BULLETIN 263 DECEMBER, 1924

Connecticut Agricultural Experiment Station
New Haven, Connecticut

SECOND REPORT

OF THE

TREE PROTECTION EXAMINING BOARD

W. E. BRITTON, Entomologist
G. P. CLINTON, Botanist
W. O. FILLEY, Forester

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

OFFICERS AND STAFF

December, 1924.

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MISS J. V. BERGER, *Stenographer and Bookkeeper.*
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B. H. WALDEN, B.AGR.
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Soil Research.
M. F. MORGAN, M.S., *Investigator.*

Tobacco Sub-station at Windsor.
N. T. NELSON, PH.D., *Plant Physiologist.*

THE WILSON H. LEE CO.

ANNOUNCEMENT.

The Tree Protection Examining Board created by the General Assembly of 1919 (see Public Acts of 1919, Chapter 181), has adopted this as its Second Report.

ILLUSTRATIONS.

The illustrations in this report are from photographs from the following sources: Plate XV, a, by Mr. Harry B. Kirk; Plates IX, X, b, XI, a, and XIV, d, by Mr. B. H. Walden; Plates X, a, XI, c and d, XIV, a, XIV, d, and XVI, by Mr. W. O. Filley; Plates XII, XIII, XIV, b and c, XV, b and c, by Dr. W. E. Britton.

W. E. Britton, Entomologist,
Chairman.

G. P. Clinton, Botanist,
Vice Chairman.

W. O. Filley, Forester,
Secretary-Treasurer.

CONTENTS.

SECOND REPORT

OF THE

Tree Protection Examining Board

Covering the Three Years Ending June 30, 1924

The first report of the Tree Protection Examining Board was issued in 1921 as Bulletin 231, and was included in the Annual Report of the Station for that year, pages 339-350. It contained an account of the activities of the Board including the law, rules and regulations, sample examination questions, forms of certificates, institute program, financial statement, list of firms and individuals receiving certificates, and a general discussion explaining the reasons for legislation, and warning tree owners to employ qualified men for their tree work and promising to investigate complaints.

The Station is often asked who is qualified for this work, and since no list had been printed since 1921, a revised list was published, April 25, 1924, as Bulletin of Immediate Information, No. 35, entitled, "Tree Workers Holding Connecticut Certificates." As this leaflet does not contain any account of the other activities of the Board, the present report has been made complete for the period which it covers. Sections on tree surgery and on the common insect and fungous pests of shade trees have also been added as a source of information to tree workers and tree owners.

The members of the Board feel that the legislation on this subject enacted in Connecticut in 1919, was fully justified by the conditions then existing, and believe that, on account of this legislation, these conditions have since greatly improved. Moreover, the Board has received from several other States requests for copies of the Connecticut law, regulations, and examination and certificate forms, with the statement that similar legislation was contemplated in those states. The law and regulations follow:

AN ACT CONCERNING THE IMPROVEMENT, PROTECTION OR PRESERVATION OF FRUIT, SHADE OR ORNAMENTAL TREES.

Chapter 181. Public Acts of 1919. (In effect July 1, 1919.)

SECTION 1. No person, firm or corporation shall advertise, solicit or contract to improve the condition of fruit, shade, forest or ornamental trees, by pruning, trimming or filling cavities, or to protect such trees from damage by insects or disease, either by spraying or any other method, without having secured a certificate as specified in section two of this act; and

any person, firm or corporation failing to comply with the terms of this act shall be fined not more than one hundred dollars; provided any person may improve or protect any tree on his own premises or on the property of his employer or on any property within the limits of the town of which he is a legal resident, without securing such a certificate.

SECTION 2. The botanist, entomologist and forester of the Connecticut Agricultural Experiment Station shall constitute a board which shall, upon application from any person, firm or corporation, examine the qualifications of the applicant to improve, protect or preserve fruit, shade, ornamental or forest trees, and if satisfied that the applicant is qualified, may issue a certificate so stating; which certificate shall be valid for one year from the date of its issue, unless sooner revoked as provided in section three of this act, and may be renewed by the board for succeeding years without further examination, upon payment of the fee hereinafter required, provided any person, firm or corporation receiving such certificate shall be responsible for the acts of all employees in the performance of such work.

SECTION 3. Said board shall prepare all necessary forms and prescribe all rules and regulations governing examinations, and any certificate issued under the provisions of this act may be revoked by it upon proof that improper methods have been used or for other sufficient cause.

SECTION 4. Each applicant for an examination shall pay a fee of five dollars in advance, and a fee of two dollars for each certificate or renewal issued; which fees may be expended by the board for any expense incurred by it in making examinations or issuing certificates, and an account of all receipts and expenditures under this act shall be rendered annually to the state comptroller.

As the law provides that this Board shall consist of the botanist, entomologist and forester of the Station, the Board was organized by electing as Chairman, W. E. Britton, Entomologist, as Vice-Chairman, G. P. Clinton, Botanist, and as Secretary-Treasurer, W. O. Filley, Forester. The following rules and regulations have since been adopted by the Board:

EXAMINATION RULES AND REGULATIONS.

I. Each person, firm or corporation required to secure a certificate under Chapter 181, Public Acts of 1919, shall be examined as follows: When a firm is under control of one person who is solely responsible for the contracts, methods and oversight of each piece of work, this person alone may be required to pass the examination, but when more than one person is responsible for the methods of work and oversight of same, each shall be required to take the examination. When foremen or others are given complete charge of recommending and applying treatments, they shall also be required to take the examination, in so far as it relates to their work. The Examining Board shall decide who shall be required to take the examination.

II. Unless otherwise arranged, candidates for certificates shall appear for examination at the Connecticut Agricultural Experiment Station, at New Haven, at such times as shall be designated by the Board.

III. Examinations may be oral, written, or both, as shall be determined by the Examining Board, and, in general, shall cover tree species, tree life and growth; diseases and insect pests of trees, with treatment for same; pruning and tree surgery.

IV. Candidates prior to the time of examination shall furnish a typewritten statement of their qualifications as follows:

1. General education.
2. Special training for tree protection work.
3. Experience in tree protection work. The latter shall include
   (a) Place of business, name of firm and position now held.
   (b) Previous positions held.
   (c) Total length of experience.
   (d) Contracts now under way or completed during the past 12 months.

In addition three or more recommendations as to reliability and efficiency shall be furnished; and where typed or printed forms of contracts, regulations, etc., are used, these shall also be supplied, or if not available, statements shall be made concerning the same.

V. If satisfied with the qualifications of the applicant, the Board will issue a certificate good for the succeeding twelve months (unless revoked for cause), then to be renewed upon application under such conditions as the Examining Board may require in each case.

VI. Upon evidence of unfitness in training or improper business methods, the Examining Board may refuse to issue a certificate or cancel one that has been issued. Complaints may be made to the Board on these points, and if deemed desirable by the Board, private hearings of the interested parties shall be held.

Renewal of Certificates.

The provision of Section 4, Chapter 181, Public Acts of 1919, regarding renewal of certificates shall be construed by this Board as meaning a continuous possession of a certificate and not an attempt to obtain a new certificate after a long period during which the old certificate has lapsed. The following rules are hereby adopted:

1. The secretary shall notify each certificate holder at least two weeks before his certificate expires, and again two weeks after date of expiration, unless previously renewed. If a certificate has not been renewed one month after date of expiration it then becomes invalid and the holder shall be notified to that effect.

2. An invalid certificate may be revalidated at the discretion of the Board for the full renewal period or the unexpired portion thereof, if request for such action is received within three years from expiration date and if all renewal fees for the intervening period, as well as the renewal period, are paid in full.

3. If application is made on or before the expiration date of a certificate, a demit or respite covering a period of three years may be issued without charge, entitling the holder to obtain a renewal certificate for one year on payment of the statutory fee of $2.00.

4. If after three years with or without a demit a certificate has not been renewed, a new application with a fee of $5.00 shall be necessary and another examination may be required by the Board.

Number of Certificates Issued

In all, 109 certificates have been issued by the Board since the law became effective. Of this number, 80 are now in force and 29 have been canceled; three by death, four by changes in business, nine by removal from the state and 13 were not renewed. The following list contains the names of individuals and firms now holding certificates which are in force:

Firms and Individuals Holding Certificates

Name	Address	Cert. No.	Certificate Expires
Armstrong Tree Service, Ltd.			
Armstrong, Newton G.	Poughkeepsie, N. Y.	86	May 25, 1925
Parmelee, Leland E.	Poughkeepsie, N. Y.	89	July 23, 1925
Baldwin, Thos. J.	P. O. Box 176, Guilford, Conn.	21	July 15, 1925
Bartlett Tree Expert Co., F. A. (F. A. Bartlett)	Stamford, Conn.	10	July 15, 1925
*Barton, Robert	P. O. Box 57, Hamden, Conn.	66	Dec. 18, 1924
Beaupain & Saunders (Henry F. Beaupain)	So. Norwalk, Conn.	27	Aug. 12, 1925
*Bertolf Brothers (August C. Bertolf)	Sound Beach, Conn.	24	July 29, 1925
Brown, Edgar M	211 Sisson Ave., Hartford, Conn.	52	June 6, 1925
Calverley, Arthur	763 Campbell Ave., West Haven, Conn.	97	Mar. 31, 1925
Cardarelli, Emilio J.	Cromwell, Conn.	57	Feb. 28, 1925
Clark, Harry E.	Middlebury, Conn.	72	Mar. 8, 1925
Clark, Wyllis S.	New Canaan, Conn.	20	July 15, 1925
Clyne, G. A.	73 Canal St., Waterbury, Conn.	5	July 1, 1925
Condon Co., Maurice L. (Maurice L. Condon)	Lake Mahopac, N.Y.	46	Feb. 2, 1925
Cromie, George A.	18 Compton St., New Haven, Conn.	88	May 25, 1925
Davey Tree Expert Company	Kent, Ohio.		
Baldwin, H. E.	General Delivery, Norwich, Conn.	91	July 23, 1925
Gammie, Peter	P. O. Box 423, Stamford, Conn.	60	May 26, 1925
Grove, D. Q.	Kent, Ohio.	87	May 25, 1925
Landis, Ray E	28 Smith St., Danbury, Conn.	108	May 15, 1925
Liming, O. N.	General Delivery, Stonington, Conn.	102	May 8, 1925
Tuomey, W. W.	General Delivery, South Manchester, Conn.	109	June 15, 1925
†Desmond, Thomas H.	Simsbury, Conn.	50	April 4, 1925
DeWolfe, John C. G.	85 Medford St., Medford, Mass.	80	Aug. 7, 1925
Dunham, L. N.	45 Park Terrace, New Britain, Conn.	104	May 8, 1925
Easton, Clifford H.	P. O. Box No. 1, Scarborough, N.Y.	53	June 16, 1925
*Elm City Nursery Co., J. L. Donnelly,	Box 1588, New Haven, Conn.	105	May 12, 1925
*Ernst, Otto F.	Norwich, Conn.	79	July 14, 1925
Fertsch, Ross L.	P. O. Box 220, Newburgh, N. Y.	84	April 4, 1925
Galligan, Clarence W.	15 Admiral Street, Allingtown, Conn.	74	June 28, 1925

* Is also a nurseryman.
† Is also a landscape architect.

FIRMS AND INDIVIDUALS HOLDING CERTIFICATES—*Continued*

Name	Address	Cert. No.	Certificate Expires
Gibbs, R. M.	33 Fairfield Street, Pittsfield, Mass.	83	April 4, 1925
Gilbert, J. E.	376 George Street, New Haven, Conn.	61	May 26, 1925
†Goodwin Associates, James L., James L. Goodwin	750 Main St., Hartford, Conn.	39	Nov. 26, 1925
Graf, Albert H.	P. O. Box 87, Bardonia, N. Y.	67	Dec. 18, 1924
Grovit, Albert	986 Whalley Ave., New Haven, Conn.	85	April 6, 1925
Gustafson, Harry A.	P. O. Box 81, Watertown, Conn.	96	Mar. 25, 1925
Hartford Forestry Company			
Hansling, Philip, Sr.	65 Sherman Street,	17	July 15, 1925
Hansling, Philip, Jr.	Hartford, Conn.	16	July 15, 1925
Herthal, G. F.	228 Bunnell Street, Bridgeport, Conn.	25	July 29, 1925
Herthal, Gus., Jr.	228 Bunnell St., Bridgeport, Conn.	36	Sept. 17, 1925
Hollister, S. P.	Conn. Agr. College, Storrs, Conn.	47	Mar. 21, 1925
Horlacher, John J.	197 Thomas Street, West Haven, Conn.	103	May 8, 1925
*Hunt & Co., W. W., (W. A. Wright)	167 Blue Hills Ave., Hartford, Conn.	33	Sept. 17, 1925
Kellner, Arthur H.	7 Grove St., South Norwalk, Conn.	26	Aug. 12, 1925
*Kellner, Herman H.	Danbury, Conn.	101	April 1, 1925
*Kelley, James J.	New Canaan, Conn.	19	July 15, 1925
Landscape Foresters, Ltd. (C. E. Mager)	52 Vanderbilt Ave., New York City	32	Sept. 17, 1925
*†Mallett Co., G. A., (George A. Mallett)	95 Catherine St., Bridgeport, Conn.	11	July 15, 1925
Maynard, Eugene	61 Coit St., New London, Conn.	94	Feb. 6, 1925
McLaughlin & Carberry			
Carberry, Joseph V.	Sharon, Conn.	78	July 9, 1925
McLaughlin, J. A.	Sharon, Conn.	77	July 9, 1925
Meader Co., L. H. (Lewis H. Meader)	75 Westminster St., Providence, R. I.	31	Sept. 17, 1925
*Millane Tree Expert Co., (Neal A. Millane)	Middletown, Conn.	1	July 1, 1925
Morris, Harry H.	9 Winthrop Place, Danbury, Conn.	40	Nov. 6, 1925
Munson-Whitaker Co. (Robert O'Shea).	1 Washington St., Boston, Mass.	42	Nov. 25, 1925
Murphy, Allen L.	Bethel, Conn.	106	May 15, 1925
Old Colony Forestry Co. (Thomas J. McGinnis)	415 Savin Ave., West Haven, Conn.	4	July 1, 1925
O'Gara, Charles E.	696 Dixwell Ave., New Haven, Conn.	110	Aug. 28, 1925
Pauley Tree Expert Co., (George A. Pauley)	New Canaan, Conn.	22	July 29, 1925

* Is also a nurseryman.
† Is also a landscape architect.

FIRMS AND INDIVIDUALS HOLDING CERTIFICATES—*Concluded*

Name	Address	Cert. No.	Certificate Expires
Perry, Lewis	Southington, Conn.	95	Feb. 6, 1925
Plumb, C. K. & J. C. (C. K. Plumb)	New Canaan, Conn.	100	Mar. 31, 1925
Pool, William H	47 Sheffield Ave., Roslindale, Mass.	63	Oct. 10, 1925
Rice, Ralph S	71 Howard Avenue, New Haven, Conn.	69	Dec. 18, 1924
Rich, Nehemiah L	101 Warren Street, Stamford, Conn.	3	July 1, 1925
*Rockfall Nursery Co., (Philip Marotta)	Rockfall, Conn.	71	Mar. 8, 1925
Rottenberg, Julius	Newington Gardens, Newington Jct., Conn.	93	Jan. 9, 1925
Royal Forestry Co. (Charles Vallett)	124 Division St., Waterbury, Conn.	62	Aug. 5, 1925
*Schoonman, W. J.	New London, Conn.	6	July 1, 1925
Shaw, Walter	494 Blake St., Westville, Conn.	55	June 16, 1925
*Sierman, C. H.	2291 Albany Ave., West Hartford, Conn.	8	July 1, 1925
*Steck, Harold W.	Newtown, Conn.	92	Jan. 10, 1925
Szirbik, George	77 East Ramsdell St., Westville, Conn.	111	Aug. 28, 1925
*van Heinigen, Jacob C.	South Wilton, Conn.	48	April 4, 1925
van Kleef, Marinus	Bridgewater, Conn.	75	July 4, 1925
*Van Wilgen Company Van Wilgen, A. C.	71 Main St.,	99	Mar. 31, 1925
Van Wilgen, W. C.	Branford, Conn.	98	Mar. 31, 1925
*Verkade, H.	Corner Crocker St. and Lower Boulevard, New London, Conn.	18	July 15, 1925
Wilcox, Reginald C.	Essex, Conn.	30	Sept. 17, 1925
Wright, John L.	P. O. Box 593, Putnam, Conn.	43	Nov. 25, 1925

* Is also a nurseryman.

EXAMINATIONS

The law provides that the fee of $5.00 shall be paid in advance. The form of application now in use is as follows:

TREE PROTECTION EXAMINING BOARD,
Box 1106, New Haven, Conn.

Gentlemen:—

I hereby apply for a certificate as provided in Chapter 181, Public Acts of 1919, to be issued in the name of

.....

Enclosed is examination fee of $5.00 required by law.

.....
Signature of Applicant

.....
Business Address

It has been the practice of the Board to hold an examination only when there were enough applicants to warrant one, rather than to set a special date for each applicant, and it has usually been possible to examine three or more candidates at one time. There have been occasional requests for examination by mail, but as a matter of policy, the Board has insisted on candidates appearing before it in person.

Since the last report, 16 examinations have been held as follows:

In 1921—July 26, October 3, December 19.
In 1922—March 9, May 18, June 26, October 27.
In 1923—April 2, May 25, July 23, November 26.
In 1924—February 5, March 25, May 2, June 6, August 28.

Fifty-three candidates presented themselves. Of this number, 48 were granted certificates without condition, three were requested to take a second examination, one was refused a certificate, and one passed the examination but decided he did not need a certificate. Fifty-one certificates were issued during the period covered, making a total of 109 certificates issued during the first five years of the Board's existence.

Form of Certificates

The form of the regular certificate adopted and used by the Board is as follows:

CERTIFICATE

FROM

Tree Protection Examining Board

STATE OF CONNECTICUT

This is to Certify that _____

of _____ has been duly examined in compliance with the provisions of Chapter 181, Public Acts of 1919, and is considered qualified to conduct the business of protecting trees.

No. _____

Date _____

Expires _____

_____ Entomologist, *Chairman*

_____ Botanist, *Vice-Chairman*

_____ Forester, *Sec'y-Treas.*

} Examining Board

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONNECTICUT

At the expiration of the regular certificate, if the fee of two dollars ($2.00) has been paid, a renewal certificate is issued in the following form:

RENEWAL CERTIFICATE

FROM

Tree Protection Examining Board

STATE OF CONNECTICUT

This is to Certify that Certificate No.....was issued by this Board on.....to.....
of....., as provided by Chapter 181, Public Acts of 1919, and said certificate is hereby renewed for one year from.....

.....Renewal .....*Entomologist, Chairman*
Expires..... .....*Botanist, Vice-Chairman*
Issued..... .....*Forester, Sec'y-Treas.*

CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN, CONNECTICUT

To show that men are working under a valid certificate issued by the Board, a small card was furnished for each foreman employed by a firm or an individual. The form of this card is shown below:

State of Connecticut
TREE PROTECTION EXAMINING BOARD

THE BEARER
is working under supervision of and is responsible to
.....
of.....Conn.,
to whom this board has issued Certificate No....as provided by Chapter 181, Public Acts of 1919. Said certificate expires.....

CONNECTICUT AGRICULTURAL
EXPERIMENT STATION .....
NEW HAVEN, CONN. *Secretary*

Institutes for Instruction

The early examinations, as well as some of the more recent ones, have shown that many of the tree men are not well versed in the life processes and care of trees. Consequently, early in the first year after the law was passed, an institute of instruction was held at the Station at which the various phases of tree life and growth were discussed. The results were such that the Board has, in each of the years 1922, 1923 and 1924, conducted a one-day institute for this purpose, in some cases at the request of the tree workers. In all, four institutes have been held, the program of the first being given in the first Report of the Board. The attendance has varied between 50 and 100, and deep interest has been shown. The program and date of each of the other institutes are given below:

February 21, 1922

10.00 A.M. The Living Tree (Illustrated), by Dr. George E. Nichols, Assistant Professor of Botany in Yale University, New Haven, Conn.; The Pruning and Spraying of Fruit Trees, by Prof. Sherman P. Hollister, Assistant Professor of Pomology, Connecticut Agricultural College, Storrs, Conn.; Effects of Smoke, Gases and Electricity Upon Trees, by Prof. J. W. Toumey, Dean School of Forestry, Yale University, New Haven, Conn.; Observations on Oil Injury to Trees, by Dr. E. P. Felt, State Entomologist, Albany, New York. 12.00, Recess for luncheon. 1.30 P. M. Pruning and Cavity Work as Applied to Shade Trees (Illustrated), by J. Franklin Collins, Forest Pathologist, U. S. Dept. of Agriculture, Brown University, Providence, R.I.; Discussion, led by Dr. George E. Stone, Amherst, Mass.; Modern Methods of Tree Surgery (Demonstration), by F. A. Bartlett, Bartlett Tree Expert Company, Stamford, Conn.; Some Common Insect Pests of Shade Trees (Illustrated), by Dr. E. P. Felt, State Entomologist, Albany, New York; Report on work of Tree Protection Examining Board, by W. O. Filley, Forester, Connecticut Agricultural Experiment Station, New Haven, Conn.; Report of Committee on Organization of a Tree Protective Association in Connecticut.

March 1, 1923

10.00 A.M. Opening Remarks, by Dr. W. E. Britton, State Entomologist, New Haven, Conn.; The Tree in the Landscape (Illustrated), by Ernest F. Coe, Landscape Architect, New Haven, Conn.; The Gipsy Moth, by A. F. Burgess, In Charge of Moth Work, U. S. Bureau of Entomology, Melrose Highlands, Mass.; Some Insects Attacking Shade Trees (Illustrated), by Dr. E. P. Felt, State Entomologist, Albany, N. Y. 12.15 P.M. Recess for luncheon. 2.00 P.M. The Living Tree (Illustrated), by Dr. G. E. Nichols, Assistant Professor of Botany, Yale University, New Haven, Conn.; Wood Rot Fungi (Illustrated), by Dr. W. A. Murrill, New York Botanical Garden, New York, N.Y.; Mechanical Injuries and Their Treatment (Illustrated), by Dr. G. E. Stone, Amherst, Mass.; Fertilizers for Trees, by Dr. E. H. Jenkins, Director, Connecticut Agricultural Experiment Station, New Haven, Conn.

March 11, 1924

10.00 A.M. Opening Remarks, by Dr. W. E. Britton, State Entomologist, New Haven, Conn.; Word of Welcome, by W. L. Slate, Jr., Director, Connecticut Agricultural Experiment Station, New Haven, Conn.; The

Living Tree (Illustrated), by Dr. G. E. Nichols, Assistant Professor of Botany, Yale University, New Haven, Conn.; Some Fungous Diseases of Trees (Illustrated), by Dr. A. H. Graves, Curator of Public Instruction, Brooklyn Botanic Garden, Brooklyn, N.Y. 12.15 P.M. Recess for Luncheon. 2.00 P.M. Some Insects Attacking Shade Trees (Illustrated), by Prof. W. C. O'Kane, Professor of Economic Entomology, University of New Hampshire, Durham, N. H.; Some Insects Requiring Special Attention the Coming Season (Illustrated), by Dr. W. E. Britton, State Entomologist, New Haven, Conn.; Cavity Work, Pruning, and Spraying (Illustrated), by George A. Cromie, Superintendent of Trees, New Haven, Conn.

FINANCIAL STATEMENTS

TREASURER'S ACCOUNT

July 1, 1921—June 30, 1922		
Balance on hand July 1, 1921		$213.98
Received for 18 examination fees @ $5.00	$90.00	
" " 44 renewal fees @ $2.00	88.00	178.00
		$391.98
Expended for Printing and Stationery	$28.45	
" " Postage	18.36	
" " Travel Expenses of Board	20.92	
" " Institute Expenses	36.87	
" " Miscel. office expense	1.80	106.50
		$285.48
Receipts paid Comptroller, for deposit in State Treasury		178.00
Balance on hand June 30, 1922		$107.48
July 1, 1922—June 30, 1923		
Received for 10 examination fees @ $5.00	$50.00	
" " 52 renewal fees @ $2.00	104.00	154.00
		$261.48
Expended for Printing and Stationery	$42.65	
" " Postage	6.00	
" " Institute Expenses	49.29	97.94
		$163.54
Receipts paid Comptroller, for deposit in State Treasury		154.00
Balance on hand June 30, 1924		$9.54
July 1, 1923—June 30, 1924		
Received for 21 examination fees @ $5.00	$105.00	
" " 60 renewal fees @ $2.00	120.00	225.00
		$234.54
Expended for Printing and Stationery	$3.13	
" " Institute Expenses	6.41	9.54
		$225.00
Receipts paid Comptroller, for deposit in State Treasury		225.00

COMPTROLLER'S ACCOUNT

Amounts deposited in State Treasury,		
July 1, 1921—June 30, 1922	$178.00	
July 1, 1922—June 30, 1923	154.00	
July 1, 1923—June 30, 1924	225.00	
		$557.00
Expenditures by Comptroller, on order of the Board,		
For Printing and Stationery	$64.18	
Postage	16.00	
Travel Expenses of Board	7.75	
Institute Expenses	43.52	
Miscellaneous Office Expense	11.98	
		143.43
Balance available in State Treasury, June 30, 1924		$413.57

TREE SURGERY

W. O. FILLEY

The problems confronting those interested in the protection and care of ornamental trees are many and various. Some problems relating to foliage, bark, and exposed portions of the trees are simple of solution and results of treatment are readily observed. In some cases, as in spraying with chemicals, complications may arise which require further study, but even in such cases the parts concerned are open to observation and the methods used are susceptible of proof by observation and test.

The filling of cavities, treatment of wounds, stimulation of growth by fertilization and cultivation of soils, and other problems which involve growth and condition of woody tissues are much more difficult of solution. In such cases, results from applied methods are not easy to determine, and there is great divergence of opinion regarding the efficiency of methods which are difficult to standardize. This fact makes it possible, and almost inevitable, that secret or patented processes should become the basis of business getting rather than knowledge and skill.

With due appreciation of this situation and believing that the solution of many of these problems is possible through concerted action on the part of those interested, this Board invited a number of scientists, tree workers and officials to join it in a Shade Tree Conference at Stamford, Conn., August 25-26, 1924. This conference (probably the first of its kind in this country) was attended by 36 individuals, including botanists, entomologists and practical tree workers. The definite results were summed up in the conclusions of Dr. Haven Metcalf, Forest Pathologist, U. S. Bureau of Plant Industry.

"Tree surgery," he stated, "is about where dentistry was in the 60's; its first object being looks. We believe that it does prolong the life of trees but we cannot prove it, and there is almost no literature on the subject. What is needed more than anything else is research records and case histories."

It was voted that another conference should be held in 1925, of which Dr. Haven Metcalf was elected chairman and W. O. Filley, secretary, with instructions to make all necessary arrangements.

It may be truly stated that nothing new came out of this conference. Everything which was said had doubtless been said before. Nevertheless, the meeting served its purpose in bringing together scientists and tree workers for an informal discussion of shade tree problems. Future conferences will undoubtedly show more definite progress toward their solution.

The feeling of many regarding the uncertain status of cavity work was expressed in a short paper by Dr. Collins of the U. S.

Bureau of Plant Industry. He has consented to its publication as a part of this report.

In common with many other observers, this Board has felt that the importance of cavity treatment and filling was somewhat over-emphasized, as compared with improvement of soil conditions, proper pruning and treatment of wounds, protection from insect and fungous pests, etc. Much wonderfully fine workmanship has gone into the filling of cavities, and in many cases it may have lengthened the life of the trees concerned, but in others it has only served to increase the size of the bill.

Neverthless cavity work, like the treatment of wounds, bracing, and other forms of tree repair, is demanded by tree owners, who are ready to pay for expert knowledge and skill. In return, they have a right to expect definite results, which can only be assured through standardized methods applied with judgment and honest intent. Tree workers ought to be able to say that a certain method is the right one because it has stood the test of time and is so universally used that it has become standardized. This can only come about through careful observation of results, frequent exchange of ideas with other tree workers and close co-operation with scientific workers who are keenly interested in the solution of these problems.

CAVITY WORK

J. FRANKLIN COLLINS

(Read before the Shade Tree Conference, Stamford, Conn., Aug. 25, 1924)

Before speaking of cavity work I wish to correct an erroneous impression that seems to be somewhat prevalent regarding the scope of the tree repair work being done by our Washington office. The Bureau of Plant Industry is not primarily concerned with the work of commercial "tree surgeons," nor has it ever been, so far as I know. Its primary interest lies in trying to help the man who owns a few trees (either shade, ornamental or orchard) to keep them in good condition so far as disease and mechanical injury is concerned, or to advise him how best to repair fresh injuries, as well as neglected ones that may have occurred in the past. To put the matter in another way, we are concerned primarily with the question, "What is the best advice to give to a man who has a few trees that he wants to care for himself and who would never, for financial or other reasons, employ a commercial tree surgeon to attend to them?" That is the information that we have tried to give in Farmers' Bulletin 1178, and the first paragraph in this Bulletin expressly states this to be its object. I might also add, this is its sole object.

I think it is the general opinion of the majority of tree workers that preventing decay is far better, from all points of view, than

trying to cure it. I think nearly all tree workers (certainly all scientific workers) also will agree that a decayed spot in a trunk or a large limb should be carefully cleaned out, sterilized, and treated in such a manner as to prevent, so far as possible, any reinfection.

Beyond this point there obviously is a difference of opinion even among commercial tree surgeons, as to what is the best thing to do with the cleaned out cavity: i.e., whether to leave it open, to cover it with sheet metal, or to fill it with concrete or asphalt mixtures, wood, or other materials.

For the past 15 years when traveling about the country, primarily on other business, I have made it a point to look over cement-filled cavities wherever I have been and had the time to do so, and check up on their general condition. My method of checking was to count only fillings that had been in place for a few years so as to get some idea of their permanency. Those which showed obvious cracks, chipped cement, severe dying back of the cambium, excessive leakage, or a loose filling were considered defective. Judged on this basis more than 90 per cent. of all the fillings examined have proved to be defective. I was not particularly concerned with who did the work, although in some cases I was told who did it. Undoubtedly most of this work had been done by men trained, at least to some extent, in the work, as the trees examined were located primarily along streets or on large estates where commercial men had been employed to do it.

I have had opportunity to dig out quite a number of fillings that had been in place for periods varying from eight to 15 years, and most of these, even when absolutely perfect on the surface, were found to be badly decayed back of the cement, in some cases the decayed area back of the cement was larger than the original cement-filled cavity itself. As a result of such observations as these it is hardly to be expected that the use of cement in other than small and globular cavities could conscientiously be recommended for the use of untrained persons, to say the least.

So far as asphalt mixtures or wood strips and blocks are concerned I can only say that although they appear to me to give promise of good results after they have been in practical use long enough to know just how they can best be handled, they have not yet stood the test sufficiently long to demonstrate satisfactorily to me their real value and limitations. Consequently, they are not at present recommended by us for the use of untrained men, except on an experimental basis.

SOME OF THE PRINCIPAL INSECTS ATTACKING SHADE TREES IN CONNECTICUT

W. E. BRITTON

It is often necessary to spray shade trees in Connecticut in order to control certain insects which otherwise might seriously injure the trees. In summer there are various chewing insects which devour the foliage, and there are also other insects, such as aphids and scales, which, when abundant, make a heavy drain upon the trees by sucking out the sap. Though most of these pests do not kill the trees in a single season, yet they weaken them, and if a tree is completely defoliated two or three times in succession, death may result.

In cities and towns as well as on large estates and other private holdings where the trees are an important asset, every effort should be put forth to keep the trees in the best possible health and vigor. Such a program must include provision for spraying the trees to rid them of their insect pests. Perhaps it may not be necessary to treat them every season because these pests fluctuate in abundance from year to year, and when absent, it might be wasting money to spray the trees. But the trees should be watched, and materials and apparatus should be always at hand in readiness to make the application whenever the conditions seem to warrant it. In no other way can the trees be given the most intelligent care.

What Insects Are

Insects are small animals belonging to the class Hexapoda (six-legged), and for the most part they have six legs in some stage of their existence. Those attacking trees may be divided roughly into two groups: (1) chewing insects, and (2) sucking insects. The chewing insects (except termites or white ants) have four distinct stages in their life cycles as follows: (1) egg, (2) caterpillar, grub or larva, (3) pupa, (4) adult insect. Such insects are said to have complete transformations. The sucking insects have incomplete transformations and do not pass through these four well-marked stages. There is usually, though not always, an egg stage, and an adult stage, but there is no distinct pupa, except in case of the males in certain scale insects and white flies, and the larvae are called nymphs after hatching from the eggs, and undergo a gradual development, molting several times with only slight changes until the adult stage is reached.

Chewing insects have strong jaws or mandibles with which they bite or tear off bits of the food which they swallow. Sucking insects have beaks or probosces which they insert into the tissues and suck out the sap.

Common Insecticides

Remedies for chewing insects include the arsenical poisons, but these are not effective against sucking insects where it is necessary to employ some substance which will kill by contact. Both kinds of insects may be killed by fumigation.

The most common arsenical poison used in tree spraying is lead arsenate, which may now be obtained in the form of paste, and also as a dry powder. It is used in various proportions from three pounds of paste or one and one-half pounds of dry powder in orchards, to 10 pounds of paste or five pounds of dry powder to 50 gallons of water for gipsy moth and certain other shade tree insects. A spreader is sometimes employed.

FORMULA FOR LEAD ARSENATE

Lead arsenate (paste)	3-10 lbs. or (dry) 1½-5 lbs.
Calcium caseinate spreader	1 lb.
Water	50 gals.

Paris green and calcium arsenate are often used in spraying especially on potatoes. Calcium arsenate is used extensively on cotton in the South, but it causes injury on apple foliage in Connecticut, and is not recommended for tree work. In case it seems necessary to use these poisons, ½ lb. of Paris green, 1½ lbs. air-slaked or hydrated lime may be used to 50 gallons; with calcium arsenate, 1½ lbs. each of the poison and lime may be used to 50 gallons of water.

FORMULA FOR NICOTINE SOLUTION

Nicotine sulphate may be obtained in 40 per cent. solution, and several different brands are on the market. Used to kill aphids and other sucking insects.

Nicotine sulphate	½ pint
Laundry soap	2 lbs. or
Calcium caseinate	1 lb.
Water	50 gals.

Nicotine sulphate solution may be added to lead arsenate if desired, but the soap should be omitted.

LIME-SULPHUR WASH

Liquid lime-sulphur	1 gal.
Water	9 gals.

This is used as a dormant spray to kill scale insects, and is also a good fungicide. Dry lime-sulphur preparations are now on the market and in using them, directions on the package should be followed. Diluted mixtures of lime-sulphur are also used on the foliage as a fungicide.

MISCIBLE OILS

There are several miscible oils on the market, and these may be used at the rate of one part in 15 parts of water as a dormant spray to kill scale insects, and 1-20 for spruce gall aphid.

LEAF-CHEWING INSECTS

Elm Leaf Beetle: The elm leaf beetle, *Galerucella xanthomelaena* Schrank, hibernates in attics, belfries and other protected places, emerges from its hiding place in early spring and eats holes in the expanding leaves in May. The sexes mate and the females deposit on the under sides of the leaves, clusters of flask-shaped, yellow eggs, which, in a normal season, hatch about June 1. The larvae or grubs feed upon the green tissue on the under surface, skeletonizing the leaves. When numerous they leave only the veins and the upper epidermis, and such injured leaves turn brown and fall, usually the latter half of July. At this time the larvae reach their maturity, drop to the ground or crawl down the trunk, and on the ground around the base of the tree transform to bright yellow pupae. About 10 days later the beetles appear and go to the trees, some laying eggs for a second generation, which seldom or never does any harm in Connecticut. The late emerging beetles probably do not lay eggs, but fly about and feed more or less and go early into their winter quarters.

This insect, like humans, congregates in cities and towns, and seldom injures trees in the open country. It is even more injurious to European elms than to the American elm. It was troublesome in 1923 and defoliated trees in some localities. There was little rainfall during the pupating period, and most of the larvae came through to the adult stage. When pupation takes place during a wet period, the pupae are often attacked and killed by a white mold or fungus. *Sporotrichum globuliferum* Speg. (*entomophilum* Peck.) This fungus and the moisture were absent at the time of pupation in both 1923 and 1924; consequently the elm leaf beetle bids fair to be abundant and to cause injury to the trees in 1925. In 1924, the season was late and the insect went through its different stages and defoliated the trees much later than normal.

The remedies are to kill the beetles in attics and belfries, and to kill the pupae on the ground around the trunks of the trees by spraying them with nicotine solution and soap, and to spray the foliage, particularly the under surface, about June 1, with lead arsenate, two to three pounds of the dry powder in 50 gallons of water.

Further information regarding this insect may be obtained from Bulletin 155 of this Station.

Tent Caterpillar: The tent caterpillar, *Malacosoma americana* Fabr., usually confines its attacks to wild cherry and apple, but it is very abundant every 10 or 12 years when it may also attack oak and other trees. The eggs are deposited in July in cylindrical masses around the small twigs, and covered with a gray, glue-like substance, probably for protection. These eggs hatch when the leaf buds first open in April, and the young caterpillars from each egg-cluster live and feed together and form a web or tent in the crotch of the tree or in a fork of one of its branches. The caterpillars go outside of the nest twice a day to feed, and enter it after feeding, except when nearly full-grown they cluster on the outside of the nest. The caterpillars become full-grown about the first week in June and make their light yellow cocoons under rubbish, fence rails, etc., near the ground. The reddish-brown moths emerge two weeks later. There is only one brood each year.

The remedies are cutting off and burning the egg-clusters in winter, removing the nests and caterpillars with a caterpillar brush, or burning them off with a torch, and spraying the foliage with lead arsenate.

Additional information on the tent caterpillar may be found in Bulletin 177 of this Station.

Cankerworms: The fall cankerworm, *Alsophila pometaria* Harris, is a common pest of fruit, shade and woodland trees in Connecticut, and in some cases is accompanied by the spring cankerworm, *Paleacrita vernata* Peck, which is usually much less abundant. Both species cause the same kind of injury, and require similar remedies. Both have winged males and wingless females which crawl up the trees to lay eggs. The moths of the fall cankerworms emerge during the warm days of November and December and the females lay eggs. The adults of the spring cankerworm emerge and lay their eggs in March. The eggs of both species hatch with the first opening buds and the larvae feed upon the leaves of fruit, shade and woodland trees. Cankerworms were so abundant in Greenwich and Stamford in 1924 that small woodland areas and many shade trees were entirely defoliated. The caterpillars normally feed during May, becoming full-grown about June 1st, and during the first week in June go into the ground and transform to naked brown pupae, remaining in this stage until the following November and December, or in case of the spring species, until the following March. In the fall of 1923 the male moths were very abundant flying about and clustering on tree trunks, especially on the warm, foggy days of November and December.

There are two preventive methods: Spraying the foliage with lead arsenate during May, and employing sticky bands to prevent the insects ascending the trees. The spraying should be

done just as early as is possible after the leaves have unfolded enough to catch and hold the poison. By using a strip of cotton batting to fill the crevices in the bark covering this with a 5-inch strip of single ply tarred paper tacked at the lap, tree tanglefoot can be applied to the paper band. It should be kept sticky during November and December, and again during March and April when the eggs hatch. The whole may be removed without disfiguring the trees.

Further information may be obtained from Bulletin No. 1238, United States Department of Agriculture.

Tussock Moths: The white-marked tussock moth, *Hemerocampa leucostigma* S. and A., often injures and defoliates elm, maple, linden, poplar, horse chestnut and other trees in cities and towns. The caterpillars are bright colored and conspicuous, being striped lengthwise with yellow and brown, and having a red head and three long black tufts or pencils of hairs, two near the head and one at the tail. There are four white tufts on the front half of the body. There are two generations each year in Connecticut, one at Albany, N. Y., and three in Washington, D. C. The insect winters in the form of egg-clusters, usually on or near the old cocoons on the trees and covered with a frothy white substance about half an inch in diameter. The eggs hatch in May and the caterpillars become full-grown about the first of July, and make their cocoons on the bark of the trees. Two week later the moths emerge. The eggs for the second brood are laid in July and the caterpillars feed through August and September, then pupate, and the females lay eggs that carry over the winter.

The females, like the cankerworms, are without wings, but as they pupate on the trees, banding is not so helpful. The males are mouse color with characteristic, rather indistinct markings, and are attracted by lights.

Spraying the foliage and gathering and destroying the egg-clusters are the common methods of control.

For further information, see Report of this Station for 1916, page 105.

The hickory tussock moth, *Halisidota caryae* Harris, and the tessellated tussock moth, *H. tessellaris* S. and A. both have tufted caterpillars which feed upon apple, oak, hickory, willow, poplar and other trees, and occasionally may require a spray of lead arsenate to prevent damage. Each species is single-brooded.

For further information, see Report of this Station for 1917, page 325.

Gipsy Moth and Brown-tail Moth: The caterpillars of the gipsy moth, *Porthetria dispar* Linn., when abundant feed upon the foliage of apple, oak, birch, maple, willow, poplar, and even conifers. There is one generation each season; the eggs are laid in clusters on the bark or in cavities in trees, during July and

August, and hatch the following May. Caterpillars become mature the last of June and make their cocoons in protected places. The adults emerge two weeks later. Soaking the egg-clusters with creosote, and spraying the foliage with lead arsenate with four to five pounds of dry lead arsenate in 50 gallons of water, are the most approved methods of artificial control. So far, this insect has been kept in check in Connecticut by the forces employed by the state.

Further information regarding this insect may be found in Bulletin 186 of this Station.

The brown-tail moth, *Euproctis chrysorrhoea* Linn., formerly occurred over the eastern half of Connecticut, but has since disappeared and for several years has not been seen. It was evidently controlled by natural enemies, and it may come back again. The caterpillars feed upon pear, apple, plum, cherry, oak, elm and maple, and live through the winter in a partially grown state in small webs on terminal branches. Brown egg-masses are laid on the under side of leaves in July by the white moths with brown tufts at the end of their bodies. The caterpillars when touched by human hands cause a rash; they become mature in June and make their cocoons on the leaves.

The remedies are to clip off and burn the winter nests, and to spray the foliage in May with lead arsenate.

More detailed information may be found in Bulletin 182 of this Station.

Fall Webworm: The fall webworm, *Hyphantria cunea* Drury, is found on all kinds of fruit, shade and woodland trees the last half of summer, the caterpillars feeding upon leaves enclosed in nests near the ends of the branches. There is a partial second brood in Connecticut, and the eggs are laid on the under side of leaves by the white female.

Clipping off and burning these nests, and spraying the trees with lead arsenate are the remedies.

For further information, see Report of this Station for 1917, page 319.

Walnut Caterpillar: Hickory, butternut and black walnut trees are often stripped of their leaves in late summer by the walnut caterpillar, *Datana integerrima* G. & R. This is a black caterpillar covered with whitish hairs, which feeds gregariously. They molt and leave the cast skins, in the form of gray patches on the tree trunks. Spraying with lead arsenate is the remedy.

For further information, see Report of this Station for 1917, page 326.

Sawflies on Conifers: There are several species of sawflies, the larvae of which feed on the various species of pine trees, occasionally defoliating them. One of the most destructive is the imported pine sawfly, *Diprion simile* Hartig, which attacks the

white pine and other five-needled pines; these may also be attacked by *Neodiprion pinetum* Norton, *Neodiprion lecontei* Norton, and other species feed upon the pitch pine and other kinds of pines.

The larch sawfly, *Lygaeonematus erichsoni* Hartig, is occasionally so abundant as to defoliate larch trees, and sometimes spruce trees are injured by *Neodiprion abietis* Harris. The proper remedy against all these pests is spraying with lead arsenate.

For further information regarding the imported pine sawfly, see Report of this Station for 1917, page 273.

Larch Leaf-miner or Case Bearer: This insect, *Coleophora laricella* Hubn., is a small moth and the larva tunnels inside the leaves from June to September, often ruining them. It then migrates to the twigs, where in brown, cigar-shaped cases it passes the winter. A dormant spray with liquid lime-sulphur in early spring will kill the larvae in their winter cases and is the best remedy known.

Further information may be found in the above mentioned Report, page 288.

Arbor-vitae Leaf-Miner: This small moth, *Argyresthia thuiella* Packard, has recently caused serious injury to arbor-vitae trees and hedges in Connecticut. The tiny larvae tunnel inside the leaves, causing them to appear transparent and later turn yellow and brown. The adults emerge late in May and early in June, and spraying with nicotine solution and soap when the adults are flying and laying eggs will materially reduce the pest.

For further information, see Report of this Station for 1921, page 157.

Imported Willow Leaf Beetle: This small, shiny blue beetle, *Plagiodera versicolora* Laich., has been brought into this country and has spread from the vicinity of New York to various parts of Connecticut. It prefers shiny leaved willows, but may attack poplars. Eggs are laid on the leaves and both beetles and grubs feed upon the leaves, skeletonizing them. There are two complete broods each season, and the beetles hibernate. The remedy consists of spraying with lead arsenate.

For further information, see Report of this Station for 1921, page 195.

Birch Leaf Skeletonizer: The larvae of a small moth, *Bucculatrix canadensisella* Chambers, often skeletonize the leaves of gray, white and yellow birch trees late in the season. There is only one annual generation, and the insect passes the winter in cocoons on the fallen leaves. The remedy consists of spraying with lead arsenate during August.

For further information, see Report of this Station for 1910, page 701.

Spiny Elm Caterpillar: Black, spiny caterpillars are often found feeding gregariously on elm, poplar and willow, stripping the branches. This insect is called the spiny elm caterpillar, and is the larva of the mourning cloak or Antiopa butterfly, *Euvanessa antiopa* Linn. There are two broods each year in Connecticut, and the adult butterflies live through the winter and may be seen flying on warm days. As the caterpillars feed in colonies it is often possible to crush them on the tree or after cutting off the infested branches. Spraying the foliage with lead arsenate is a remedy.

For further information, see Report of this Station for 1906, page 260.

Borers or Wood-Chewing Insects

Maple Borer: Sugar maple trees are commonly injured by the maple borer, *Glycobius speciosus* Say, a handsome black beetle with yellow markings, and about an inch in length. A conspicuous mark is the W on the base of the wing-covers. The beetles appear in Connecticut the first half of July, and a little later the eggs are laid. The tiny grub begins tunneling in the bark, soon entering the sapwood, where it works around the trunk or branch, usually going upward in a spiral course. Two years are probably required for the complete life cycle, and, of course, the grub increases in size with age and makes a much larger burrow when it is nearly full-grown. This results in some large scars on the trees, and when two or more grubs are at work in the same trunk, they sometimes girdle it and the tree breaks over. When mature, the grub pupates in the burrow and emerges the following July through a nearly circular, somewhat flattened hole, nearly half an inch in diameter. The best control measure is to examine trunk and branches of choice maple trees, preferably in September, find the grubs by following up the sawdust emitted, and cut them out or kill by inserting a wire in the burrow. Also destroy the adult beetles when found resting on the trunks of trees in July.

For further information, see Report of this Station for 1922, page 351.

Leopard Moth: Elm, maple and other shade trees as well as fruit trees are attacked by the leopard moth, *Zeuzera pyrina* Linn. The female moth has a wing-spread of about two and a half inches, is white with fore-wings coarsely dotted with blue and black spots. The male is smaller though similarly marked. The moths emerge mostly in July. Eggs are laid in crevices in the bark, and the young caterpillars usually enter the twigs at the base of a bud, and after feeding for a time, leave their burrows and enter larger branches where they excavate large, irregular galleries. The branches are weakened and often break off. The

grub is white or pinkish, with head, neck shield and tubercular spots, black; it is nearly three inches long when fully grown. The borer causes most of its damage the second summer, lives in the burrow the following winter and pupates, the moths emerging in July, two years being necessary for its complete life cycle. A systematic cutting and burning of infested branches will check the pest, and where sawdust is thrown out from the main trunk and larger branches it is possible to dig out the borers. A wire may be inserted in the burrow or a few drops of carbon disulphide injected and the opening closed to kill the borers.

For further information, see Report of this Station for 1911, page 317.

Bronze Birch Borer: Many European white birches, particularly the cut-leaf form, have been killed during the past few years by the bronze birch borer, *Agrilus anxius* Gory. This small beetle begins its attack on the branches in the upper part of the tree and spiral swellings or ridges show on the surface of the bark. Later the lower branches are similarly affected and the tree is soon killed. Native species, though not immune, are less susceptible to injury. If a tree becomes generally infested, it cannot be saved. The beetles emerge in June, feed for a time on the leaves and lay eggs in slits in the bark. There is only one brood annually and the grubs make shallow galleries in the sapwood just beneath the bark. Where a few branches are infested, they should be cut off and burned in early spring. Dead trees should also be burned before the beetles emerge. As the beetles feed somewhat on the leaves, the trees should be well coated with lead arsenate early in June.

For further information, see Report of this Station for 1922, page 359.

The Twig Pruner: Small terminal twigs of oak and some other trees are often cut off by a borer in late summer and fall upon the ground. This is the work of the twig pruner, *Hypermallus villosum* Fabr., one of the long-horned beetles. There is only one brood each year and the borer usually drops to the ground in the base of the severed twig. Consequently, gathering and burning these twigs is advisable, and about the only control measure known. Trees are not seriously injured by the attacks of this insect.

For further information, see Bulletin 332, Ohio Agr. Expt. Station, page 327.

Carpenter Worm: Large grubs, occasionally found tunneling in the heart wood of ash, elm, and other trees, are called carpenter worms, and are the larvae of one of the Cossid or goat moths, *Prionoxystus robiniae* Peck. It is related to the leopard moth, and there is one generation each year. About the only remedy

is to inject carbon disulphide into the burrows and close the opening, or cut out the grubs.

For further information, see Bulletin 332, Ohio Agr. Expt. Station, page 329.

Locust Borer and Painted Hickory Borer: Young locust trees are often killed or deformed by the locust borer, *Cyllene robiniae* Forst., and hickory trees are less seriously injured by a closely related species called the painted hickory borer, *Cyllene pictus* Drury. In fact, some claim that these two species are identical, but there are slight structural differences and the adult of the painted hickory borer emerges in the spring, while the locust species appears in the fall. Both are long-horned, black beetles, three-fourths of an inch in length, marked with narrow cross-bands of greenish yellow and with a W-shaped mark on the base of the wing covers. The life cycle of each occupies about a year. Dr. Craighead reports success by injecting into the burrows kerosene soap emulsion made with water containing five per cent. of sodium arsenate.

For further information, locust borer, see Bulletin 787, U. S. Department of Agriculture: Painted hickory borer, New York State Museum Memoir 8, page 264.

Saperda Borers: Linden trees are often injured by the linden borer, *Saperda vestita* Say, hickory by the hickory borer, *Saperda discoidea* Fabr., poplars by the poplar borer, *Saperda calcarata* Say, elms by the elm borer, *Saperda tridentata* Oliv., and apple by the round-headed apple borer, *Saperda candida* Fabr. Trees badly infested with the elm borer should be cut and burned. These borers are usually cut out, but carbon disulphide may be employed and possibly the poisoned kerosene emulsion may prove successful.

For further information regarding these borers, see Manual of Tree and Shrub Insects.

White Pine Weevil: The leaders or top-most shoots of young white pine trees are commonly attacked and killed by a snout beetle, *Pissodes strobi* Peck, which lays eggs in punctures in the bark of the leader during May. Numerous grubs hatching from these eggs tunnel in the stem, becoming full-grown about July 1, and pupate in oval cells in the wood. The leaders wilt and die during July. Repeated attacks cause the trees to become crooked, forked and ill-shaped. It is commonly recommended that the leaders be cut off and burned before the adults emerge, or still better, place them in cages which will permit the escape of their parasites but not of the snout-beetles. Small plantations and choice ornamental trees may be protected to some extent by spraying the leaders about May 1, with liquid lime-sulphur (1-9) or lead arsenate, or by jarring the leaders twice a week for six weeks and catching the beetles in a net.

For further information, see Report of this Station for 1919, page 144.

The Hickory Bark Beetle and Other Bark Beetles: Hickory trees are beset more or less periodically by epidemic attacks of the hickory bark beetle, *Scolytus quadrispinosus* Say, which breeds in the cambium, effectually girdling the tree. Later the exit holes give the tree the appearance of having been punctured with shot. Thousands of hickory trees have been killed in Connecticut by this insect during the past 25 years. The adults feed on the leaf petioles, and a thorough spraying of the foliage about July 1, with lead arsenate and nicotine sulphate is believed to be of some benefit. Badly infested trees should be cut and burned or barked before the beetles emerge. Related bark beetles with similar habits attack pine, spruce and other kinds, usually the unthrifty trees. Keep all trees as vigorous as possible. Cutting and burning the infested trees will generally check the outbreak.

For further information, see Manual of Tree and Shrub Insects.

The Parandra Borer and the Maple Sesian: Weakened trees of nearly all kinds are attacked by a brown beetle known as the Paranda borer, *Parandra brunnea* Fabr., which tunnels in the heartwood near the ground. The maple sesian is a clear-wing moth, *Sesia acerni* Clem., which breeds in the vicinity of wounds on the trunk and branches, particularly of soft maples. Careful dressing of the wounds is a good preventive. Where trees are kept in a thrifty condition there is little injury from either of these insects.

For further information, see Report of this Station for 1921, page 201 (Parandra borer), and for 1922, page 355 (maple sesian).

Pigeon Tremex: The pigeon tremex, or horn-tail, *Tremex columba* Linn., is a borer in dead and dying trees of nearly all deciduous kinds, and is common in maple, elm and hickory. Round holes the size of a lead pencil mark the points of exit of the adults, which are rather large, four-winged flies, about two inches in length, marked with yellow and black and with a conspicuous horn or ovipositor at the rear end of the body. Trees which are infested by the pigeon horn-tail are commonly visited by two of its very conspicuous parasites called "long stings." In fact, the parasites are usually the first indication to the owner that anything is wrong with his tree, and he thinks them responsible for the injury. The black long-sting, *Megarhyssa atrata* Fabr., and the lunate long-sting, *Megarhyssa lunator* Fabr., are among the largest of the parasitic Ichneumon flies, and the females have bristle-like ovipositors nearly four inches in length and resembling horse hairs.

For further information, see Manual of Tree and Shrub Insects.

Carpenter Ant and Termites: Trees are often tunneled and honeycombed by the large, black, carpenter ant, *Camponotus herculeanus pennsylvanicus* DeGeer, and by the so-called white ants or termites, *Reculitermes flavipes* Kollar. The white ants are white only in their immature stages, the adults being brown. The best remedy for both species is to inject carbon disulphide and confine it in the burrows by plugging the opening.

For further information, see Report of this Station for 1922, page 365.

Sucking Insects

Spruce Gall Aphid: Cone-shaped galls at base of new growth on Norway, black, white and red spruce trees are caused by the spruce gall aphid, *Chermes abietis* Linn. This insect has two generations each year the winter being passed by the immature females on the twigs, and particularly around the buds and under the bud scales. They reach maturity in spring, and lay their eggs about May 1. The young cluster at the tips where the new growth starts, and form the cone-shaped galls. The insects become mature in August and escape from the galls and lay eggs for the second brood. Another species *Chermes cooleyi* Gillette, makes larger galls on the Colorado blue spruce. Thoroughly spraying with nicotine solution and soap, or with a miscible oil (1-20) in the fall or spring will hold this pest in check. Clipping off and burning the galls in early summer can also be practiced on small trees.

For further information see Report of this Station for 1922, page 357.

Leaf Aphids: There are many kinds of aphids which injure the various kinds of trees by sucking sap from the leaves. Some of these are: Green apple aphid, *Aphis pomi* DeG., rosy apple aphid, *Anuraphis roseus* Baker, of apple; woolly aphid of apple and elm, *Eriosoma lanigera* Hausm.; woolly beech aphid, *Prociphilus imbricator* Fitch; birch aphid *Calaphis betulaecolens* Fitch; pine bark aphid, *Chermes pinicorticis* Fitch, and many other species. As a rule, these aphids may be held in check by spraying with nicotine solution and soap. Calcium caseinate may be used as a spreader in place of soap. Dusts containing nicotine may also be blown upon the leaves.

Further information may be obtained from Manual of Tree and Shrub Insects.

Hickory Gall Aphid: The compound leaves of hickory are often distorted and fall in midsummer on account of the attacks of the hickory gall aphid, *Phylloxera caryaecaulis* Fitch, which forms hollow, globular galls on the leaf petioles, often causing them to break off. Apparently no control measures have been worked out for this insect.

For further information, see Manual of Tree and Shrub Insects.

Oyster-Shell Scale: The oyster-shell scale, *Lepidosaphes ulmi* Linn., kills branches and sometimes entire trees, and attacks many kinds of deciduous trees and shrubs. Some of those most commonly attacked are ash, maple, apple, poplar, willow, butternut, birch and lilac. Silver maple street trees are sometimes seriously infested and it makes the branches very brittle so that they break off in storms. This insect has one generation each year and passes the winter as white oval eggs under the old female shells. These eggs hatch during the last days of May, and the young crawl about for several hours and establish themselves on the bark, begin to suck the sap and remain stationary afterward. Late in August, the females become grown and die after depositing eggs under the shells. The shells are mussel-shaped, about an eighth of an inch long, and gray or brown, usually nearly the color of the bark. Spraying with lime-sulphur (1-9) or miscible oil (1-15) in early spring has proved effective. Also a spray of nicotine solution and soap or with kerosene emulsion about June 10th will kill the newly-hatched young.

For further information see Report of this Station for 1903, page 229.

San José Scale: This is a small, circular scale, grayish in color and about one-sixteenth of an inch in diameter. The shell is formed of concentric rings with a nipple in the center. It is called the pernicious or San José scale, *Aspidiotus perniciosus* Comst., and it attacks many different kinds of trees and shrubs, but shows a preference for fruit trees and shrubs of the rose family. There are three broods each year, and the winter is passed in a partially grown condition. The young of the first brood appear the last days of June. Though in part controlled by natural enemies, this insect formerly destroyed hundreds of fruit orchards, and after subsiding as a pest for several years, is now troublesome again. A dormant spray of lime-sulphur (1-9) or of miscible oil (1-15) are the remedies.

For further information, see Bulletin 165 of this Station.

Maple Woolly Leaf Scale: Sugar maple trees throughout the cities and towns of Connecticut are attacked and injured by the woolly maple leaf scale, *Phenacoccus acericola* King. The females are found on the under sides of the leaves in midsummer where they produce their eggs in large flocculent masses of white wax, resembling tufts of cotton or wool. Badly infested leaves drop in July. The male cocoons as well as the winter cases of the immature females are placed in the crevices of the bark of the trunk and at the base of the larger branches. There are three broods each season. Spraying the winter cocoons on the dormant trees in March using lime-sulphur (1-9) with the addition of nicotine has proved an effective remedy in New Haven.

For further information see Report of this Station for 1905, page 226.

Cottony Maple Scale: Soft maples in the vicinity of Stamford for several years have been badly infested with the cottony maple scale, *Pulvinaria vitis* Linn., which also attacks many other kinds of trees. This insect has one generation each year and passes the winter in the form of thin, brown, oval, soft scales on the bark of the twigs. In early summer the development of the egg-sac causes one end of the brown scale to be lifted by a cotton-like mass of white wax. The young are crawling in July. Spraying the trees with miscible oil (1-15) in spring before the buds start has given good control.

For further information, see Report of this Station for 1921, page 179.

Terrapin Scale: Another pest of soft maples is the terrapin scale, *Lecanium nigrofasciatum* Pergande, a small, reddish, convex species occurring on the smooth bark of the smaller twigs. Occasionally the sugar and Norway maples and other kinds of trees are attacked by this scale. Badly injured branches should be cut off and burned, and the trees sprayed in early spring with miscible oil (1-15) or with a kerosene emulsion containing 20-25 per cent. of kerosene.

For further information, see Report of this Station for 1921, page 183.

Tulip Tree Scale: The lower branches of tulip trees are often infested and killed by the tulip tree scale, *Toumeyella liriodendri* Gmel., which appears as brown hemispherical shells nearly one-third of an inch in diameter. There is only one brood each year, and the young hatch in September, establish themselves on the bark, and pass the winter in a partially grown state. The next season they continue to suck sap from the branches, becoming mature in August, and the honey dew drips upon the ground and lower leaves, appearing like a coat of varnish. The best times for treatment are after the leaves drop in the fall, or just before they put out in the spring. Liquid lime-sulphur (1-9) or a miscible oil which does not contain phenol, may be used for this purpose.

For further information, see Report of this Station for 1921, page 176.

Elm Scale: The trunks of small elms and the lower branches of larger trees are often infested and injured by a soft scale called the elm scale, *Gossyparia spuxia* Mod. This scale occurs in longitudinal rows in the crevices of the bark, and is oval in shape, chocolate brown in color margined by a whitish fringe of wax filaments. There is only one brood each year, winter being passed in a partly grown state, and the young appear late in June. Spraying with miscible oil in early spring is a satisfactory remedy.

For further information, see Manual of Tree and Shrub Insects, page 161.

Pine Leaf Scale: Small pine trees in protected places are often infested with the pine leaf scale, *Chionaspis pinifoliae* Fitch, which appears as white elongated shells on the needles. It attacks the various species of pines but seldom causes injury in exposed situations. There are two generations each year, though not well defined, the young of the first brood beginning to appear in May and the second in July. It passes the winter in the form of purple eggs under the shells. Badly injured branches should be cut off and burned. Dr Felt advises spraying with miscible oil (1-16) in spring, but it is probable that summer applications of nicotine solution and soap will also keep the pest in check.

For further information, see Report of this Station for 1921, page 181.

Other Scale Insects: There are several other kinds of scales which are occasionally troublesome, such as the scurfy scale, *Chionaspis furfura* Fitch, on trees and shrubs of the rose family, the rose scale, *Aulacaspis rosae* Bouché on roses and blackberries, the euonymus scale, *Chionaspis euonymi* Comst., on euonymus, the apricot or European fruit scale, *Eulecanium corni* Bouché, on various trees and shrubs, and the golden oak or pit-making oak scale, *Asterolecanium variolosum* Ratz., on golden oak. Send specimens to the Station for identification and advice about treatment.

For further information, see Manual of Tree and Shrub Insects.

Lace Bugs and Leaf Bugs: Leaves of sycamore are commonly attacked and somewhat injured by a lace bug, *Corythucha ciliata* Say, oak by another species, *Corythucha arcuata* Say, and rhododendron by *Leptobyrsa rhododendri* Horv. Several kinds of leaf bugs of the family Miridae also injure the leaves by sucking out the sap. As a rule all of these may be controlled by spraying the under sides of the leaves with nicotine solution and soap as for aphids.

FUNGOUS AND NON-INFECTIOUS TROUBLES OF ORNAMENTAL TREES

G. P. CLINTON

This article does not include the troubles of fruit or forest trees except as grown for purely ornamental purposes. Aside from the injuries caused by insects, which are treated elsewhere in this report, the other troubles of ornamental trees fall into two classes: First, a variety of more or less obscure troubles, often non-progressive and always non-infectious, due to a great variety of causes, which we may designate as "unfavorable environment." Second, definite infectious and progressive diseases, which are caused by fungi.

NON-INFECTIOUS TROUBLES

Because the agents are so obscure or are present only for a short period, these troubles are the hardest to identify. Likewise the symptoms may be so similar from dissimilar causes, that, lacking both agent and characteristic symptoms, one often has to give a guess as to the cause. The elimination of other possible causes and extended observation, help to make the guess of value. In our experience with ornamental trees, we have found injuries of the following character: Winter, Drought, Smoke and Gas, Spray, Electrical and Mechanical.

Berls, Knots, Bunched Sprouts: Besides these determined troubles, there occur on certain trees growths whose cause is not definitely known. We do not include here the galls caused by insects, whose nature is usually revealed by some signs of larvae at their center.

Knots: On oak and less frequently on hickory, there are occasionally seen on ornamental, as well as on forest trees, hard, roundish, gall-like growths that vary in size from an inch to a foot in diameter. Usually several or many of these may occur on a single tree, while other trees of the same variety in the vicinity show no such growths. This looks as if the trouble were spreading over the tree. Its infectious nature, however, remains yet to be proved. The resemblance of the smaller knots to crown gall has caused some to think that they may be bacterial in nature. Whatever its cause, this trouble apparently starts with injury or irritation to the cambium layer, so that it is stimulated into great activity and in such unusual directions as to form a gall-like growth rather than the natural woody layers. This growth, however, is usually not so permanent as the normal tissues, though many knots are of considerable age as shown by the growth rings. Where feasible, such growths may be removed by cutting off the branch some distance below the growth.

Bunched Sprouts: Besides knots, certain trees, especially elms and maples, occasionally show bunched growths of fine branches or unexpanded buds on the main trunk. These evidently come from adventitious buds developing because of some hidden injury to the tree. The writer suspects that winter injury is often the cause. When abundant, they give the main trunk a somewhat knotted or scraggy appearance. Continued pruning will probably finally prevent their reappearance.

Winter Injuries: *Conditions.* Trees show winter injuries under the following conditions. 1. Some trees are not hardy, being grown too far north or out of their natural environment. There is a demand for trees of all sorts for ornamental purposes, and nurserymen aim to supply the demand. Inexperience at first induced them to grow semi-tropical trees that were easily winter injured, but now they have largely cut out these for their own protection. However, there are still grown a number of species that are not entirely acclimated and, of course, these suffer most. 2. A cultivated or fertilized fruit tree is more likely to suffer from winter injury than a native forest tree. This is partly because the tissues make a faster, softer growth that often does not properly mature before winter sets in. The ornamental tree occupies a position between these two classes, as it sometimes receives cultivation or fertilization or both. 3. Ornamental trees often stand by themselves and so are more exposed to wintry blasts or, on the other hand, they are planted in sheltered nooks where they receive undesirable stimulation during warm, sunny, winter days. 4. Warm winter weather followed by sudden drops in temperature or extreme cold weather may cause injury to trees ordinarily hardy.

Causes and Types. Winter injury takes place in a variety of ways. With trees grown for their blossoms, severe winter weather or late spring frosts may destroy the blossom buds. Warm, sunny weather of some duration may start sap activity on the south or southwest side and result in death of the bark there, so-called winter sun-scald, when the temperature suddenly drops.

Cankers caused by killing the bark in localized spots, especially at the base of the tree, may result, the latter type being known as collar girdle. We have seen elm trees in the vicinity of Stamford and New Haven that showed cankers of varying size, small on the branches but a foot or more on the main trunk where they are most frequent, for which investigators have been unable so far to find any definite insect or fungous cause. The most reasonable supposition, with our present knowledge, is that these are winter injuries where the cambium has been killed in localized spots. See Plate XV, c.

We have also been shown an elm tree, in Stamford, by the head of the F. A. Bartlett Company, where the inner bark had

been winter killed while the cambium remained alive, so that a new growth of smooth bark was formed beneath and finally sloughed off the outer rough bark, thus presenting an unusual appearance.

Sometimes the cold is severe enough to kill trees outright. Even when the tree has its wood properly matured, if the cold is sudden and severe, the difference in temperature between the inner and outer wood is so great that the contraction of the tissues outside is faster than within, and frost cracks suddenly appear in the bark or wood lengthwise of the tree. When healed over, these often show as ridges on the trunk.

*With improperly matured wood, winter injury may be local*ized in the sap wood. If severe and extended enough to kill it prematurely, the next year the tree suffers from lack of sufficient carrying space for the elaborated sap, and the tree makes a very slow growth. This injury shows through the prematurely darkened color of the sap wood, when cut across, and is sometimes followed by rot fungi.

Finally, the injury may be localized in the roots, which are injured or killed, because of too much moisture in the soil in wet places or because weakened by summer droughts. Here the injury is usually hidden from view but sometimes can be detected where the exposed roots join the trunk.

Drought and Heat Injuries: *Heat,* as such, apparently causes very little injury to trees, though, as a factor in excessive transpiration from leaves where there is a limited supply of water to replace that lost, it is indirectly involved. When strong sun light beats down on the exposed south and west sides of trees recently transplanted, and summer sun-scald results, it is probably more directly a cause, though even here the loss of water is a factor. Shading the trunk by V-shaped boards on the south side lessens injury in such cases.

Leaf Scorch. Lack of moisture in the soil, injuries to the roots or wood preventing the conveyance of water to the leaves, bright sunshine suddenly following rainy or muggy weather, or unusually hot days—all are factors in causing transpiration of water from the leaves faster than supplied by the roots with resulting leaf scorch troubles. Whipping winds, also by favoring transpiration and by mechanically injuring the young leaves, are often involved in such troubles. Hard maples, more than any other ornamental trees, are subject to leaf scorch in this state, and, as this injury usually appears suddenly and conspicuously, people often suspect it as being a fungous injury. The tissues of the leaves, especially at their edges, are killed in an irregular manner turning a reddish or brownish color and later they are often infested with saprophytic fungi. They usually adhere to the tree throughout the season, although some may drop pre-

maturely. Sometimes only one tree of several together may show the trouble; this may indicate root injury. Again, trees may show it only on the more exposed side. In the early spring of 1924, when the injury was prominent, trees on the exposed hills were the ones that suffered most. In this case a whipping wind was a prominent factor in the injury. Besides the hard, other maples, elm, ash, and linden less frequently show leaf scorch. Sometimes the pine needle blight is caused in these ways.

Scorch of Evergreens. Another type of leaf scorch is that shown on a variety of evergeens in which the foliage is browned and eventually killed on the more exposed trees, particularly when young in nurseries. Frequently this takes place in late winter or early spring before growth has started, and results from warm days causing transpiration from the leaves when the ground is frozen and the tree cannot replace the water so lost. Again, in severe winters, it may be entirely due to the unusual cold which partly kills the old leaves. Less frequently a very late frost, after new leaves have started, kills their exposed ends but does not injure the protected growing bases, so that the leaves continue to grow but retain the permanently injured tips. These troubles may be considered as a purely winter or a combination of winter and drought injury.

Pine Needle Blight. This is a special form of the leaf scorch of evergreens, and is due to the same causes. The white pine is by far the most susceptible species. The needles are killed from the tip inward, sometimes for half their length. If the injury occurs early in the season, the leaves are often dwarfed and somewhat bunched. As the leaves usually adhere for at least two years, this injury continues to be conspicuous the second year and affects the growth of the tree that year as well. With injury to the new leaves the second year, the trees not infrequently die. Other trees lag along in a sickly condition for a number of years; while those little injured, and with vigorous roots, recover and show no special signs of injury after the blighted needles drop off.

Severe Summer Drought also may cause the premature death of the older leaves of evergreens. These leaves, further back on the branches beyond the new growth, turn brown and eventually drop off prematurely. Before they are shed the injury is prominent because of the evident contrast between the dead and living leaves on the same branch. This prematuring and dropping of the oldest living leaves is merely an effort on the part of the tree to preserve the moisture for the younger leaves and hence protect them from injury. It was quite conspicuous this year, especially on species of Arbor-vitae and Retinosporas, and traced back, in part, to the very dry summer of last year, as well as to the drought of this year.

Yellow Leaf and Leaf Fall. A type of drought injury to deciduous trees is that which takes place when there is a continued severe drought in midsummer or early fall. In this case the roots cannot supply sufficient moisture for the leaves, with the result that those least vigorous and having the most competition for the water drop off. Most leaves of a tree do this gradually, often turning yellow before they fall, as with the elm which also sometimes sheds its young branches as well. With the Norway maple, on the other hand, the leaves may drop off while still green. The dry summer of 1923 caused more of this trouble than that of 1924.

Injured Rootlets. Everyone knows that in transplanting a tree the roots should not be allowed to dry out too much. In case of severe drought this undoubtedly takes place in nature, with the premature death of many of the finer feeding rootlets. The direct injury though hidden from view is shown, in part, by the leaf fall to readjust the foliage and root relationships. Frequently the whole story is not told until the succeeding year, when scantier foliage results, especially as shown in 1924 by certain fruit trees. No doubt, too, such trees come through the winter with less vigorous roots and sapwood. It is difficult, therefore, in some cases where trees are backward, to determine how much injury is due to drought and how much to winter injury, as both may be involved even when the winter is not unusually severe.

Smoke and Gas Injuries: *Smoke Injury* of trees in this state usually comes from brick kilns, though occasionally we have seen injury from smoke stacks of factories. In any case, the injury results from sulphur in the coal that, on burning, escapes into the air as sulphur dioxide. Ordinarily this does no harm, when the atmospheric pressure is such that the smoke is carried upward, but when it drags along the ground and the leaves are moistened by rain or dew, this sulphur dioxide is absorbed by the moisture and apparently changed to sulphurous or sulphuric acid with accompanying burn of the foliage. Such injury has occasionally occurred to the trees in East Rock Park and near-by yards in New Haven, showing on birch, beech, elms, maples, spruce and other conifers. With the maple its injury is similar to that caused by sun scorch or gas. Such smoke injury may also affect other vegetation and law suits have occasionally resulted. The smoke in railway yards from engines seems to be more objectionable from the soot settling on the leaves than from actual burn.

Gas Leaks in mains often cause injury to street trees. The leak may not always be close to the tree, but the gas, by following the pipe escapes into the soil in the vicinity of the roots, injuring or killing them. The visible effect is shown, in time, by the sickly appearance or death of the leaves. Hard maples seem to

be most subject to this trouble, and the injury to these is very similar to that of sun scorch. This latter source of injury should be first eliminated as a cause. A gas leak can usually be detected only by the odor, and is especially evident when a hole is bored into the soil at a suspicious location. The gas is rarely or never strong enough to ignite from a match.

Spray Injuries: Occasionally in spraying trees to prevent insect or fungous troubles, there results more injury than caused by these agents. This is not always the fault of the person applying the spray, as he may be doing it under conditions recommended by scientific investigators and which ordinarily cause no injury.

Insecticides. With these, where arsenic in some form is generally used, the poison is supposed to be practically insoluble and so incapable of injury, but various brands, at times, contain an amount that is soluble beyond the danger point. Again the other ingredients, with which the insecticide is combined, may raise the solubility to this degree. For example, the use of salt water from the Sound has been known to increase the solubility of lead arsenate, and produce injury that did not previously occur with the use of well water. Also when mixed with fungicides, the combination of ingredients used sometimes increases the solubility of the arsenic. With certain of the oils or emulsions improperly mixed or applied, serious injury may result even to dormant trees.

Fungicides. On the other hand injury may be directly due to the fungicide as this must be used at a strength that kills, by contact, the fungus, but ought not to be strong enough to injure the tissues of the leaves. Sometimes this strength is beyond that of safety to the foliage, especially of certain trees, and injury results. Again, chemical change, as with Bordeaux mixture, may occur after the spray is put on the foliage; or the higher temperature or rains, following the treatment, are deciding factors that produce injury that would not ordinarily occur. Lastly, sprays are sometimes applied that are sure to cause more or less damage and should never have been used; the injury from this source, however, is becoming less frequent because of greater caution on the part of manufacturers in trying out their insecticides and fungicides before placing them on the market.

Electrical Injuries: *Electric Wires.* The injury from electrical currents, either direct or alternating, of high voltage occurs when the wire comes in direct contact with the wet branches or leaves. Street trees are the most exposed to these conditions. Personally, we have seen very little serious injury from this cause. We have, however, observed street trees along car lines where an occasional branch or leaves or small branches have been killed. Where the feed wire ran through the trees and its insulation had become worn, we have seen maples, whose wet leaves

had blown in contact with the wire at these points, with localized dead foliage on a considerable number of trees.

Stone (Mass. Agr. Exp. Sta. Bull. 170: 233.) says: "When strung too close to trees, wires also often cause serious injury by burning, sometimes mechanical injury is done, and lightning discharges will cause harm when guy wires are attached to trees. Both the alternating and direct currents are used. They produce different physiological effects on plant life, the alternating current apparently being less injurious than the direct. . . . . Most of the injury to trees from trolley or electric light currents is local, *i.e.*, the injury takes place at or near the point of contact of the wire with the tree. This injury is done in wet weather when the tree is covered with a film of water which provides favorable conditions for leakage, the current traversing the film of water on the tree to the ground. The result of the contact of a wire with a limb under these conditions is a grounding of the current and burning of the limb, due to 'arcing'. The vital layer and wood become injured at the point of contact, resulting in an ugly scar and sometimes the destruction of the limb or leader. . . . . Practically all of the burning of trees from either alternating or direct currents occurs in this way, since the high electrical resistance characteristic of trees does not permit injurious currents to pass through their tissues."

There were occasional cases, however, where Dr. Stone found that large trees had been killed when the wire in contact, contrary to the usual custom, carried the negative current and the rails the positive. This resulted in a girdling of the tree near the base and its subsequent death. Professor Toumey claims that injury to the trees may, in part, be due to copper and zinc compounds carried from the corroded wires into the tissues so injured.

Lighting Injuries are said to be of two types, the most common one is where the tree is struck directly and the injury is entirely mechanical, splitting open the wood and breaking loose the bark or breaking off large limbs. Such a tree remains otherwise entirely normal and may live indefinitely, if the mechanical injury has not been too severe or opens the way to further injury by other agents. Plate XV, d, shows a large white pine at Cornwall, Conn., that was injured in the fall of 1917 but is still living.

On the other hand trees when struck are occasionally so badly injured, apparently in the cambium layer, without much evident mechanical injury that death results immediately or in a short time. We have seen white pine trees, dead and dying, where we could find no other evident cause.' Mr. Stoddard, of this department, records a case of an oak shade tree at Litchfield, that was struck, and the leaves were immediately killed, the tree soon dying without evident mechanical injury.

In a few cases we have heard of shade trees on which, after a storm, the leaves, or part of them, suddenly died while still

green. In these cases it is possible that the injury was the result of earth discharges as reported by Stone. He says: "These discharges occur during thunder storms, and those who have observed them for many years relate that they give rise to a dull, characteristic report resembling that caused by throwing a wet cloth on a hard surface. The whole tree is not affected as a rule, as the lightning stroke seldom follows up the main trunk, but discharges at the point of several branches. As a rule, however, one side of the trunk and one or more of the limbs on that side are affected and the symmetry of the tree destroyed. The first indication of the discharge is shown by the immediate wilting and subsequent death of the leaves of the affected limbs, which also die later. In the course of time cracks similar to those caused by frost, and later ridges due to healing, will be seen on the trunk, showing the path of the discharge, and occasionally, when the injury is considerable, the bark near the affected part of the tree falls off. The limbs, however, are not always killed, frequently splitting and a cracking of the wood for some depth is now and then observed on the trunk and limbs along the path of discharge."

Mechanical Injuries: Besides the special types of mechanical injuries already mentioned, these may be caused in a variety of other ways, such as by hail, ice and wind storms and by animals, of which mice, horses and men are the chief offenders.

Hail Injury on fruit trees is frequently conspicuous, but apparently shade trees suffer less because of their more hardy bark. On July 17th of the present year, one of the most severe hail storms of recent years caused great harm to the fruit trees in the vicinity of Wallingford, and less costly, though evident, injury to the shade trees. A severe wind greatly exaggerated the injury, as the large hail stones struck with great force. On one small apple tree less than 10 feet high, we counted over 450 distinct bruises on the trunk and limbs. Many of these showed the bark killed, drying up or sloughing off in time, and there resulted small canker-like areas. Later the injury was partly obscured by callus healing of the bark, so that eventually much of the injury will disappear or show merely in irregular growth at these points. The chief injury of course was the severe marring of the fruit, also opening the way for various rots, so that it was of little or no value.

Among the shade trees showing evident injury were red and hard maples, ash, sycamore, hickory, wild cherry and elm. The cankers were most evident, of course, on the smaller more tender branches with smooth bark, but could also be seen on limbs several inches in diameter. They were almost always longer lengthwise of the twigs and varied from one-half to one and a half inches long by a quarter to half an inch wide. Specimens collected

late in the fall by Mr. Stoddard showed most of the cankers completely healed over.

Ice Injury results chiefly from the breakage due to the unusual weight of the ice which is often many times that of the weight of the branch which is encompassed especially on the smaller twigs. Mr. Zappe of this Station records a case in the New Haven storm, referred to later, where the ice was 30 times that of the branch. Whether injury also results from the freezing of the sleet on the twigs is doubtful, though injury of this kind, especially to evergreens or tender deciduous trees, might result. Some believe that the ice acts as a lens in strong sunlight and burning of the enclosed tissues results. If any heating or stimulation of the tissues occurs, the injury probably results from the later freezing at night. It is also uncertain whether the cold of the icy coating causes any more harm than the dry cold on the uncoated branches.

The severe ice storm early in February, 1924, caused unusual damage to ornamental trees in the southern part of the state, especially in the vicinity of New Haven. The ice in this case stayed on the limbs for nearly a week. In the early winter of 1921, a severe ice storm occurred in northern Connecticut and Massachusetts, and caused unprecedented injury to shade trees, besides great damage to fruit trees and especially to telephone, telegraph and electric wires. The financial burden to the towns just in clearing up the rubbish from the trees and on the streets was very heavy. Some idea of the damage wrought by this storm is shown by the photograph, in Plate X, a, which was taken near Pomfret, Conn.

Wind Injury is common with most storms, breaking off the dead branches and those weakened from disease first. With very severe storms, large branches of the healthy but unprotected or soft wooded trees are blown down. The worst injury occurs when the heavy wind accompanies an ice storm. The wreckage from the ice storm at New Haven in 1924, while great, was much less than it would have been had a strong wind occurred during the five or six days that the ice was on the trees. (See Plate IX.)

Animal Injury is most common on street trees. The gnawing of the bark by horses hitched near the trees used to be a very common occurrence, and there are still in evidence large canker-like areas on many of our street trees caused by the repeated injuries they have received in the past. Now the automobile seems to have replaced the horse somewhat as a cause of barking trees. Injury by mice, especially at the base when long covered by snow in winter, occurs prominently in some years, but not in well kept yards. In orchards, nurseries or isolated places along the roadside it is not infrequent and may be quite severe.

Of all the animals, man leads in the mechanical injuries he

inflicts on trees. The cutting off of branches to allow passage of telephone and electric wires is a common occurrence, but not nearly so obnoxious as formerly because done in a more scientific manner. Changing the soil level, cutting off interfering roots for laying walks and pavements, and grading and digging for lawns and buildings are other common causes of injury. Improperly moving and transplanting large trees also often results in a sickly growth or their final death.

Bleeding, Sour Sap, Slimy Flux: *Bleeding* usually results from some mechanical injury but under ordinary conditions stops of itself. This was the case with the maples following the recent ice storm in New Haven, as the injury occurred about the time active sap flow was starting. The dripping from the broken twigs occasionally formed icicles during the night, or frequently made a wet spot on the sidewalk that was still evident long after it dried out. Of course some food, as sugar, etc., was lost to the trees in this way, but this injury was negligible.

Bleeding may also start as a result of pruning or cavity work and in the elm, from whatever cause, it is sometimes very difficult to stop. The loss of the water or sap, while undesirable, is not the evident evil here. The food in the sap affords a fine opportunity for the development of bacteria and *Sour Sap* results. This leakage may in time become a soft slime through the presence of both bacteria and yeast fungi. Good examples of this, as *Slimy Flux,* can be seen on the stumps of yellow birch that are cut in late winter or early spring. In any case, this infected sap, covering the healthy bark, is likely in time to kill the cambium and decay of the bark results. Leakage is frequently prevented or stopped by searing over the exposed sap wood with a hot iron. Again the drip is sometimes successfully carried away from the bark by a protruding iron pipe in the filling. There are cases, however, where bleeding and injury result despite all precautions.

Treatments: *Watering.* For all of these injuries spraying, of course, is of no value. With valuable trees where drought is long and severe, watering is helpful. This must be kept up, however, until the danger is past. It should not be of the frequent sprinkling type, as given to lawns, but rather an occasional good soaking in which the water penetrates deep into the soil. This may be aided by drill holes around the trees in which the hose is inserted.

Fertilizing. Where injury is manifest but the tree is still vigorous enough to save, whether the injury is due to drought or winter, fertilization, especially of deciduous trees, may be employed. One must use care, however, that this is given early enough in the season so that the tree may properly mature its wood and buds before winter sets in. Manure can be used with less impunity in this respect than most chemical fertilizers. The

quickest action is obtained with the use of nitrate of soda; this can be placed in drill holes in the ground, about 10 feet apart with large trees, around the spread of the branches and washed in with a hose. From one to 10 pounds, according to the size of the tree, may be used. A complete fertilizer scattered broadcast over the ground is sometimes used to increase the general vigor of the tree. Dr. Jenkins has recommended, in the past, the following: Nitrate of soda, acid phosphate and muriate of potash, each five parts by weight, to be mixed not more than a week before using and to be spread broadcast, one-half pound to each 50 square feet of ground, in two applications one month apart in the spring.

Pruning, etc. With the preceding tree injuries, of course, one of the first treatments consists in removing seriously injured and dead branches, and protecting the cut and exposed surfaces. The trimming should be done with reference to preserving or renewing the symmetry of the tree. Bark loosened but not torn off may sometimes be grown back by nailing to the tree, if done immediately and protected from drying out. If dead it should be cut back to the living tissues to prevent decay and to favor proper callus formation. Sometimes cavity work may be necessary, especially later if wood rot starts.

FUNGOUS DISEASES

While the injuries caused by fungi may be as conspicuous as those caused by insects, nevertheless, the general public is not so often microscopic in size, and usually not readily differentiated well acquainted with their causal agents, since the fungus is from the injury itself. They have, on the other hand, this advantage to the scientist—they do not fly away after causing the injury but stay there permanently, though they are not always easily determined individually because the fruiting stage is often late in maturing. To understand fungi and the injury they cause, it is desirable to know something of their general, as well as their specific, nature. We give this information briefly in the following paragraphs:

Nature. Fungi are the lowest forms of plant life. They differ from all other plants in lacking the green coloring matter, characteristic of leaves known as chlorophyll. Lacking this they cannot manufacture from water, gases and the chemical constituents of the soil, their food. This they must obtain in an organized form from products of living or dead plants or animals. If from the living, they produce disease as a result and are called parasites; if from the dead, they merely produce decay and are called saprophytes. With wood destroying fungi decay of the dead heart wood by a saprophytic fungus may, by weakening the

strength of the trunk or roots, be indirectly responsible for more injury than the parasitic form that directly attacks the living tissues.

Stages. Fungi consist of two stages, a vegetative stage that has to do with gathering their food, and spore stages that perpetuate their existence the same as the seeds do the flowering plants. The vegetative stage is usually inconspicuous and often not visible to the naked eye, as it consists of microscopic branched threads that ramify through the substratum or host, on which it occurs, in search for food. There is comparatively little difference in the appearance of the vegetative stage, or *mycelium*, of different fungi, hence the necessity of seeing the spore stages for identification.

The *spores* are formed on or near the surface of the host and are much more conspicuous and differentiated especially as seen under the compound microscope. Mushrooms and shelf fungi are the largest fruiting forms. Unlike flowering plants, fungi may have more than one kind of spores, but only one corresponds directly to the seed in that it is the result of fertilization of the sexual elements, the other kinds being of an asexual nature such as buds, tubers, runners, etc., in plants. Some spores are temporary and are merely useful in quickly spreading the fungus over the host or to new ones. Other spores are more hardy and serve to carry the fungus over unfavorable periods, such as winter. With the rusts, not infrequently, certain spore stages occur as parasites on one host and others on an entirely different host species, thus greatly complicating the life history of the fungus.

Infection. In any case the spores give rise to new individuals by germinating into threads that by later growth form the mycelium. With parasitic forms this germ tube or thread must penetrate in some manner into the living tissues in order to gain the food necessary for its growth. All preventive treatments of fungous diseases by spraying are based on killing the spores that are carried to the susceptible parts of the plants before they can gain entrance by their germ tubes into the tissues. Once inside, the mycelium is no more injured by the spray than the plant tissues on which it is placed. This makes it necessary to protect the tissues by repeated and thorough spraying as long as there is danger of the fungus gaining entrance. It also means that the fungicide must be able to kill the spores or their germ tubes but cause no injury to the plant tissues.

LEAF AND BARK FUNGI

We may include most of the parasitic fungi of trees with those that cause injury to the leaves or the bark. They are numerous and of great variety. Quite frequently each species is limited to a single kind of tree or its very close relatives. Usually the

earlier spore stages are parasitic while the later ones merely occur as saprophytes on the dead or dying tissues. We can best consider them here, grouped semi-scientifically, under the following headings: Anthracnoses, Leaf Spots, Leaf Curls, Powdery Mildews, Rusts, Blights and Cankers.

Anthracnoses: This is a general term applied to certain genera of fungi that locally kill the tissues of the leaf or the twig and ooze out their spores as inconspicuous, sticky drops on the surface of the host. The more common ones met with so far in this state are as follows:

Ash Anthracnose, *Gloeosporium aridum* Ell. & Holw., in wet years, especially along the coast, has caused considerable injury to the white ash foliage, large areas withering up or turning a light brown color.

Maple Anthracnose, *Gloeosporium saccharini* Ell. & Ev., is most likely to show on the sugar maple, but only occasionally causes conspicuous injury. It is so similar to the leaf scorch of this tree that one usually has to examine the leaves microscopically for the spores before he can be sure of the real cause.

Oak Anthracnose, *Gloeosporium canadense* Ell. & Ev., was unusually conspicuous last spring on white oaks, but, partly because it does not carry over so abundantly on the twigs, the injury is less evident than that of the sycamore. Fewer leaves are killed in the bud, and the injury is more localized as light brown dead areas on the mature leaves.

Sycamore Anthracnose, *Gloeosporium nervisequum* (Fckl.) Sacc., derives its specific name from the fact that it seems to prefer the tissue of the leaf along the main veins. It develops early in the season, often as soon as the buds begin to unfold, with the result that many of the leaves fail to develop. It can do this because its spores develop first on the young branches and are washed into the opening buds. The injury was the most severe in the spring of 1924 that we have ever seen. Some trees had all their very young leaves killed and had to develop a new crop, which, of course, resulted in a scanty foliage all summer. When seen at first it looked as if the trees were dead or doomed to die, but sycamores can stand a lot of such punishment and still survive. However, they usually look in this state as if half winter killed, because of repeated attacks. The European sycamore is much less susceptible to injury than the American.

Other Anthracnoses, of a less conspicuous nature, are those occasionally occurring on hickory, *Gloeosporium Caryae* Ell. & Dearn.; Linden, *Gloeosporium Tiliae* Oud.; Poplar, *Marsonia Castagnei* (Desm. & Mont.) Sacc.; Butternut and Walnut, *Marsonia Juglandis* (Lib.) Sacc. We even found an unusual one, more or less conspicuous the past year, on Beech, *Gloeosporium Fagi* var. *Americana* Ell. & Ev.

Leaf Spots: These are injuries of leaves very similar to the Anthracnoses, usually showing as small, circular or angular, dead spots, varying in color but occasionally occupying areas of considerable extent. They are caused by a great variety of microscopic fungi whose fruiting stages may show as inconspicuous pustules imbedded in the injured or dead tissues or as a moldy growth on the surface.

Ash Leaf Spot or Speck, *Piggotia Fraxini* Berk. & Cke., shows as small purplish specks on the upper surface of the leaves with the fruiting stage of the fungus rather prominently scattered over the lower surface as small black pustules. It is not a very important parasite. There are several other fungi that cause more definite leaf spots of the ash but are infrequently seen here.

Box Elder Leaf Spot, *Phyllosticta minima* (Berk. & Cke.) Ell., appears as grayish or reddish-brown circular spots, a quarter of an inch or so in diameter, with minute, black, fruiting pustules imbedded in the center. This leaf spot is identical with or very closely related to similar spots on leaves of various maples, *P. acericola* Cke. & Ell. On the latter, in some seasons, it is quite prominent and has been complained of as causing marked injury.

Catalpa Leaf Spot, *Macrosporium Catalpae* Ell. & Mart., shows in certain seasons as definite, rounded, reddish-brown spots an inch or less in diameter appearing suddenly on the new leaves, often rather abundantly, so that partial defoliation results. Similar spots are said to be caused by another fungus, *Phyllosticta Catalpae* Ell. & Mart., but while we have found one or the other occasionally present, more frequently a definite fruiting stage is absent and we still are in doubt as to the real cause. The Japanese catalpa apparently is most frequently attacked. Whether spraying will prove of value remains yet to be demonstrated.

Chestnut Leaf Spot, *Septoria ochroleuca* Berk. & Cke., is usually very evident as numerous, grayish, circular spots with a purplish border about a quarter of an inch in diameter. The fruiting bodies are more evident beneath as small, embedded, blackish specks. This trouble, on account of the rarity of its host as a shade or forest tree, is now seen only occasionally on sprout growth.

Elm Leaf Spot, *Dothidella ulmea* (Schw.) Ell. & Ev., known also as *Gnomonia ulmea* (Schw.) Thuem., forms minute black eruptions, somewhat clustered together in small circles or scattered over the whole upper surface of the living leaves. In time there is a whitish or grayish margin around these groups, due to the wearing away of the epidermis. The fungus matures its spore stage on the old leaves on the ground in spring, its fruiting perithecia opening on the lower surface. When severe, more or

less defoliation in midsummer takes place. Occasionally it is quite bad, and it is usually present in a small way every year. Burning the leaves in the fall is desirable.

Hawthorn Leaf Spot, *Entomosporium Thuemenii* (Cke.) Sacc., appears as very small, angular, reddish-brown spots most frequently on the English hawthorn, grown occasionally in yards. It has been sent in for identification a few times as it causes some defoliation where bad.

Horsechestnut Leaf Spot, *Phyllosticta Paviae* Desm., seems to occur largely on the European species commonly grown in this state. Some years, like 1922, it is very injurious and again, like the present dry year, comparatively inconspicuous. It is one of the most injurious of our leaf spot diseases of trees, since the reddish-brown dead areas often cover a considerable part of the leaves. Most of the leaves of the tree are infected and early defoliation occurs. It looks very much like a sun scorch. The tree itself does not seem to be so seriously injured as might be expected, since the next year it usually starts out with a full crop of leaves. Besides spraying with Bordeaux, raking up and burning the leaves is desirable.

Maple Tar or Black Spot, *Rhytisma acerinum* (Pers.) Fr., as its name indicates, shows as a black spot on the upper surface of the leaf much resembling a finger print. The tissues involved are somewhat thickened and slightly raised above and are concave and lighter colored below. Many of these spots are often crowded on the leaf. An inconspicuous summer spore stage is said to develop in these spots but the mature stage does not appear until the following spring, on the dead leaves on the ground. Soft maples, especially the cut-leaf form, are especially subject to attack. The fungus also is common on the red maple. Burning the leaves in the fall, or when they drop prematurely, is recommended.

Leaf Curls: These produce a thickening of the leaf tissue, together with a cupping or other slight distortion, and, occasionally when involving buds or fruits, form a bag-like enlargement. They are found chiefly on fruit and forest trees. The infected tissues are often whitish or flesh colored.

Oak Leaf Curl, *Taphrina caerulescens* (Desm. & Mont.) Tul., is about the only conspicuous form occurring on ornamental trees, where we have noticed it common the past few years. It produces a cupped thickening of the leaf tissues an inch or less across, often several occurring closely placed over the leaf. The upper surface is light colored while the lower reveals a grayish-purple growth of the fruiting stage. The same tree often shows the trouble year after year, indicating that it might be carried over on the young branches though it is said not to be perennial. Here

is another case where burning the fallen leaves might prove helpful. A related species, occasionally found on the elm, is *Taphrina Ulmi* (Fckl.) Joh.

Powdery Mildews: These differ from most of the other disease producing fungi in that almost all of their mycelium, as well as their fruiting stages, is exposed on the surfaces of the tissues, only short sucker-like threads penetrating these to extract the food necessary for growth. They consequently form a whitish cobweb-like growth more or less evident to the naked eye. The small blackened dots embedded in this growth are the mature fruiting bodies, or perithecia. Under the microscope these show numerous appendages radiating out from the central spore case. Quite a few trees, as well as shrubs and herbaceous plants, are attacked by these mildews, chiefly on the leaves, but rarely serious injury results to the ornamental trees. The following may be briefly listed:

Catalpa Powdery Mildew, *Microsphaera elevata* Burr., is considered by some as not distinct from that on oak or chestnut. It shows as a rather inconspicuous whitish growth, most commonly on the upper surface of the leaves.

Chestnut, Oak, Powdery Mildew, *Microsphaera alni* (Wallr.) Wint., attacks a wide variety of trees and shrubs, both cultivated and wild. Usually there is a conspicuous, cobweb-like coating, most frequently on the upper surface of the leaf, and in this are finally seen the numerous, small, black, spore-bearing receptacles.

Maple, etc., Powdery Mildews: *Uncinula circinata* Cke. & Pk., on the hard maples, usually forms a rather inconspicuous mycelial growth in spots on the leaves, with few perithecia; *U. flexuosa* Pk., on horsechestnuts, has a similar but more general growth over the whole leaf surface; while *U. Salicis* (D.C.) Wint., on willows, is apt to be very evident and with a great abundance of perithecia. All these species, as the generic name (*Uncinula*) indicates, have appendages hooked at the end.

Rusts: These are the most interesting and destructive of all fungi because of their several spore stages, some of which occur on entirely different hosts, and because in all stages they are strict parasites. They usually form dusty, erumpent, small pustules, more or less thickly scattered over the infected tissues. The earlier spore stages are generally a yellow or orange color, and the later a red- or black-brown. Seen by the naked eye, they are not apt to be confused with any other fungi, except the smuts which do not occur on trees. Not only do the rusts cause serious injury to trees, but they are among the most destructive parasites of all kinds of plants, particularly the cereals. Because the different stages frequently inhabit different hosts and their relationships were or are not known, scientific names have been given to the

earlier or immature stages that apply only to them, while the name given to the latest, or mature stage, not only applies to it but to all of the stages. For example:

Ash Rust, *Aecidium Fraxini* Schw., is the early stage of a rust that has the repeating and mature stages, known as *Puccinia Fraxinata* (Lk.) Arth., on marsh grass. Therefore the most complaint of injury to ash trees in this state is in the vicinity of the Sound, where marsh grass is common. The rust not only attacks the leaves, petioles and young twigs but also the winged fruits of the ash. It occurs in the cluster cup stage projecting above the tissues as minute, aggregated, toothed receptacles filled with orange colored spores. The infections give rise to some swelling and distortion of the invaded tissues.

Flowering-Crab Rust, *Roestelia pyrata* (Schw.) Thax., is a stage similar to the preceding, on apple leaves, but differs chiefly in having the cluster-cups fringed with hairs rather than toothed. Its mature stage occurs in the jelly-like horns, formed during wet spring weather, on the so-called "cedar apples" of the red cedar. The flowering crab is one of the most susceptible hosts attacked, though the Wealthy variety of apples is about as bad.

Mountain-Ash Rust, *Roestelia cornuta* (Pers.) Fr., is similar to the apple rust. It is rarely found here and has its mature stage on the juniper.

Poplar Rusts: *Melampsora Medusae* Thuem. is not infrequent on the Carolina poplar, showing, in its repeating stage, as minute yellow pustules and, in its mature stage, as reddish blisters, on the under surface of the leaves. Its earlier stage occurs on the larch. A very similar rust, known as *Melampsora Abietis-canadensis* (Farl.) Ludw., occurs on the large tooth aspen and has its earlier stage on the cones and leaves of the hemlock.

Willow Rusts, *Melampsora Bigelowii* Thuem. and *M. americana* Arth., are very similar rusts on the leaves of these hosts, and have their earlier stages on the larch and balsam.

White-Pine Blister Rust, *Peridermium Strobi* Kleb., is the rust that was accidentally imported from Europe some years ago and against which such united effort by government and state officials has been expended to prevent its further spread in this country. The stage on the white pine is the early one, showing as conspicuous white blisters that soon rupture and disclose the orange powdery mass of spores. These carry the fungus to *Ribes* species, currants and gooseberries, and form there the later stages known as *Cronartium ribicola* Fisch. de Wald. On the latter hosts there is formed, first, the repeating stage, showing as small powdery pustules whose spores spread the fungus on these hosts during the summer and, finally, the mature stage, short hair-like spores that carry the rust back to the pine needles in the fall.

The injury to the currants and gooseberries is not serious, though frequently causing defoliation, but to the pine, because of its perennial mycelium, the rust eventually girdles the trunk or branch and causes its death. The disease is controlled on ornamental trees by isolation from *Ribes* and by cutting off infected branches some distance below the infested place. In plantations, eradication of all *Ribes,* within and nearby, is advocated. A similar rust on several two- and three-needle pines, *Peridermium Comptoniae* Arth., in this state, has its mature stage, *Cronartium Comptoniae Arth.,* on sweet fern.

Other Rusts, occurring on ornamental trees here but never causing serious damage, are: *Gymnosporangium Juniperi-virginianae* Schw., on cedars, mature stage of *Roestelia pyrata* (Schw.) Thax., *q. v.; Peridermium acicolum* Underw. & Earle and *Peridermium delicatulum* Arth. & Kern., on pitch pine needles, mature stages on goldenrod and asters known as species of *Coleosporium; Peridermium Peckii* Thuem., on leaves of hemlock, mature stage on huckleberries and blueberries known as *Pucciniastrum Myrtilli* (Schum.) Arth.; *Caeoma Abietis-canadensis* Farl., on leaves and cones of hemlock, mature stage of *Melampsora Abietis-canadensis* (Farl.) Ludw., *q. v.*

Bacterial Blights and Galls: These diseases are not common on ornamental trees, though a number have been found on fruit trees. Their cause, as indicated by the above title, is bacteria, the smallest of living things, which are so destructive to other plant life and are responsible for many of the contagious diseases of animals.

Crown Gall, *Pseudomonas tumefaciens* (S. & T.) Stev., as its name indicates, produces galls on the trunk and roots and occasionally higher up on the limbs of a great variety of trees, as well as of shrubs and herbs. So far we have found it on ornamental trees only on poplar and willow. The obvious treatment is to cut off the infected limb some distance below the gall. When on the main trunk, cutting out the infected tissues is of doubtful value.

Mulberry Blight, *Pseudomonas Mori* (B. & L.) Stev., produces small, watery, reddish-brown areas on the leaves and cankers usually on the younger twigs. It is rarely met with.

Fire Blight, *Bacillus amylovorus* (Burr.) De Toni, while common on such fruit trees as pear, quince and apple, has only been seen once on trees grown for ornament. In this case it was quite prominent on the English Hawthorn. The young twigs are killed back for a foot or more, the blackened leaves still adhering. infection takes place chiefly at blossoming time. The bacteria are carried there accidentally by bees, etc., and multiplying in the nectar of the blossoms, work downward through the tender

tissues of the twigs. More rarely large branches are killed through cankers in the bark. Cutting off the infected twigs, when dormant, some distance below the diseased tissue and wiping the pruning tool each time with a cloth saturated with carbolic acid or corrosive sublimate, to kill adhering germs, has been the common method for control.

Cankers: When a fungus enters a branch or trunk of a tree, it usually becomes perennial there and, gradually killing the bark, makes a cankered spot which, if it encircles the branch, causes death of the parts above. Fortunately, few of the fungi thus invade large limbs or the main trunk.

Chestnut Blight, *Endothia parasitica* (Murr.) Anders., is one of these canker fungi that has proved destructive in this way. Its action has been unique in tree history in this state, as it has practically eradicated not only all forest chestnuts but ornamental ones as well. All that are left are the sprouts that come up from the cut trees and occasional small seedlings, both of which are still subject to attacks. Treatment of any kind, so far, has been unsuccessful with this disease. This and the forestry department, however, expect soon to start small seedling plantations for future observation.

Poplar Cankers, *Dothichiza populea* Sacc. & Bri., is another, apparently European, importation that has recently been producing havoc with our ornamental poplars, especially the Lombardy. Not all the injury, however, is due to this fungus, as insects and winter injury have played their part. The remedy for this trouble seems to be to start with a young tree entirely free from the disease, as we have seen large isolated trees that continue to escape any injury.

Nectria Cankers, *Nectria cinnabarina* (Tul.) Fr., and *N. galligena* Bres., are apt to produce more localized cankers, especially the latter. The former, in our opinion, is not a serious trouble as it seems to follow winter injury only, and is especially prominent on those trees least hardy. The clustered bright-red fruiting pustules are conspicuous on the dead bark. The latter species makes a distinct canker that slowly enlarges year after year, in time showing a series of concentric rings of denuded wood with the canker deepest at the center. It is especially prominent on black birch in the woods but is occasionally found on cultivated trees of this species as well as on apple, maple and oak.

Treatment: Treatment of leaf destroying fungi by spraying depends upon prevention rather than cure. Hence the sprayings must begin before infection and continue while this danger lasts. This usually takes from two to five treatments according to the disease. With the anthracnoses and leaf curls, these treatments usually have to be started quite early, in some cases as soon as the buds begin to swell in the spring; with the leaf spots and mil-

dews, some time in the late spring or summer, before the first signs of injury show. With rusts, spraying is usually of little or no value. In deciding whether spraying is desirable, one must take into consideration how injurious or obnoxious the fungus has proven, especially the preceding year, and how frequently it causes trouble. The 4-4-50 Bordeaux mixture, on the whole, is the best fungicide to use; in some cases where conspicuous sediment is objectionable, commercial lime and sulphur, 1 to 50 gallons of water, can be used. When necessary, an insecticide can be added to either. See the Station's Spray Calendar for further information.

Treatment for the Blights, Cankers, and Blister Rust is chiefly, as already indicated, through pruning off the invaded parts. Occasionally, under certain conditions, spraying is also given.

WOOD DESTROYING FUNGI

Nature: Almost all of the wood destroying fungi, whether on living or dead wood, belong with that class known as shelf fungi and toadstools. These represent the larger and more conspicuous fungi. Some of them are real parasites on the trees, killing the living tissues first and later causing decay of the dead wood; others are saprophytes, occurring only in the heartwood and causing its decay. Many, while not strictly parasites, are semi-parasitic as they cause some injury to the living tissues though usually confined to the dead. Therefore, it is not always easy to distinguish the parasitic from the saprophytic forms. We treat them together here, dealing, however, only with those saprophytic forms, that, in our experience, commonly occur on the dead wood of living ornamental trees. Most of the fungi discussed belong to that group known as Polypores, so-called because their spores are borne in pores that form the lower surface of the conspicuous fruiting bodies. Some have their spores borne on spines, teeth, gills, etc. Many other species are more prominent as agents of decay in dead forest trees than those mentioned here. There are others that are more important as parasites of living trees, but we have not met with them on ornamental trees in this state.

Trunk Forms: *Daedalea quercina* (L) Pers. confines itself largely to oaks and is rarely seen fruiting on living trees though on dead stumps in the forest it is common. It occasionally causes a heart rot of the ornamental oaks even if rarely fruiting on the same. The fruiting body shows as a conspicuous bracket, light brown in color and of a semi-corky texture. The lower fruiting surface has very large irregular or labyrinthiform pores.

Fomes applanatus (Pers.) Wallr., like all the species of the genus *Fomes*, is a perennial fungus developing a new poroid fruiting layer each year over that of the preceding year, so that when

cut through these show as a series of stratified tubes. This species is one of the largest and most common of the shelf fungi. It is not found fruiting on living trees as commonly as on the dead ones. The woody shelf varies in size from a few inches to even a foot or more in width, and projects out from the trunk horizontally almost as far. Its upper surface is a light brown and its fruiting surface is white, minutely poroid and easily etched; the tissues within are chocolate-brown. We have found it occasionally on living maples, poplars, willows, apples and peaches, and believe it to be the common heartwood rot of the maple.

Fomes connatus Fr. is a whitish, semi-fleshy or finally somewhat woody, species less than a foot wide and consists usually of several irregular shelving and overlapping brackets. The fruiting surface develops flesh-colored, small, thin-walled pores having a satiny lustre. We have found it fruiting on hickory and hard maple where it caused heartwood rot.

Fomes igniarius (L.) Gill. is a single, woody, roundish to hoof-shaped bracket four to eight inches wide. It is at first light brown and smooth above but with age dark brown and more or less concentrically zoned and rimmed. Below, the minutely poroid surface is a rusty-brown color. It has been found on oaks and apples, where it seems to injure somewhat the living tissues as well as cause rot of the wood.

Polyporus squamosus (Huds.) Fr. is a semi-fleshy mushroom-like fungus with a side stem. The upper surface is covered with conspicuous patches of rusty scales and the lower is coarsely poroid. It has been found a few times on living maples where heart rot was present.

Polyporus sulphureus (Bull.) Fr. is a striking species with adhering and overlapping brackets of considerable size that are at first fleshy but on drying corky in texture. The upper surface is orange-red while the lower is a sulphur-yellow with moderate sized pores. While commonly a saprophyte on stumps and logs, at times, it is parasitic on living trees especially, as seen here, on oak.

Polystictus conchifer Schw. is a small, papery, conch-like species found on elm limbs where it produces slow rot and causes the branches to break off easily in storms. Some writers consider it semi-parasitic.

Pleurotis sapidus Kalch., *P. ostreatus* Jacq., oyster mushroom, and *P. ulmarius* Bull. are all evident, fleshy, gill fungi of the mushroom type. The two former occur as large, usually clustered or overlapping, brackets with the individual parts narrowed backward to a more or less distinct base down which the gills run for a short distance. The last species consists of a single fruiting body with a much more pronounced stem, arising near the center of the cap, to which the gills are attached by a notch. All are white forms with the tops often more or less brownish, especially

toward the center. They are most frequently found on the elm and hard maple and are associated with a heart rot of the wood. All three species are edible.

Hydnum septentrionale Fr. is a very conspicuous but rather uncommon, semi-fleshy when young but leathery when old, bracketed form with the overlapping irregular shelves joined to the trunk by a united but not distinct base. The tops of the shelves are whitish, often somewhat scabrous and the lower fruiting surfaces are differentiated quite markedly from other fungi by the very crowded, pinkish, fine, fruiting spines about half an inch in length. It has been found here, so far, only on hard maple and hickory and is apparently semi-parasitic.

Root Forms: It is not always easy to determine whether roots have been killed by these larger fungi, since the fruiting bodies are not usually present. Even when either the mycelial threads or the fruiting bodies are seen it is still a possibility that the fungus is a secondary agent following winter or some other injury. The only two species we have found here apparently injuring the roots of ornamental trees are of the toadstool type.

Armillaria mellea (Vahl) Quel. is the most important of the mushrooms attacking the roots of living trees. The umbrella-like cap is usually a honey-yellow with patches of brownish scales; the gills are white and the central stem has a more or less evident ring. They occur in clusters on the ground with the mycelium forming conspicuous, dark colored, rounded strands running over the roots and flattening out under the bark where the woody tissues are invaded. It is more likely to attack coniferous than deciduous trees.

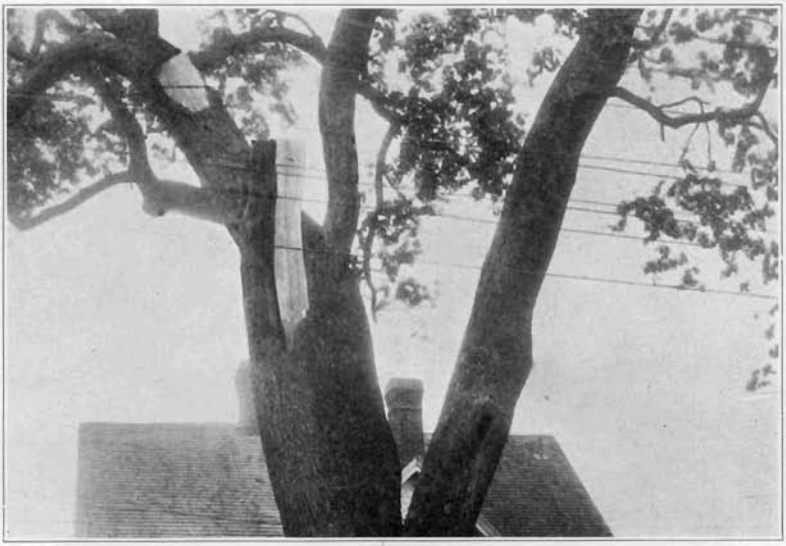
Collybia velutipes Curt. is a yellowish to tawny mushroom, somewhat smaller than the preceding, that is especially distinguished by the velvety brown stems of the clustered fruiting bodies. It is claimed by some to cause injury to the roots of trees though commonly found on dead wood.

Treatment: For further statements concerning the control of wood-destroying fungi, the reader is referred to the articles by Collins and Filley elsewhere in this Report. We shall mention here only the fundamental requirements. The first is the complete removal of all decayed or infected wood and bark to prevent, or at least to arrest, further decay. The exposed wood is usually given an antiseptic and waterproof coating or coatings. The cavity should be properly shaped and the bark so left that rapid callus formation is favored. Whether or not the cavity should be filled is a matter of opinion, but, if filled, there is no question that it should be done properly. This means that the filling should be permanent, semi-flexible, waterproof, non-injurious to the living tissues, especially the cambium layer, tight fitting or better adherent to the wood, and so shaped that the callus readily grows over its exposed surface.

Black oak on Station grounds, broken by ice on February 5, 1924. A tree surgeon is needed in such a case.

PLATE X

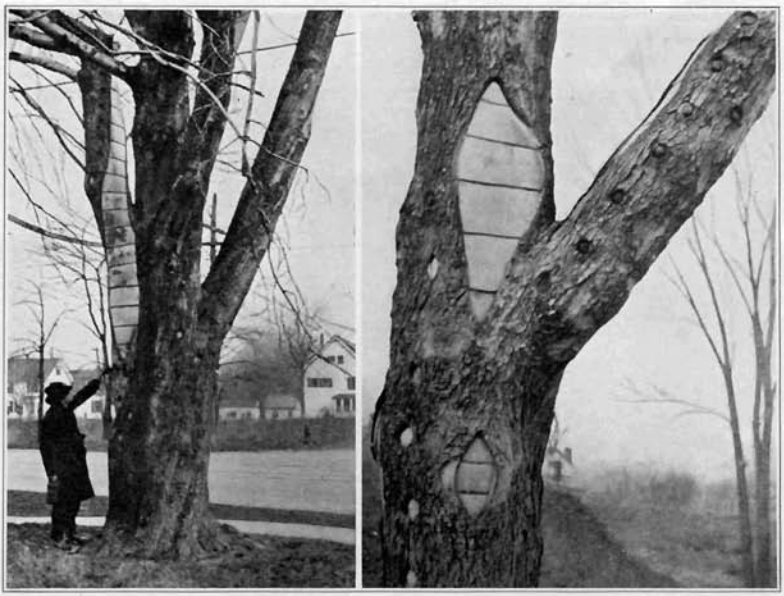
a. View in Pomfret where trees were broken by ice storm of November 27–30, 1921. This scene also justifies the tree surgeon. Photograph December 6, 1921.



b. Elm tree in Mount Carmel, showing bad pruning. Cavities usually follow such careless work. All cuts should be made close to the trunk or branch. Photograph 1909.

a. Young elm tree in Pomfret, where a large branch had been removed the preceding year. This was a good cut, and healing is well started. Photographed in 1909.

b. The same wound four years later. Photographed in 1913.

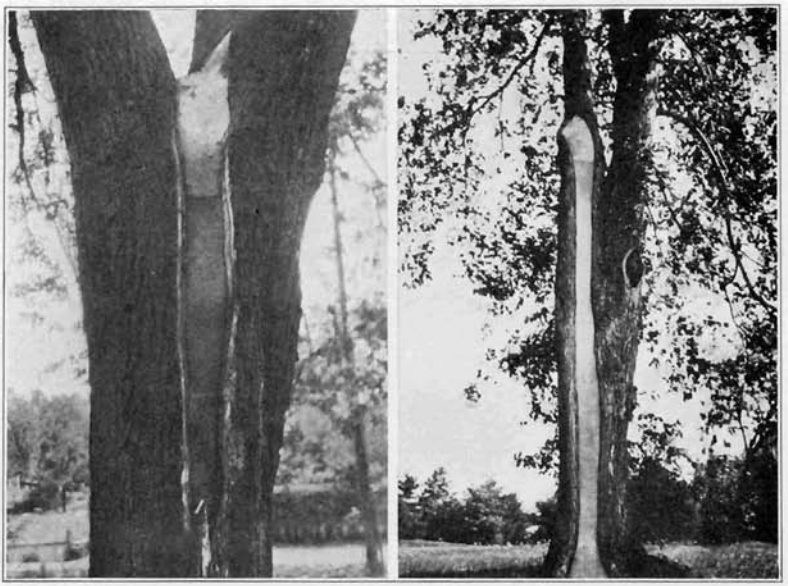


c. Large red maple in Bridgeport injured by fire. Cavities were filled with cement concrete in sections.

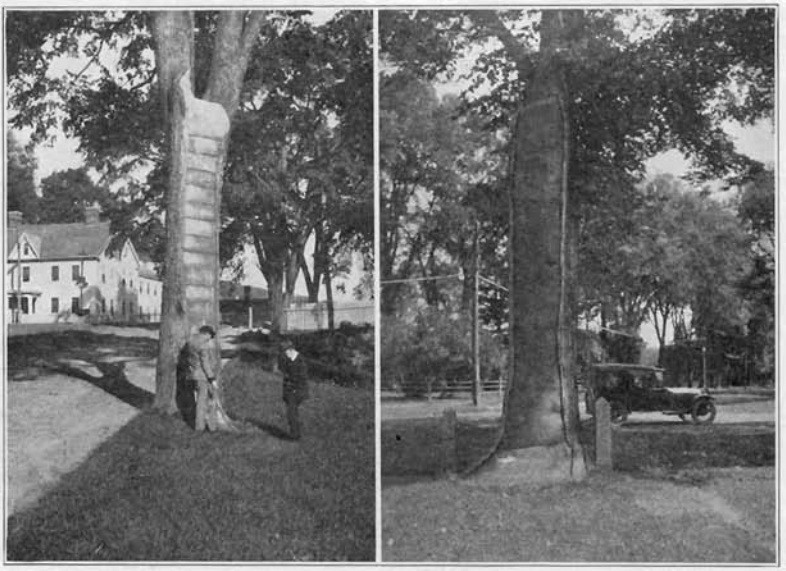
d. Sugar maple near the preceding, Bridgeport.

The work on both trees was overdone. The bolts were so near together that the cambium died between them.

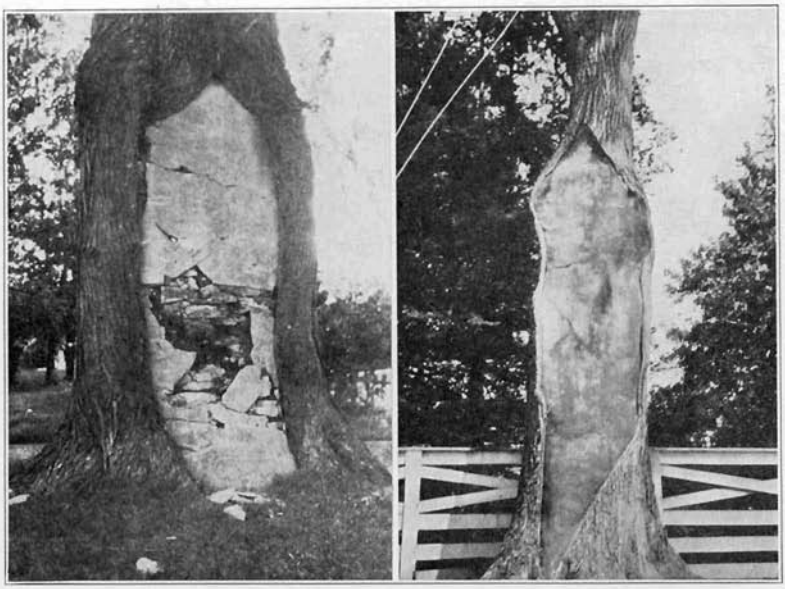
PLATE XII



a. Elm tree, Stamford, filled with "Nu Wud". Cambium dead at bottom of cavity. Filling has since been replaced. Photographed August 26, 1924.
b. Elm tree, Greenwich, filled with "Nu Wud". Photographed August 25, 1924.

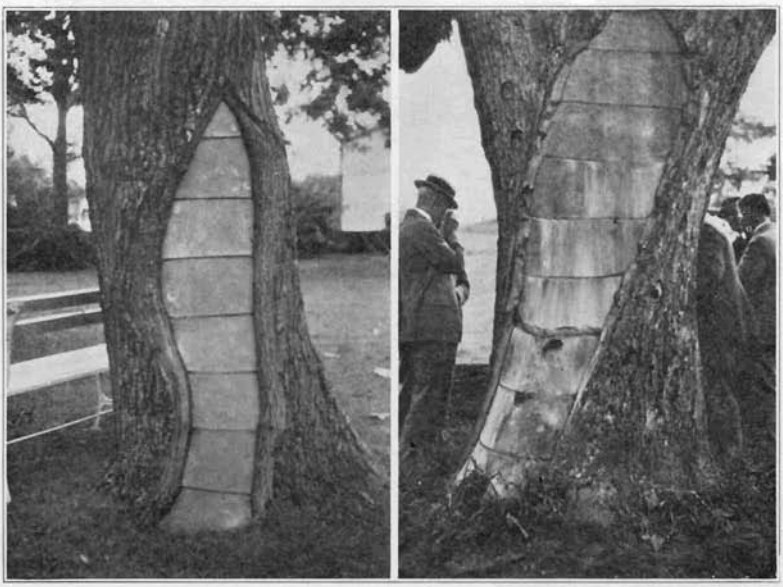


c. Elm tree at Baltic filled with cement concrete in sections. Photographed September 13, 1919.
d. Elm tree at Old Lyme injured by fire and filled with cement concrete not in sections. Photographed September 12, 1919.



a. Large double elm, Westport, where one-half was broken away in a storm. Resulting cavity was filled with stone and brick and covered with a layer of cement, which has now broken apart. A home-made filling. Photographed August 26, 1924.

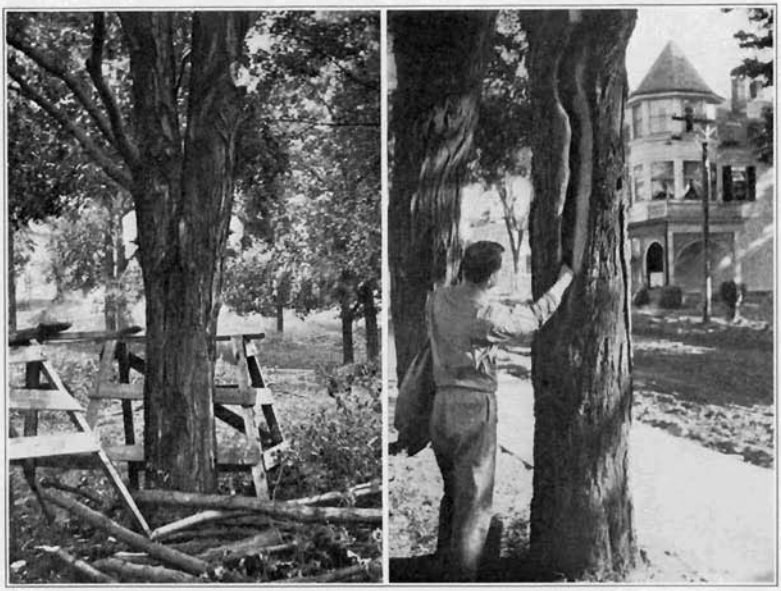
b. Elm in Greenwich where cavity had been filled with monolithic cement concrete. Photographed August 25, 1924.



c. A satisfactory filling of sectional cement concrete in oak, Sound Beach. Photographed August 26, 1924.

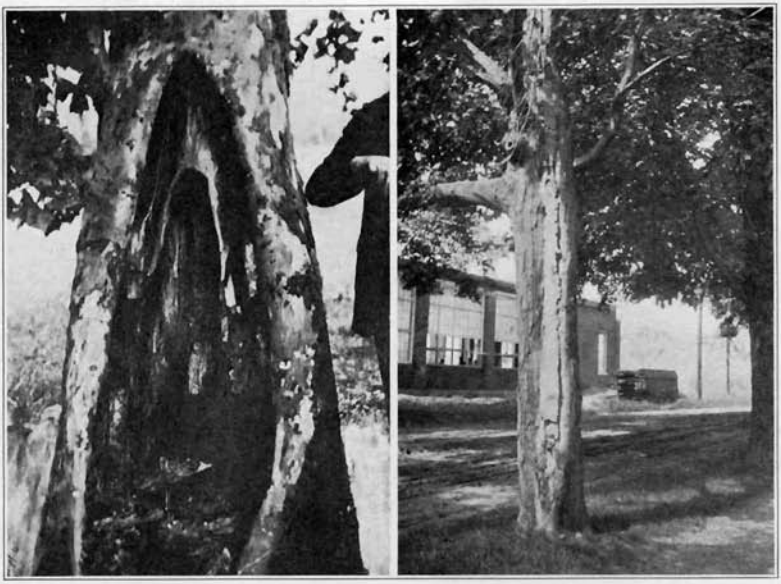
d. Large white oak at Rye, N. Y., filled with sectional cement concrete. This is rather unsatisfactory, as filling is broken somewhat and new tissue has been killed at base. Photographed August 25, 1924.

PLATE XIV



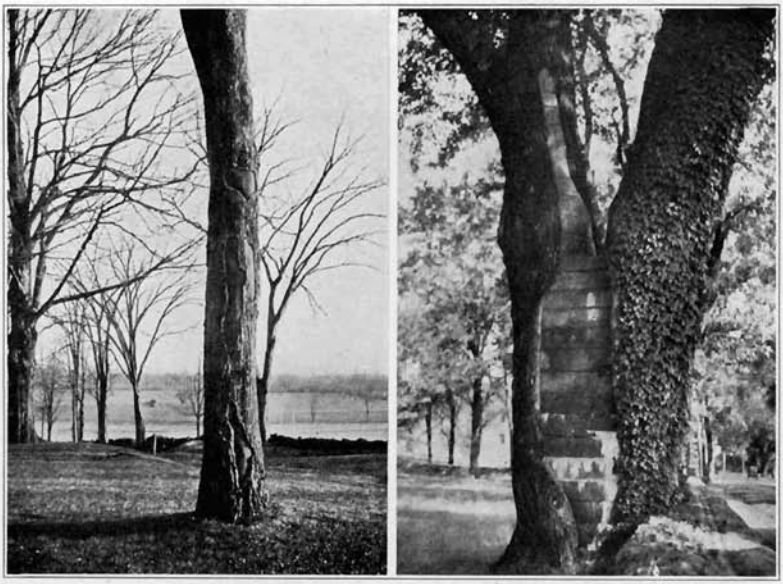
a. This splitting tree, a sugar maple, Cheshire, has just been bolted. Photographed August, 1920.

b. Example of poor cavity work in a sugar maple, Goodyear. The filling has mostly fallen out. Photographed September 13, 1919.



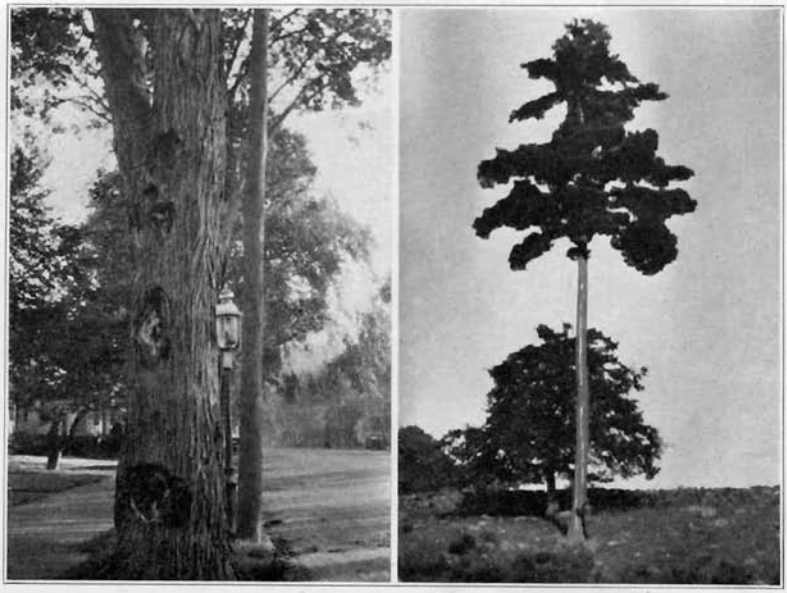
c. Open cavity in large sycamore, Bronx Parkway, N. Y. Unsatisfactory because decay sets in back of the waterproof coating. Photograph August 25, 1924.

d. Unsatisfactory filling of monolithic cement concrete. This filling was put in over the bark and is now being pushed out by new growth. Sugar maple tree in Hamden. Photographed in 1909.



a. Elm in Wallingford where curious shaped cavities (possibly cankers) have been filled. Photographed in 1912.

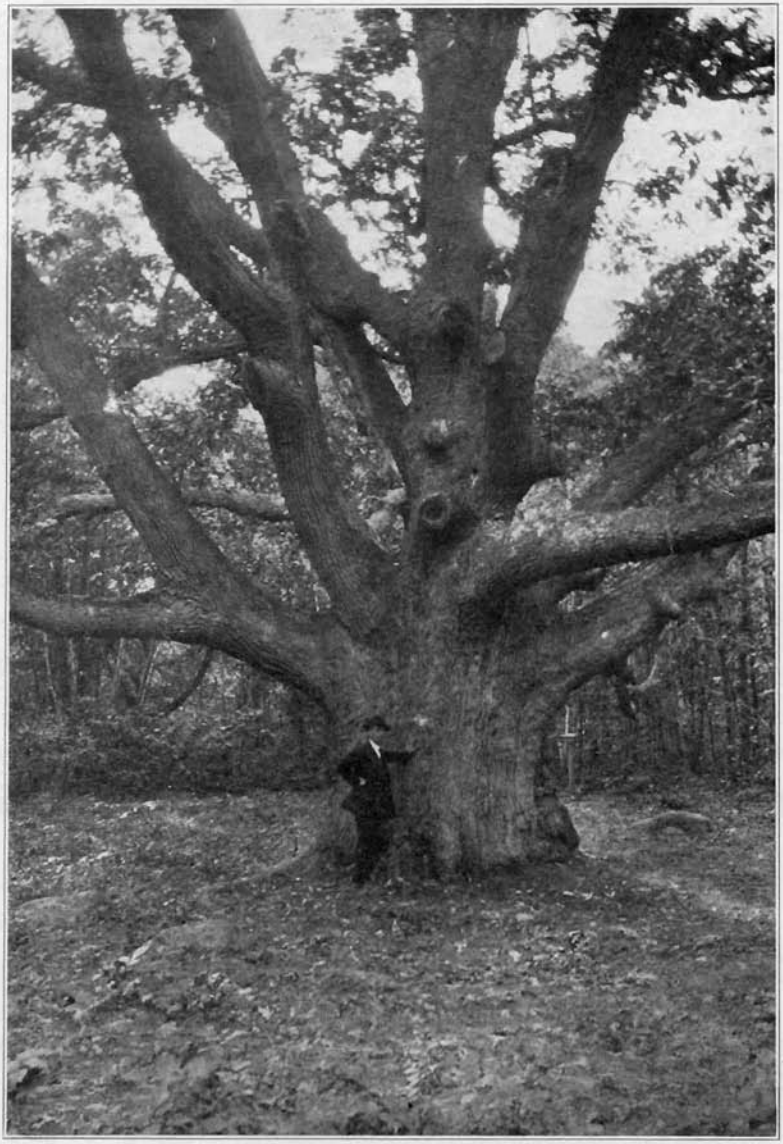
b. Large elm, Stamford, filled with sectional cement concrete. There is a white exudation near the base and the bark has been killed. Photographed August 25, 1924.



c. Elm in New Haven, showing cankers on the trunk. Photograph August 27, 1924.

d. White pine in Cornwall, struck by lightning, showing scar on trunk. Photographed September 13, 1917.

PLATE XVI



Giant white oak on farm of Dr. C. B. Graves, Ledyard. This tree has survived for at least 300 years without the aid of a tree surgeon.