia (Beech)	336	11	..	...	...	372	12-
Bot. Gaz. June '80	Jackson	Castanea dentata (Chestnut)	671	22	..	213	70	...	...
Schneck	L. W. V.	Quercus alba (White Oak)	549	18	..	220	72	503	165
Schneck	L. W. V.	Quercus Schneckii (Red Oak)	618	20	3	287	94	552	181
Ridgway	L. W. V.	Quercus falcata (Spanish Oak)	427	14	..	213	70	396	130
Schneck	L. W. V.	Quercus macrocarpa (Burr Oak)	671	22	..	220	72	503	165
Ridgway	L. W. V.	Quercus Michauxii (Cow Oak)	396	13	..	88	29	364	119
Schneck	L. W. V.	Quercus palustris (Pin Oak)	366	12	..	70	23	366	120
Ridgway	Gibson	Quercus rubra (Red Oak)	702	23	..	232	76	...	
Ridgway	Knox	Quercus rubra (Red Oak)	427	14	..	168	55	436	143

TABLE OF MEASUREMENTS OF THE LARGEST TREES OF SOME SPECIES THAT OCCUR IN INDIANA—Continued.

Authority.	County.	Name.	Circumference.			Clear Bole.		Total Height.	
			cm.	ft.	in.	dm.	ft.	dm.	ft.
Schneck	L. W. V.	Quercus velutina (Black Oak)	610	20	..	229	75	503	165
Ridgway	L. W. V.	Ulmus americana (White Elm)	488	16	..	152	50	366	120
Ridgway	Gibson	Celtis occidentalis (Hackberry)	336	11	..	253	83	409	134
Johnson	Posey	Morus rubra (Mulberry)	314	10	4	61	20	183	60
Schneck	L. W. V.	Liriodendron Tulipifera (Yellow Poplar)	762	25	..	278	91	580	190
Schneck	Posey	Asimina triloba (Pawpaw)	69	2	3	...	...	146	48
Johnson	Posey**	Sassafras Sassafras (Sassafras)	236	7	6	229	75	290	95
Schneck	L. W. V.	Liquidambar Styraciflua (Sweet Gum)	518	17	..	244	80	500	164
Schneck	L. W. V.	Platanus occidentalis (Sycamore)	1,116	33	4	207	68	537	176
Bot. Gaz. June '80	Daviess	Platanus occidentalis (Sycamore)	1,464	48	..	76	25	.	...
Deam	Steuben	Amelanchier canadensis (June Berry)	56	1	10	...	...	92	30
Deam	Porter	Prunus pennsylvanica (Wild Red Cherry)	60	2	..	...	...	107	35
Deam	Knox	Cercis canadensis (Redbud)	203	6	8	30	10	122	40
Ridgway	Knox	Cercis canadensis (Redbud)	84	2	9	70	23	165	54
Ridgway	L. W. V.	Gleditsia aquatica (Water Honey Locust)	212	7	..	...	...	198	65
Schneck	Posey	Gleditsia triacanthos (Honey Locust)	549	18	..	186	61	593	129
Ridgway	Knox	Ilex decidua (Holly)	89	2	11	...	...	85	28
Deam	Posey	Acer Negundo (Box Elder)	300	9	10	24	8	122	40
Schneck	L. W. V.	Acer rubrum (Red Maple)	396	13	..	183	60	329	108
Schneck	L. W. V.	Acer saccharum (Sugar Maple)	381	12	6	183	60	345	113
Schneck	L. W. V.	Tilia americana (Linn)	534	17	6	152	50	332	109
Deam	Jefferson	Tilia heterophylla (White Linn)	256	8	8	37	12	183	60
Ridgway	L. W. V.	Nyssa sylvatica (Black Gum)	549	18	..	...	...	...	...
Deam	Posey	Diospyros virginiana (Persimmon)	178	6	10	24	8	137	45
Ridgway	L. W. V.	Diospyros virginiana (Persimmon)	168	5	6	244	80	351	115
Schneck	L. W. V.	Catalpa speciosa (Catalpa)	183	6	..	146	48	308	101

*L. W. V.—Lower Wabash Valley.

**See note on page 238.

Specific Gravity of Indiana Woods.*

The specific gravity was derived from wood dried at 100° centigrade (212 Fah.) until it ceased to lose weight.

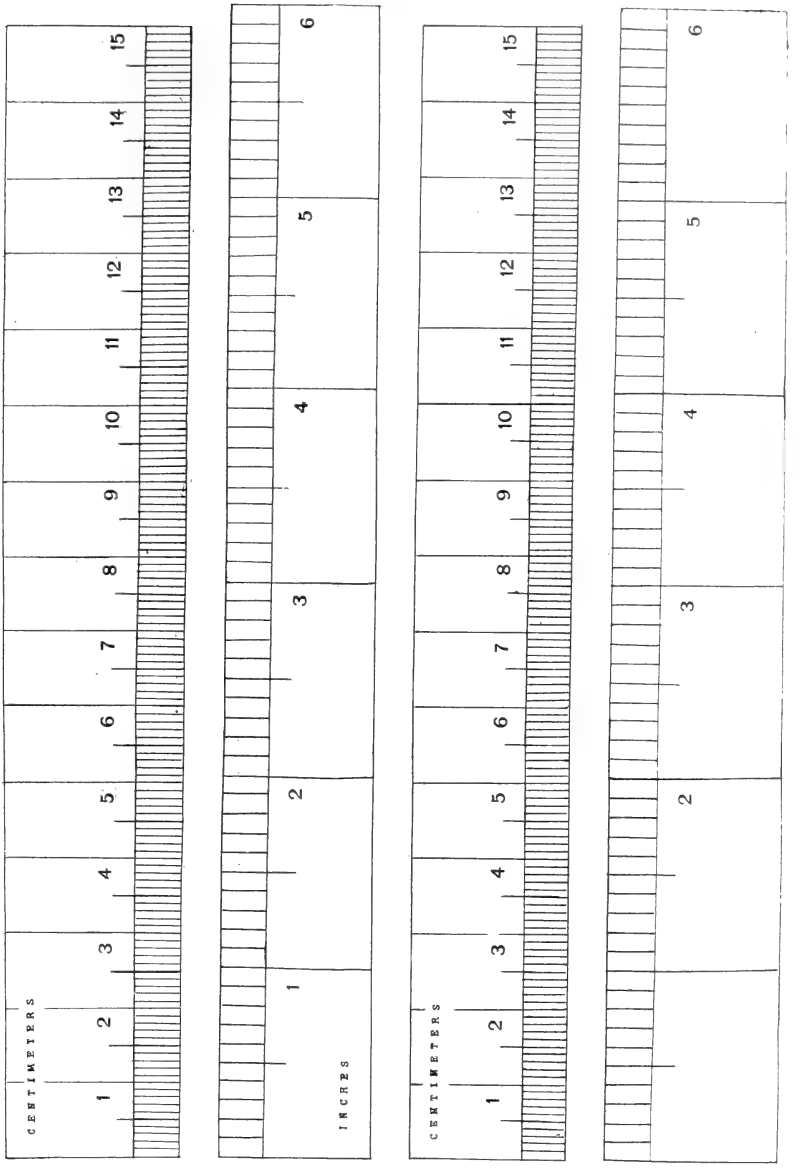
Hicoria ovata (Shellbark Hickory)	0.8372
Quercus stellata (Post Oak)	0.8367
Viburnum prunifolium (Black Haw)	0.8332
Quercus lyrata (Overcup Oak)	0.8313
Ostrya virginiana (Ironwood)	0.8264
Hicoria alba (White Hickory)	0.8218
Hicoria glabra (Black Hickory)	0.8217
Cynoxylon floridum (Flowering Dogwood)	0.8153
Hicoria laciniosa (Big Shellbark Hickory)	0.8108
Quercus Michauxii (Cow Oak)	0.8039
Diospyros virginiana (Persimmon)	0.7908
Amelanchier canadensis (June-berry)	0.7838
Toxylon pomiferum (Osage Orange)	0.7736
Quercus bicolor (Swamp White Oak)	0.7662
Hicoria cordiformis (Pig Hickory)	0.7552
Quercus imbricaria (Shingle Oak)	0.7529
Quercus Prinus (Chestnut Oak)	0.7499
Ulmus alata (Cork Elm)	0.7491
Quercus alba (White Oak)	0.7470
Quercus macrocarpa (Burr Oak)	0.7453
Ilex decidua (Holly)	0.7420
Quercus coccinea (Scarlet Oak)	0.7405
Gleditsia aquatica (Water Honey Locust)	0.7342
Robinia Pseudo-Acacia (Black Locust)	0.7333
Quercus marylandica (Black Jack Oak)	0.7324
Viburnum Lentago (Sheepberry)	0.7303
Celtis occidentalis (Hackberry)	0.7287
Carpinus caroliniana (Water Beech)	0.7286
Ulmus Thomasi (Hickory Elm)	0.7263
Prunus americana (Wild Plum)	0.7215
Fraxinus quadrangulata (Blue Ash)	0.7184
Hicoria Pecan (Pecan)	0.7180
Malus coronaria (Crab Apple)	0.7048
Quercus velutina (Black Oak)	0.7045
Ulmus fulva (Slippery Elm)	0.6956
Quercus palustris (Pin Oak)	0.6938
Gymnocladus dioica (Coffeenut)	0.6934
Quercus falcata (Spanish Oak)	0.6928
Acer nigrum (Black Maple)	0.6915
Acer saccharum (Sugar Maple)	0.6912
Fagus grandifolia (Beech)	0.6883

*Adapted from Sargent's "Trees of North America".

[24—28415]

Gleditsia triacanthos (Honey Locust) 0.6740
Cornus alternifolia (Swamp Dogwood) 0.6696
Betula lutea (Yellow Birch) 0.6553
Fraxinus americana (White Ash) 0.6543
Quercus rubra (Red Oak) 0.6540
Ulmus americana (White Elm) 0.6506
Cercis canadensis (Redbud) 0.6363
Nyssa sylvatica (Black Gum) 0.6356
Forestiera acuminata (Swamp Privet) 0.6345
Fraxinus nigra (Water Ash) 0.6318
Fraxinus pennsylvanica (Red Ash) 0.6251
Larix laricina (Tamarack) 0.6236
Acer rubrum (Red Maple) 0.6178
Juglans nigra (Black Walnut) 0.6115
Betula papyrifera (Paper Birch) 0.5955
Liquidambar Styraciflua (Sweet Gum) 0.5909
Morus rubra (Red Mulberry) 0.5898
Padus serotina (Black Wild Cherry) 0.5822
Betula nigra (River Birch) 0.5762
Betula populifolia (White Birch) 0.5760
Platanus occidentalis (Sycamore) 0.5678
Pinus virginiana (Jersey Pine) 0.5309
Acer saccharinum (Silverleaf Maple) 0.5259
Sassafras Sassafras (Sassafras) 0.5042
Prunus pennsylvanica (Wild Red Cherry) 0.5023
Juniperus virginiana (Red Cedar) 0.4926
Pinus Banksiana (Gray Pine) 0.4761
Magnolia acuminata (Cucumber Tree) 0.4690
Alnus rugosa (Alder) 0.4666
Populus grandidentata (Quaking Asp) 0.4632
Alnus incana (Tag Alder) 0.4607
Taxodium distichum (Cypress) 0.4543
Æsculus glabra (Buckeye) 0.4542
Tilia americana (Linn) 0.4525
Castanea dentata (Chestnut) 0.4504
Salix amygdaloides (Willow) 0.4502
Catalpa Catalpa (Catalpa) 0.4474
Salix nigra (Black Willow) 0.4456
Acer Negundo (Box Elder) 0.4328
Æsculus octandra (Sweet Buckeye) 0.4274
Tilia heterophylla (White Linn) 0.4253
Tsuga canadensis (Hemlock) 0.4239
Liriodendron Tulipifera (Yellow Poplar) 0.4230
Catalpa speciosa (Catalpa) 0.4165
Populus heterophylla (Downy Cottonwood) 0.4089
Juglans cinerea (Butternut) 0.4086
Populus tremuloides (Quaking Asp) 0.4032
Asimina triloba (Pawpaw) 0.3069
Populus deltoides (Cottonwood) 0.3889
Pinus Strobus (White Pine) 0.3854
Thuja occidentalis (Arbor-Vitæ) 0.3164

PLATE 133.



ENGLISH AND METRIC SCALES COMPARED.

These can be cut out and pasted on wood.

Index.

The accepted botanical names are in bold-face type, synonyms in italics and where the subject receives the most extended notice the page number is in bold-face type.