EASTERN SHADE TREE CONFERENCE

1938

EASTERN SHADE TREE CONFERENCE

PROCEEDINGS

NEW YORK BOTANICAL GARDEN

Bronx Park, New York City

December 8 and 9, 1938

WITH THE COMPLIMENTS OF
THE EASTERN SHADE TREE CONFERENCE COMMITTEE

W. O. Filley

W. O. FILLEY, *Forester,* Conn. Agricultural Experiment Station

B. O. Dodge

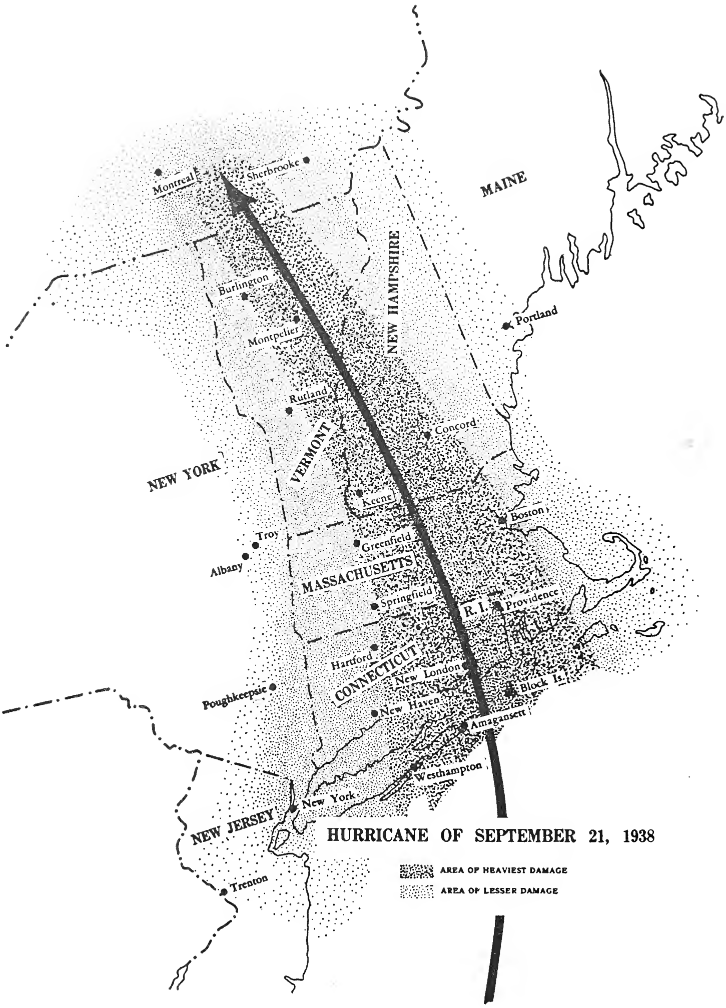
B. O. DODGE, *Pathologist,* New York Botanical Garden

E. P. Felt

E. P. FELT, *Director,* Bartlett Tree Research Laboratories

NEW YORK

1939



The approximate track of the hurricane, reproduced with the permission of the American Telephone and Telegraph Company

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EASTERN SHADE TREE CONFERENCE

Organization and Business

The wide spread destruction and injury in the area swept by the hurricane of September 21, 1938, resulted in an exceedingly serious shade tree condition. First, it was necessary to clear away debris and reopen traffic and communication lines. Then followed the problems of rehabilitation and consideration of possibilities of lessening such damage in the future. It was believed that a discussion of these problems by those confronted with the various aspects of the situation would prove a contribution to tree welfare and an aid in an early restoration of many areas where the storm had taken a heavy toll of shade trees. A general outline of the plan with a covering letter was sent throughout the affected section to parties especially interested in shade trees. The numerous replies were so favorable that it was deemed advisable for a committee to arrange for the Eastern Shade Tree Conference.

Committee

W. O. Filley, Forester, Connecticut Agricultural Experiment Station
Dr. B. O. Dodge, Pathologist, New York Botanical Garden
Dr. E. P. Felt, Director, Bartlett Tree Research Laboratories

The committee was granted the use of the facilities of the New York Botanical Garden and at its request, Doctor W. J. Robbins, Director of the Garden, called the Conference to meet December 8 and 9.

The committee hereby expresses its appreciation to all who cooperated in perfecting the details for the Conference and especially to those who participated in the program and did so much to make it a success.

Business Details

Mr. W. O. Filley, Forester of the Connecticut Agricultural Experiment Station, consented to act as temporary chairman and call the meeting to order. He was duly elected Chairman and presided at all sessions. Doctor Rush P. Marshall, of the U. S. Bureau of Plant Industry and located at New Haven, Conn., was elected Secretary of the Conference.

It was decided to publish the Proceedings in the belief that they would prove to be of material value to individuals and organizations charged with tree welfare. The expenses are to be met by subscriptions of $2 for each copy of the Proceedings and the assistance of a limited number of individuals designated as Patrons who have generously contributed $25 each in order to aid in a fuller and wider dissemination of the information made available by this Conference.

The New York Botanical Garden, Bronx Park (Fordham Branch P. O.), New York, N. Y., has charge of the distribution of the Proceedings. Subscriptions may be forwarded to E. J. Countey, Accountant of the New York Botanical Garden, who has been made custodian of Conference funds.

Greetings from The Southern Shade Tree Conference

The following telegram expressing good wishes was received.

Eastern Shade Tree Conference
New York Botanical Garden
Bronx Park

Greetings and best wishes to Eastern Shade Tree Conference stop You have our full cooperation and we earnestly request your members to attend forthcoming Southern Shade Tree Conference at University of Florida School of Forestry February twenty-third and twenty-fourth stop We have many attractions to offer during this meeting.

H. S. Newins
Chairman Southern Shade Tree Conference Committee

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EASTERN SHADE TREE CONFERENCE

New York Botanical Garden

December 8, 9, 1938

ADDRESS OF WELCOME

By W. J. Robbins

Mr. Chairman, Ladies, and Gentlemen:

It is a great pleasure for me, as director of the New York Botanical Garden, to welcome you to the Eastern Shade Tree Conference and to extend to you the facilities and hospitality of the Garden. I am sure that your conference will result in definite advance in solving the numerous problems associated with shade trees, problems which have been dramatically brought to our attention by the destruction resulting from the recent hurricane. Such an event brings sharply to our mind how important shade trees are in our scheme of living. We are too likely to accept them as parts of our world, parts which just happen, placing them in much the same category as other natural phenomena which come into being without thought or foresight on our part; until we are reminded by such wholesale destruction as the hurricane caused, that trees are living growing things which only time, foresight, and care can give us. Terrible as the loss through the destruction of houses and other buildings may have been, they can be rebuilt in a year or two but to replace many of the magnificent trees now lying in ruin will require a century or more.

I hope that during your conference here you will have time to become acquainted with The New York Botanical Garden, that you will visit our fine library on the third floor of this building, that you will view the newly reconstructed conservatory of which we are very proud, and that you will wander through our hemlock forest which has been described as "the most precious natural possession of New York City". We feel fortunate indeed that the destruction in our Garden was not extensive. Our sympathy with less fortunate neighbors and our desire to help them is no less great because we escaped. If there is any way in which the staff of the Garden may be of assistance to you during your stay here and after, I hope you will not hesitate to call upon us.

THE PURPOSES OF THE CONFERENCE

By W. O. Filley, *Forester, Connecticut Agricultural Experiment Station*

The purpose of this conference is stated on the program as, "a broad discussion of hurricane damage to shade trees, with special reference to rehabilitation and related problems". It seems to me that this states the purpose so clearly and concisely that most of you may be wondering why I should take your time for any further explanation. However, the title, "Eastern Shade Tree Conference" may cause misapprehension which I wish to allay in advance.

The only conceivable reason for calling such a conference at this time is the emergency caused by the hurricane of last September. It was so absolutely outside our experience in this region that most of us are still gasping for breath and wondering how it all happened.

Now that the most completely damaged shade trees have been disposed of, we are confronted with many problems as to future conditions which few of us feel adequate to solve single-handed. Hence, the need for a meeting of this kind.

As many of you doubtless know, I had some part in the development of the National Shade Tree Conference, and you may wonder why that well-known organization was not utilized in this instance. The National Shade Tree Conference, however, functions as an annual event and is slated to hold its next meeting here in New York in August 1939. These emergency problems of ours would not wait until then for discussion, for we must begin to solve many of them before spring.

Furthermore, the hurricane was confined to New England and neighboring states, so that the resulting problems are to that extent localized and restricted in scope. They are of most immediate interest to us here in the northeast who experienced the hurricane and now have to live with the results.

For these reasons, a conference of similarly restricted scope seemed most practicable, and I was glad to serve on the committee of arrangements and now as temporary chairman. The choice of name may have been unfortunate, but, so far as I am concerned, no permanent organization is proposed and this emergency conference will stand on the record made here and now.

(Mr. Filley also showed an excellent series of lantern slides depicting hurricane injury in Connecticut forests.)

Rainbow Forest plantations, Windsor, Conn., hurricane effects on white pine (Photo *W. O. Filley*)

THE STORM IN NEWARK, N. J., OF WEDNESDAY SEPTEMBER 21ST

By Carl Bannwart, *Superintendent, Shade Tree Bureau, Newark, N. J.*

The storm of Wednesday, September 21, was by all odds the worst we have ever experienced in 35 years of continuous street tree administration in Newark. We have been visited by high winds every year, but the number of trees blown over upon 300 miles of streets, 600 miles of frontage and in the city parks, once a year, were rarely more than a dozen or twenty.

Our total loss of street trees within city limits in the hurricane was 977 trees. In the private grounds the total was 918. Very few trees came down in the city parks. One County Park within the City limits, lost 180 trees in an instant. The entire Park became impassable in the twinkling of an eye.

When the hurricane struck us about 2:30 in the afternoon, two telephones in our offices, became constantly busy in taking down addresses of trees fallen across the streets or leaning on wires or buildings. The City Hall telephone switchboard handled the overflow and the Police Headquarters also took addresses of such casualties and relayed them to us in lists. Thus, four telephone lines were busy continuously from the time the storm hit, about 2:30 P.M. until 6:00 P.M. After that, distress messages were received at the homes of Director Byrne and Deputy Director Masini—and also the home phones of the Superintendent and the Forester.

The wind was not solely responsible for the damage. The successive days of heavy rains had loosened the earth. The fact that we had an unusually long growing season, which produced heavy crowns of foliage were also contributing factors. These full crowns made large sail areas affording leverage to the wind, particularly on the high trees. The weakly and scant-foliaged trees stood fast.

Three shade tree gangs, consisting of 23 men, under experienced foremen, sprung into action immediately, working until 3 A.M. Thirty-seven (37) experienced men were added to our force on the 22nd. They worked continuously from daylight until dark during the ten succeeding days, including Sundays.

Our first concern was to clear the right-of-way—open the streets and sidewalks to traffic; enable the people to enter their homes. Trees leaning on buildings were our first consideration. We had only one truck with a winch. Many cases could not be handled by lesser equipment and had to wait their turn on this equipment. The trunks and brush were laid along the roadways and the Street Department gangs and Relief Gangs carted away the trunks, roots and brush. They used chains and heavy trucks and dragged these roots, weighing two and three tons, to a temporary morgue, whence they were later carted away.

Five weeks after the storm we were still clearing away trees in yards leaning on buildings!

In addition to the Shade Tree gangs, numbering 60 men, with four trucks, the Fire Department, two Police Emergency crews, with flood lights and efficient engineering gangs, the Telephone and Telegraph companies and the Public Service with 17 tower trucks, were working continuously for 36 hours. The day after the storm 300 men from the Street Department with 10 trucks were also put on the job of clearing up. In fact, all the emergency crews that could be mustered by city and county, numbering approximately 600 men, were continuously active in clearing the roadways. Another group that sprung into action were the citizens who coped with the problem whether it was a street tree or yard tree problem "on their own". Saws and axes were at a premium—and the humble hatchet was not despised. Imagine clearing three towering poplars from your front yard with one dull hatchet! That same family brought the clothes line into requisition, holding a tug-of-war with the tempest while it was raging, and saved the Norway maple 8″ diameter and a Norway Spruce from going over! The stuff of the pioneers—doing yeomanly under difficult conditions is still with us when the emergency makes demands for these qualities.

The preponderant species which were bowled over in Newark were the poplars and silver maples (*saccharinum*). Being soft-wooded and quick-growing and carrying heavy crowns of foliage, these were the chief sufferers. We did not plant these varieties. Many of them were planted too close together. Thus, the loss of some of these among the street trees was not an unmixed calamity. A small proportion were oaks, Norway Maples and Oriental Planes. The complete tabulation of the figures is under way. We hope to have an accurate summary in due time. The W.P.A. Census Project with an adequate staff, is addressing itself to this task.

The trees toppled over taking the sidewalks with them. On one block of Osborne Terrace, twelve (12) poplars, 18 to 24″ in diameter were laid diametrically across the street. One substantial frame garage was lifted eight (8) feet into the air by the roots of a falling hickory tree. No windows were broken.

This is perhaps the best place to give the figures of some of the contiguous towns. The County Parks suffered a total loss of 262 trees. Branch Brook Park—300 acres—Mr. Witte reports, was hit the hardest —180 trees. East Orange, according to Martin Herman, the Executive, lost 128 street trees. He does not venture to give an estimate of the loss in the private grounds. Maplewood, according to the reports of Richard Walter, the Forester, lost 110 street trees—ten to twenty inches in diameter.

Mr. Clarence Biebel, the Forester of Irvington, gives the following summary: 560 street trees blown down, 182 did damage to porches or buildings; 121 were demolished in the backyards, with 35 casualties to buildings; 178 trees were straightened and several hundred other trees were damaged by the storm, necessitating pruning; 52 trees were blown down in school yards, public and parochial, and 17 in the parks.

The New Jersey Bell Telephone Company reported a total of 23,243 telephone lines affected; 321 cable failures. I quote, "Approximately 900 large trees were blown across wires and cables—there were 4000 other cases where telephone equipment was damaged by small trees and branches. Telephone traffic quadrupled, reaching record breaking proportions on the day of the hurricane. There were over 4,000,000 originating calls. Over 500 temporary operators helped handle the traffic."

In addition to this direct loss of trees uprooted, we have a problem of young trees that were pushed out of plumb. We estimate 5000 trees of our planting—planes, pin oaks, Norway maples from six to twelve inches in diameter will need severe trimming, straightening and staking until they have developed new roots. We have already straightened and severely cut back hundreds of these trees. In connection with this straightening of trees, we head them back severely and brace them with extra sized stakes, etc.

In the budget for 1939 provision is made for an extra Spring planting program. Many of the gaps made by the destruction of the poplars will be filled with a hardier breed, such as oaks, maples and planes. Many citizens in the same breath with which they reported the loss of their trees said: "Please list our frontage for planting in the Spring."

"Hope springs forever in the human breast."

HURRICANE DAMAGE TO PARK AND STREET TREES IN NEW YORK CITY

By Allyn R. Jennings, *General Superintendent, Department of Parks, New York City*

The tropical hurricane of September 21 caused untold damage to park and street trees in New York City. The wind attained a velocity of 80 miles an hour at 3.39 P.M., greatly exceeded, undoubtedly, by gusts of short duration, and accompanied by 3¾ inches of torrential rain on September 21, which, added to the heavy fall of the four previous days, made a total of nearly 9 inches. So the ground was in a receptive condition when the hurricane struck. Over 21,096 park and street trees in New York City were destroyed and damaged, causing a loss of approximately $1,437,600 for replacements, repair and stump removal.

We went into action while the storm was at its height with our entire force, aided by details from the Police, Fire and Sanitation Departments and Borough Presidents' Offices, spurred on by thousands of telephone calls from citizens stating that trees were lying on their houses or were leaning in such a precarious position that they were liable to fall and damage their property. Gangs with special equipment were rushed to the worst places, where, aided by Police and Fire squads working straight through the night, they eliminated the most dangerous conditions where life and limb were concerned. Other squads opened up thoroughfares where trees had fallen, blocking the highways. All the main traffic arteries were opened for travel by noon of the 22nd. Of course, some of the streets in the outlying districts were not opened for several days, and invariably those were the sections where the most damage was done, as the streets were planted with Poplars and Silver Maples which had grown to a vulnerable height for damage by high winds. Of course, the Park Department is not responsible for the planting of either Poplars or Silver Maples, and does not grant permits for planting these varieties as street trees. Any Poplars or Silver Maples now standing on City streets were planted by private real estate developers years ago and when these private streets were turned over to the City, the trees became a part of the care of the Park Department.

With an assignment of 500 WPA men to supplement our regular forces, work has gone on continuously to date on the straightening of any trees, no matter how large, with lists less than 30%, and, as most of you know, the straightening and salvaging of large trees is quite a process. The WPA has also assisted in the digging out and removal of felled trees and it will take several months before this work is finished, as to date, 2,285 stumps have been removed.

In going over the records and analyzing the varieties of trees to which the most damage occurred, I find that out of a total of 2,181,421 trees standing in parks, on parkways and on City streets, our loss was 12,319. Silver Maples and Poplars accounted for the largest majority; there were 3,645 Silver Maples and 2,946 Poplars destroyed. The remainder of the varieties in the larger brackets were as follows: 651 Willows, 605 Lindens, 525 Norway Maples, 400 Cherries, 360 Planes, 169 American Elms, 157 Locusts, 118 Oaks and 30 Ashes. There are at least 30 varieties of trees growing on our streets. If Silver Maples and Poplars, which constitute 53% of the total, were eliminated, the loss would have been only 4,328 trees, and this same ratio applies to trees damaged. These weeds of the tree family sustained the most damage, such as broken tops and large branches, and trees partially uprooted and with a bad list. This clearly demonstrates that they are not good park or street trees and their use should be discouraged as much as possible. They raise the cost of maintenance wherever planted, as well as causing trouble to the property owner by raising and breaking sidewalks and stopping sewer pipes.

The Park Department has and is still making an intensive study of the better trees for park and street tree usage, assisted by the staff of the Botanical Garden, whom I take this opportunity of publicly thanking for their generous help and advice. With this assistance added to our own experience, we have reduced the roster of suitable street trees to Pin and Red Oak, Linden, Norway Maple, Honey Locust, Oriental Plane, American Elm, Tulip and Ginkgo.

We make every effort to foster street tree planting by not only giving advice on the variety of trees to plant, but also in interesting and helping various property owners and large real estate holdings with their street tree problems. This activity has met with gratifying success throughout the City and I have no doubt but that the hurricane has brought before realty owners the fallacy of planting any but sturdy growing trees in front of their property.

I am thoroughly convinced in my experiences in the City and my observations in the Long Island area that was hit hardest by the storm, that no tree would stand up under the blow that occurred. Oaks, Ashes, Pines, Maples and Lindens all went down or were broken in half when the hurricane struck them. We salvaged every tree possible and, of course, we will not get a 100% salvage on all trees, but as most of the trees were of the better type, it was deemed advisable to try every available means to save them, especially in the park areas. The Commissioner of Parks has made a request to the Board of Estimate for $275,000 to replace trees destroyed and for tree surgery for the damaged trees, caused by the storm. We realize that if work on the damaged trees is not pushed ahead, these trees with open wounds, broken branches and scarred tissue will be in a receptive state for insect and fungous attacks.

I would like to place before this meeting the colossal responsibility the Park Department has in the planting and maintenance of park and street trees. With a force of only 247 men in the Forestry Division, a total of 2,181,421 trees are cared for; 1,200,671 of these trees are in the parks which comprise 18,830 acres and 980,750 street trees scattered over 5,521 miles of streets. To this total we added 67,773 trees this year which, based on average mortality of 50 years, means over 50% more than is needed for normal replacements. This means spraying, removal of dead and dangerous trees, pruning, planting, tree surgery and other activities in connection with the care of trees. Of course, we cannot begin to solve a problem which calls, for instance, for 150,000 individual pruning jobs each year, with such inadequate forces, but by systematic geographical scheduling of our work, by doing entire blocks or sections in one operation rather than a hit-or-miss schedule, we have been able to raise the efficiency of the tree divisions. We hope in time to impress on the City's budget authorities the need for a more adequate appropriation for Forestry.

SHADE TREES AND THE FUTURE IN NEW HAVEN, CONN.

By Frederick Selden Eaton, *City Forester, New Haven*

Mr. Chairman, and Members of the Eastern Shade Tree Conference:

When I received your invitation to address this gathering, and found enclosed a copy of the tentative program, suggesting as my subject: "New Haven's Shade Trees and the Future," I felt quite relieved. Because, not so long ago, I was asked to talk to a group of Girl Scout Leaders. I had just been speaking to another group about trees (a talk on both dendrology and the hurricane). At the close of the meeting a young lady asked me if I wouldn't come and talk to her group. Well, I got there at the appointed hour and was amazed at the introduction:

"We will now listen to Mr. Eaton who will talk to us on Mineral Collecting in Connecticut"!

As some of you know, New Haven has the oldest city Bureau exclusively devoted to Shade Tree care. Mr. George Cromie, in 1909 and 1910 drew up a plan for the systematic care and replacement of street trees, and served as Superintendent of the then formed Tree Bureau until 1930. So we are not faced with any tremendous theoretical problems in replacement of our trees or in caring for the injured ones. Out of 31,000 street trees (about 20,000 of these being 8″ or larger in diameter) we lost over 4000 trees. (We lost about 11,000 park trees as well). We fear that mid-summer 1939 will reveal a situation necessitating the removal of many more street trees whose appearance of soundness today may later prove erroneous.

Before darkness had set in the night of the storm, we had organized the city into 13 sections, with one of our 13 regular, old-time employees as foreman of each area, and were hiring extra men as fast as we could find them. A day and a half after this (when we already had thirty extra climbers working) we asked the Board of Finance for an appropriation and authorization to employ this extra help! Within twenty-four hours of the onset of the storm every street in the city was open at least to one-way traffic, and before 72 hours had passed there was no traffic obstruction remaining except in a few places where material had not yet been removed from the gutters. We since have removed over 2000 dangerously leaning, loose, or wrecked trees, and are still doing this in 3 of the 13 original areas. In the remaining 10 areas we are systematically trimming the standing but storm-damaged trees.

On some streets every single large tree suffered damage, necessitating systematic trimming of these trees. As an example, on two miles of Whitney Avenue we had to trim 280 very large elms, each of which suffered storm injury.

By October 8 I had completed a survey covering 442 miles of tree planting (221 miles of street) and at that time we noted 1440 downed trees or stumps; 360 completely removed; 790 to be removed; 167 to try to straighten; and 2000 needing immediate trimming (all these last presenting a dangerous condition to traffic). That was a hasty survey, made from an auto in about 110 hours.

Now, two months later, we find we have already had to remove 1600 more trees. We have trimmed 5500, straightened 560, and are still in the thick of it. Our emergency appropriation will last until the end of the year. By that time we think everything hazardous to the public will be taken care of. There will remain hundreds, no, thousands of trees still needing attention for their own health.

Our elms *must* be pruned of broken and weakened branches as an item of Dutch Elm Disease Sanitation; this work must be completed by spring. We have Dutch Elm Disease very near New Haven now.

We have a serious cause for worry in the loosened tree. Due to the location of New Haven with respect to the center of the hurricane (we had a 45 minute calm with 28.19 barometer) our trees were struck by gales 14 points apart (almost opposite in direction). These shocked and stricken trees constitute, perhaps, our only unknown factor in rehabilitation.

I mentioned the barometer. That reminds me of a story, one that seemed to me one of the best hurricane yarns I have heard. Down on the shore east of New Haven there lived an old retired sea captain. He was very old, feeble, and deaf and spent his days sitting in an easy chair and dozing. Frequently he would, however, tap his barometer—it seemed to be about his only interest in life. He had quite a reputation as a weather prophet, and when going by we'd frequently step in and ask "Cap" what the glass said, and what the weather'd be tomorrow. Well, the afternoon of the hurricane things got pretty bad down by the shore. A huge elm came crashing down on the street out in front, and pretty soon the big maple in back came down on the wood shed, but old Cap Brown dozed on. Finally the tidal wave came in and salt water was lapping around the stoop. The folks began to think about evacuating grandpa, but his daughter looked in the front room and he was peaceful and ignorant of all trouble about him.

In a minute though, the folks looking out the kitchen door were startled by grandpa's banging his cane on the floor (as he did to call people) and his shouting for his daughter. "Mary, Mary, come here quick!" His daughter ran in and found the old man screwed around in his chair and pointing a shaking finger at his barometer. "See here, if that damned thing there were working right we'd be right in the center of a hurricane"!

As to the future, especially regarding replacements: for the last five depression years we have been unable to purchase any saplings for street planting. We have depended on the yield of our shade tree nursery. We have had an ample income of young trees for replacements, and for planting the newly opened streets that were waiting each spring. Now we shall require about 4000 trees, where normally we expected to take about 2000. We *have* 4000 sizeable saplings but not in all the species needed, being short on many ordinarily less used items as pin, red and scarlet oak, linden, tulip, hackberry, etc. (We like the red oak and hackberry for our streets near the seashore).

It would have worked out better for us if this hurricane had blown in five or six years hence, for by that time we would have had available an enormous wealth of new material, now only in large seedling, whip, or small sapling stage. We are now growing a variety of linden that won't shed leaves in a hot mid-summer, nor become unsightly from red spider; we are propagating more hardy planes that we hope won't frost crack or winter-kill as have many of those *purchased as* London planes 5 to 10 years ago. We have a far better Asiatic elm than that commonly sold as *U. pumila*. Our variety has dense, deep green foliage of tough almost coriaceous leaves (that don't get buggy with aphid and aren't so attractive to elm leaf beetle), a well-shaped crown, leafs out early and is evergreen to Thanksgiving time or later—much better than the "Siberian Elm" variety so unfortunately introduced via Ft. Worth and Toppenish and now widespread over the United States. We have high hopes for one of the Chinese hackberries, of several lesser known oaks, for our grafted (fruitless, double flowering) horse chestnuts, a new phellodendron, etc.

For two years past we have been making our own soil for transplanting street trees, from pond-bottom material, New Haven being "all sand and gravel". We can't get loam or top-soil any more, so we have skimmed off old ponds or swamps, and we mix the fine material so obtained with the poor soil of the street locality.

We have been collecting leaves for many years, both from the cleaner streets after autumn rains, and from old dumping places and gullies. This material is now a high grade mulch and is available for use where needed.

So, you see, our problems are practical—involving costs and the question: "How *much* can we do this spring?"—rather than theoretical or in asking "What should we do?". We have had our systematic planting plan for thirty years, constantly improving it with added knowledge and changing conditions; we have grown or are growing the trees needed; we have the soil and the mulch; all we need is the time, or a little money to do the same job quicker. We will *not* compromise by planting unsuited species of trees, or too small individuals; nor do we care to discredit what we have considered a carefully planned replacement program and scheme, by changing to another variety of tree just because the latter may be more readily available today than the really desired one.

THE HURRICANE IN RHODE ISLAND AND ITS LESSONS FOR A FUTURE SHADE TREE POLICY

By A. E. Stene, *R. I. State Dept. of Agriculture and Conservation*

The type of storm, known as a hurricane, of which we had a terrific and unexpected manifestation in the New England States on September 21 of this year, has been frequently mentioned "as Nature's most violent and destructive disturbance." In view of the extensive areas involved and especially of its capacity to build up colossal and devastating wave action along seashores, it is easy to subscribe to its superior total destructiveness as compared with other storms. It is rather difficult, however, for anyone who has seen the results of a tornado in the central west to accept the statement that the hurricane is the most violent disturbance. There were a great many people who from necessity or even from curiosity were abroad, on foot or in automobiles, during the recent storm and who were none the worse from the effects of the wind alone. It is not easy, on the other hand, to conceive of anyone becoming curious enough to move into the path of a real tornado to see what it is like or to remain in its path if it is possible to side step it. Furthermore, when we speak of Nature's disturbances in general, we should include also earthquakes, and again, a real superior manifestation of Nature's power is not an event likely to invite the merely curious to test its possibilities.

Rhode Island probably suffered more from the hurricane than any other state when we consider the terrible losses of life and property which resulted from the huge ocean waves piled up by the wind. In its effect on shade and other trees now under discussion there is probably little difference in results as between the states in the path of the storm, except as the salt laden air added to the damage near the seashores.

The velocity and force of the wind in Rhode Island was probably not much different from other sections affected. It is unfortunate that the only wind gauge in operation in the state blew down early in the period of the storm and we have no accurate records above the 95 mile an hour mark, or means of knowing the maximum velocity attained. That it was variable and very much stronger at different periods can be attested by anyone who tried to walk or to drive an auto against the wind. The writer in driving from Providence to Kingston during the height of the storm and facing it part of the time found it difficult to keep the car going straight and stay on his side of the road even where there were

Main Street, Kingston, R. I., the morning after the hurricane, (Photo *A. E. Stene*)

four lanes. At times, however, it was a question whether the engine would continue to drive the auto forward or the wind would drive it backward. The wind must also have varied considerably in different sections, otherwise it is hard to explain the wholesale destruction of rugged trees in some places and the escape of much weaker trees in other areas.

Since the storm, many Rhode Islanders have been asking themselves and others what lessons the results of the storm may have for those who are to set out new trees or replace old ones. Some are inclined to feel that no matter what trees we plant they cannot be depended on to stand up successfully in all cases against such storms as that of September 21. Furthermore, they say "Why worry, the next preceding storm occurred 123 years ago in 1815 and the only other storm in our history which made any lasting impressions occurred 180 years before that. If we are to have these storms in the future a century or two apart, what is the necessity of trying to plant particular kinds of trees resistant to similar storms?" "This is especially pertinent since any variety we plant may become undesirable at any time because of attacks by epidemic plant diseases or by injurious insects of newly introduced species, or of old species with newly acquired appetites for the trees we set out."

This argument is not well founded. The last storm and the one of 1815 were outstanding because of a combination of tidal wave and wind destruction. Storm damage to trees has been more frequent. The writer a short time ago helped make a survey of the recent storm damage in Rhode Island and during an interview with an aged farmer's wife, she stated that she well remembered the last great hurricane which caused similar damage. She was not, however, referring to the storm of 1815, which most people think of as the only great storm of earlier history, but to one which occurred in 1868. Most of us can recall wind damage to trees more recently than that and of considerable frequency.

The recent hurricane has tested trees for storm resistance and also for resistance to killing of foliage by salt as they have rarely been tested before and it would seem highly desirable to take stock of results as proposed for this conference and to make use of this information in future planting. There is especially need at all times for information, such as we may now compile, among those desiring to set out trees in seashore plantations and for this alone, if for no other purpose, the compilation of observations is worth while.

Damage to trees resulted from several factors connected with the storm. First and foremost was blowing down or otherwise wrecking the woody structures of trees due to the force of the wind; 2nd, blowing off or lacerating and shredding of the leaves due to the same cause; 3rd, killing of the leaves by salt laden moisture churned up from the ocean and carried inland for many miles, and 4th, the dessicating of leaves by the strong wind. There has been considerable discussion among observers in Rhode Island over the relative effect of the last two factors. Some maintain that there was not sufficient salt in the air to kill leaves and that the widespread browning was due almost entirely to the drying effect of the wind. This conclusion, however, is hardly tenable since the browning as manifested on white pine for instance was worse near the shore where there was plenty of moisture in the air, even when not raining and hardly perceptible, in New Hampshire, where the force of the wind appeared to be equally violent. To anyone who had occasion to drive an auto facing the storm during its greatest intensity and found windshield wipers incapable of removing the crust of crystalized salt and shredded leaves which formed on the windshield, there was little question regarding the presence of a deleterious quantity of salt in the air as well as of the mechanical damage to leaves by the force of the wind. After the storm also the ground, buildings and other objects were more or less covered with whole leaves and pieces of leaves, and crystals of salt were perceptible everywhere for many days. Fruit such as grapes, apples or pears on trees and vines or on the ground were so salty that they were decidedly unpalatable until thoroughly washed.

So far as our Rhode Island observations indicate, it will be somewhat difficult to evaluate the potential resistance to wind damage among different varieties of trees, due to the variations in amount and kinds of damage to individual trees of the same variety and in different places. In some cases magnificent sturdy looking trees with tremendously large and heavy balls of earth attached were uprooted while a short distance away, perhaps, the only trees of the same or other varieties blown over would be those with shallow roots and light balls of earth.

Again trees of the same variety standing side by side differed greatly in resistance. Near the writer's home is a north and south road with elms on both sides. Some of the trees on the east side of the road have had branches broken in the past by the combined effects of ice and wind and were relatively low crowned. Trees immediately opposite on the west side were splendid high crowned symmetrical specimens that had never been injured except by workers who about two years ago laid a sidewalk against the base of the trunks and cut some of the heavier roots serving in part as anchors on the east side of the trees. Two out of three trees on the east side went over from east to west with trunks broken although they were entirely sound, while only small branches were blown off on trees directly across the road. It is true that the trees on the west side would have given an impression of greater ruggedness even before the storm and the fact that they stood up in spite of their high, wind-intercepting tops and the loss of some of the roots on the side where they needed them most, speaks well for the real strength of these specimens. One may well ask on the basis of this record for elms and of similar records for other trees, if it would not be well to propagate from such trees for future planting by grafting or cuttings in order to perpetuate in some degree the individual high qualities which they appear to possess.

Another example of unexpected resistance to wind damage is that of a spruce tree on the main street of the same village. Originally there were two such trees growing about 20 feet apart in front of a house. One went down and fell across the street in a storm a few years ago. Most of the other spruces in the village suffered broken trunks from the hurricane and a few uprooted completely. The first mentioned spruce however is still standing with trunk intact and no evidence of damage except a slight thinning of smaller branches, while on either side sturdy elms were uprooted.

Many more examples could be cited of variation in resistance of individual trees to wind force or perhaps of vagaries of the wind itself, but the cases mentioned must suffice. Of greater importance under our present methods of propagation by seed and our more or less careless planting is the relative resistance of different kinds of trees to storm and salt damage.

In spite of a great many more or less unexplainable discrepancies in the effects of the storm on trees of the same variety, it may nevertheless be possible by observing a large number of trees, not weakened by borers or by decay in trunk or branches, to single out varieties that have stood up rather better than others and, other things being equal, it should be worth while to favor their planting in the future.

Owing to the inevitable indefiniteness of each person's observations, it is probable that no two observers will agree entirely in their conclusions, but if a large number of such observations are recorded by many persons, it should tend to establish a concensus of opinion at least regarding some of the varieties commonly grown.

To begin with, evergreens seemed to be especially vulnerable because of the dense heavy foliaged tops. Norway spruce which has been quite generally planted in Rhode Island suffered heavily. In a majority of cases perhaps the roots held but the trunks snapped off at varying heights from the ground. Pines, including white, Austrian, Scotch and pitch, on the other hand, were more likely to be uprooted, except possibly in cases of single trees growing on fully exposed sites where constant exposure to the wind has developed high resistance. Fir and hemlock suffered about the same as the pines. Arbor vitae stood up well and red cedar was among the most resistant to over throw by the wind. All evergreens if they resisted uprooting or breaking of trunks, suffered less branch and direct foliage injury due to the force of the wind than broad leafed trees.

Broad leafed trees suffered from uprooting, breaking of trunk and heavy branches, or of smaller branches, and shredding and blowing off of leaves. Since the storm came late in the season, the loss of leaves is not an important injury and needs no further comment. With the possible exception of the American plane tree and ginkgo, no species escaped damage under one or more of the above headings. Beeches with sound trunks and branches, both European and American varieties, were quite resistant. The oaks, especially the white in spite of their reputed strength and ruggedness, suffered considerably and were uprooted or lost branches of varying size. Among maples, the soft maple seemed to be the least resistant to both uprooting and breaking of trunk and heavy branches. The hard maple was similar with a majority of trees uprooting rather than breaking. Red maples uprooted badly and of course this was more prevalent in wet ground. The Norway maple was by all odds the best among the maples in resistance to wind damage and stands high among all trees commonly planted for shade trees. The tulip and the American linden also established good records. In ash, uprooting was more common than breaking of the trunk. Hickory was similar but appeared to stand its ground somewhat better than the ash. The American elm, because of its wide spreading top, intercepted a large volume of wind and many were uprooted. A considerable number lost large branches but only rarely did a sound tree suffer from breaking of the main trunk. A considerable number of elms are still standing, wholly uninjured in every way, in places where nearby elms or other shade trees went down before the storm. The black locust uprooted easily and in some cases where borers had been at work, the trunk snapped off. Poplars and willows suffered heavily and emphasized more fully than ever that these trees are of little value as shade trees. Birches, especially the gray, uprooted readily but were relatively free from breaking of either trunk or branches.

Resistance to damage of salt to foliage is somewhat less difficult to evaluate. It was easy, for instance, to note that white pine and pitch pine suffered severely from leaf killing by salt. On the other hand, the Scotch and especially the Austrian pines were much more resistant to injury. The Norway spruce may be classified with the Scotch pine and the white spruce was outstanding in resistance. A Rhode Island nurseryman called the writer's attention to a clump of white spruce set by him on a hill at Newport, 15 or 20 years ago, less than three-quarters of a mile from the shore and fully exposed to the ocean winds. The trees leaned a little from the effect of the terriffic wind, but so far as could be seen at a distance of about 300 yards, there was no browning of the foliage. Blue spruce was also fairly resistant, umbrella pines were uprooted in many cases but showed little browning. Douglas fir and Swiss stone pine were poor and *Taxus cuspidata* and Irish juniper were fairly high in resistance. Japanese red pine, Mugho pine, arbor vitae and red cedar, and rhododendrons and azaleas were quite resistant.

The more common broad leafed trees also varied in resistance. Elm, linden and ash suffered greatly, beech and oak were more resistant, and the maples were damaged the least. As a general rule, no broad leafed tree escaped considerable injury, but since the damage came late in the season, there will probably be little set back of the trees from this cause another year.

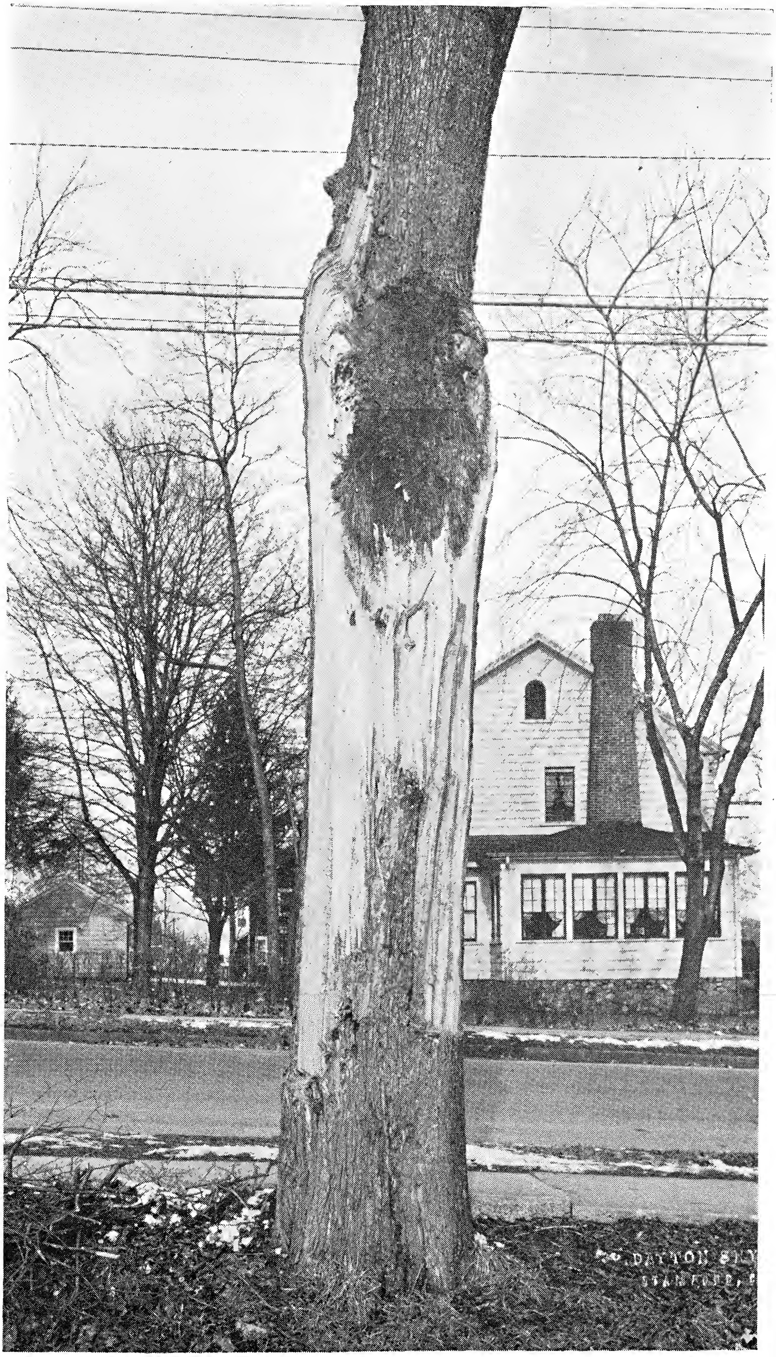
There are some phases of the tree rehabilitation work following the storm that will materially affect future shade trees policies of the state. The first work on trees following the storm was a rapid clearing of roads and release of light and telephone wires. Following this came pruning of broken limbs on roadside trees, cutting up and carting away of wood, and lastly, the removal of stumps. The wood has been piled largely as cordwood and the stumps in many cases have been unloaded in depressions, where fills are needed, or, in some cases, in piles for burning. Most of the clearing work was done with efficiency and dispatch by regular road employees and WPA laborers. There is, however, much pruning yet to be done and quite a little that needs to be done over to remove short or broken stubs and also some care of wounds made by tearing away of the bark. Finally, there is much need of thoroughly treating all wounds with suitable wound dressings.

On private lands, especially in woodlands, many trees are uprooted or badly broken and little work has been done to remove dead or badly damaged timber.

As Felt, Bromley and others have already pointed out, this vast amount of dead or partially dead timber and that piled as cordwood or as dead stumps, will, unless disposed of at the right time, offer places for prolific breeding of various kinds of bark and wood borers such as the beetles that carry the Dutch elm disease. This will, no doubt, in Rhode Island as elsewhere, greatly increase the problem of preventing the introduction of the Dutch elm disease and, in lesser degree, of controlling of other insect borne diseases. Our State and Federal governments are likely to feel increasing pressure in the future for greater economy in government expenditures and new activities, such as removing insect-pest-breeding trees are liable to suffer from lack of funds. Those interested in trees, however, must call the matter to the attention of the proper authorities and urge joint public and private effort to reduce damage likely to result, for we will surely pay heavily later for any neglect which may be countenanced in the present crisis.

Summing up the situation for Rhode Island, it seems to the writer that the hurricane has emphasized several lessons of value for the future in connection with shade tree programs and policies. First of all, it has tested the ability of many different kinds of trees to stand up under severe storm conditions and when exposed to salt laden winds along ocean shores. It has indicated considerable variations in wind resistance among individual trees of the same variety and points out the necessity for future study of this variation and the possibility of breeding by selection, and, perhaps by hybridization, of trees that possess in a superior degree qualities that are desirable in connection with different uses of trees and the sites they are to occupy and of propagating our shade trees, like our fruit trees, more largely by asexual methods.

It has been evident also that many trees went down because they were planted over ledges or hard pans or that their roots were not extended in all directions or had been partly cut by excavations. It indicates the need for greater care in planting, blasting if necessary to loosen the soil and encourage the growth of a symmetrical root system, and also of alloting the tree the space needed for natural development. Much of the early planting, whether by individual property owners or by public agencies, was done without adequate planning for future growth so that now mature trees often have little room in which to



Structurally weak elm with large limb torn off. Wood screws or cables might have prevented this

grow and frequently encroach on sidewalks or roadways. Quite often too, they are surrounded by bitulithic and concrete sidewalks and roadways impervious to water and an absolute barrier to the application of plant food. Since the storm removed many of the old trees, it is now a good time to plan carefully for a more systematic and appropriate planting in the future.

As anyone would expect, many trees broke down because of decay in trunks or branches which in most cases can be traced to improper pruning, or to insufficient care of wounds made by pruners or to storm or other neglected injuries to the trees. To prevent the repetition of such neglect, we should have a more active and intelligent public interest in the care and protection of our shade trees. Such interest when manifest at present is sometimes too sporadic and flares up more or less ineffectually or even awkwardly when some especially dangerous or injurious disease has become established or when perhaps some public works or revised landscape program requires the removal of trees. There is insufficient interest in systematic, long term programs backed by adequate funds for the regular employment of skilled men to carry on work comparable to what is provided for road construction and maintenance and for many other public enterprises. We have in recent years had a very commendable improvement in efficiency among private individuals and firms doing arboricultural work, but unfortunately, they find opportunity for continuous and systematic service only among a relatively few estate owners who value their trees as permanent assets. The care of trees on public streets and roadsides is sometimes left to someone with little training and the funds provided for the work are frequently inadequate to carry on a well planned program. We have in Rhode Island a tree warden law, excellent in many respects but faulty in that it permits frequent changes in tenure of wardens, and makes no provision for a systematic shade tree program. This sometimes results in assigning the care of trees to men who know little or nothing about arboriculture and for whom there is now little incentive to acquire more adequate proficiency in the work to be done. The law should be amended to provide long term, carefully planned programs of shade tree planting and maintenance and funds sufficient to employ wardens and other workers with adequate training on a more permanent basis.

Such programs would not necessarily involve large expenditures of funds. The purpose should be to do some definite piece of work, no matter how small, in a progressive plan each year and to provide for adequate annual maintenance of plantations set out very much in the same manner that public road work is now carried on. There is a story which went the rounds many years ago of an Irishman who was observed dropping a quarter between the planks of a wooden sidewalk. A bystander chided him on his foolish extravagance, but the Irishman replied, "I had already lost a quarter under the sidewalk and I have put another with it to make it worth while for me to take up the plank and recover my money." In spite of its absurdity, there is a bit of philosophy in this story for some of our public work and especially for our shade tree program. We are now and then in a hit or miss manner putting many quarters in our shade tree work but we need to put a little more money with them in order to get the full benefit of the funds expended.

CEMETERY TREES WITH ILLUSTRATIONS OF STORM DAMAGE

By O. F. Burbank, *Superintendent, Hope Cemetery, Worcester, Mass.*

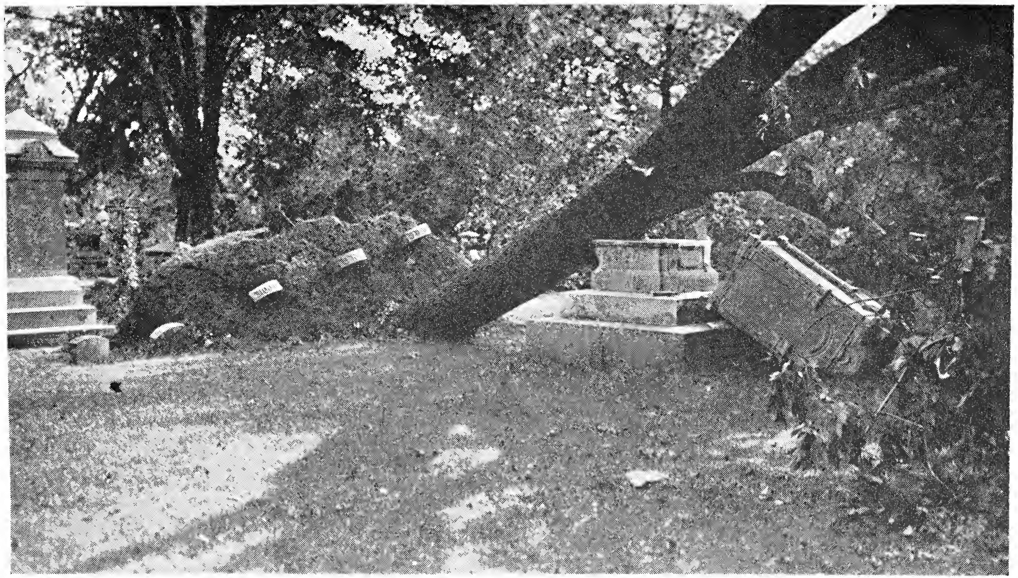
Photographs, especially those in natural color, are so much more eloquent than language, that I propose to let these pictures tell their own story. They were taken at Hope Cemetery at Worcester, Massachusetts, most of them on the day following the storm of September 21st.

A few slides show trees as they appeared before the hurricane. I have tried to group them in such succession as to point out some conditions that may be object lessons in what to avoid, and perhaps worth consideration in planning the work of rehabilitation. If observation of the effects of this hurricane convinces us that mistakes, both of commission and omission, have been made in the past, the institutions we serve will surely benefit from our ability to profit by such knowledge.

Worcester is located close to the center of the storm-affected area. Information from and visits to other parts of New England convince me that nowhere was the force of the wind more violent than in this city. Records from local weather stations confirm this view. True, destruction and loss of life was greater along the sea and large waterways, where flood and tidal wave were factors.

No wind disturbance of equal intensity over such a large area ever before has been experienced in New England, at least, none has been officially recorded in more than a hundred years. And so, I think we may safely discount the probability of an early recurrence of such a combination of destructive forces. But it would be less than wise to

PLATE 4



Cemetery in eastern Massachusetts showing uprooted tree and damaged monument

ignore the fact that what has occurred may recur, and as we contemplate the destruction we have seen in our cemeteries, this possibility brings to mind certain questions that seem to require free discussion, through which we hope to arrive at conclusions that will satisfy, so far as past experience and reason may do so, a desire to safeguard remaining and projected plantings.

While we may seem to limit this discussion to areas affected by the storm of September 21, 1938, its conclusions can certainly be applied to other regions, and ought to be, for no one in any of our Eastern States can now say with assurance, "It could not happen here."

And so, as we run through these slides, I wish to comment very briefly on some of them, and I wish you would consider them very critically from a professional viewpoint.

While the planting and care of trees is less vital than many other duties, it is an important part of the work of cemetery officials. And so, with no pretense of special knowledge farther than that which anyone in my profession is bound to pick up after twenty years, I should like to offer for the consideration of this group several questions which their education, training, and experience seem to fit them to discuss, and upon which their opinions should carry the weight and authority that we look for from specialists.

First, should a study and examination of the effects of this storm lead in future planning to modification, as to variety and location, of shade trees?

Should we not curtail, perhaps eliminate, expenditures for repairs on trees when found to be in a condition similar to those which, after repair, failed to survive this storm? (Possible exception might be when a private owner, by reason of sentimental attachment to a particular specimen, might be willing to gamble.) Is it not sound practice to consider, not only the space which will be required both above and below ground for future growth, but also whether or not you are planting greater numbers than will be given adequate and proper future care?

Should not more consideration be given in the future than in the past to the question of whether or not the variety is adapted to its proposed environment?

Will any landscape effect gained by close grouping of shrubbery around a tree compensate for the possible injury to the tree by such a practice?

What effect, if any, did systematic feeding have upon the ability of specimens to withstand this storm?

Tree injuries that I am going to show fall into five general classes:

1. Total destruction by breaking off,
2. Total destruction by uprooting,
3. Partial destruction by breaking or splitting.

(In each of these three classes the tree stump was removed.)

4. Tipping over at various angles,
5. Breaking off some of its limbs.

(Some included in these two latter classes also had to be removed.)

Out of 500 trees, the numbers affected in the different classes were approximately as follows; in the first class, 25; in the second class, 40; in the third class, 100; in the fourth class, 260; in the fifth class, 75.

(The following are the author's comments on his excellent colored lantern slides.)

1. Shows a heavy granite cross blown over by the wind. No other cause was involved, as there were no trees anywhere near it. This cross, falling into the sodden ground, was entirely uninjured.
2. Shows a tall cross 18 feet high, which was moved on its base, but did not fall.
3. Shows the effects of the twisting action on the granite.
4. On the left shows a large Oak tree 40″ in diameter before the hurricane.
5. Is a better view of the same tree. This tree had been braced with rods and the cavity filled with cement.
6. Shows what the hurricane did to it. It was broken off about 12′ above the ground. Of ten cavity jobs, this is the only one that failed in the hurricane.
7. Shows a close-up of the same tree with part of the filling intact.
8. Is an Oak tree of approximately the same size as the one shown, which stood the storm fairly well. It lost one large limb, which is shown resting on the ground. This tree can be repaired at very small expense.
9. Is an Elm tree about 85 feet tall, and was entirely undamaged in the hurricane.

10. The next four slides show a landscaping as it appeared before the hurricane and
11. how it still appears. This was undamaged except that one or two of the taller
12. Arborvitaes and one or two of the Pines had to be forced back to a horizontal
13. position and guyed.

14. Shows a Beech tree before the storm, which was entirely unaffected.
15. Shows two Blue Spruces, one of which was taken out.
16. Shows the same tree after the storm.
17. Shows a part of a row of 12 trees along the edge of a bank only one of which was blown over so that it had to be removed.
18. Shows the result of the whipping effect of the wind on some of the Evergreens.

19–21. Shows some of the trees that were broken off. In nearly every case where a tree was broken off or split, signs of decay were revealed.

22. Shows the effect on curbing of trees when uprooted. When this wall was set some of the larger roots were cut, thus making it easier for the trees to tip over than it would have been if the roots had been in their normal condition.
23. This does not apply in 23, as this curb has been set more than forty years, and the tree was broken with sufficient force to lift the curb out of its position.

24. Is a view of the same.
25. Is a view of the same.
26. Shows a tree partially tipped over. No doubt this was weakened by cutting away the roots when the wall was built. Note the large root which was broken.
27. Shows a tall Larch with a good root system, which tipped over with sufficient force to lift several markers.
28. This seems to be a case where the curbing adjoining the tree had prevented normal rooting, allowing the tree to be tipped more easily than it should have been.
29. Shows a case similar to some of the previous views, where the tree was weakened by chopping away roots to allow the curb to be set.
30. Is similar, as is also 31.
32. Shows a tree that uprooted, taking with it a piece of curbing that had been in place for probably fifty years.
33. Shows a tall evergreen almost completely uprooted, whereas the one shown in the background is still apparently in good condition.
34. Shows a row of Willows tipped over or splintered.
35. Beginning with No. 35, we show a row of Maples about 6″ in diameter that were upset along the entire length of the avenue on the north side, while those on the south side were uninjured.
36. Shows a close-up of a tree on the same avenue.
37. Another tree on the same avenue.
38. This shows a row of trees on an adjoining avenue on the north side, of about the same diameter, every one of which was tipped. These were all straightened, however.
39. This is another avenue in the same vicinity.
40. Shows a part of a row of Larch trees about 14″ in diameter completely uprooted.
41. Some of the trees on the right hand or north side of this avenue were uprooted, while those on the other side were not affected, or very little.
42. Four large trees were uprooted along this bank. It is easily seen what caused this. The roots seem to be very sparse and undersized.
43. This large tree was tipped over and rested on the roof of a mausoleum. It was set back in place and guyed.
44. Shows a well rooted tree which failed.
45. Shows one of the street shade trees that went over, taking some of the wires down with it, but saved from going completely over by their support.
46. Along this rock garden about 10 Arborvitaes were blown over or broken off. Nearly every one of them was diseased or in some way weakened.
47. This tree was poorly rooted. Evidently the granolithic walk and the foundation under it interfered with making a proper root system.
48. The same is true of No. 48.
49. These evergreens were completely uprooted.
50. This Austrian Pine was broken off twenty feet above the ground.
51. Same.
52. Show the first steps in the process of cleaning-up.

STORM DAMAGE IN VERMONT AND THE FOREST TENT CATERPILLAR

By Harold L. Bailey, *Director, Division of Plant Pest Control, Vermont Department of Agriculture*

Approximately 20 percent of tapped maples in Vermont were blown down by the great storm of September 21, 1938. The number of maple shade trees felled and others most susceptible to forest tent caterpillar damage has not been estimated. Though not comparable to the loss in shade elms, it was considerable. This loss in maples, had it been evenly distributed, would have been serious at best, but it would have been far less serious than that which we actually have as a result of concentration of the damage. Far from being evenly distributed, a very large part of the hurricane damage is in the northeastern quarter of the state. In Orange, in Caledonia, in Orleans and in parts of Windsor, Washington and Essex Counties, sugar places with from 50 percent to nearly 100 percent downed trees are the rule rather than the exception and there are wide swaths of fallen forest timber. This not only means the loss of the fallen trees themselves, but it makes a debris problem of serious import. That it has rendered many of the remaining trees inaccessible for tapping and has created a fire hazard is fully realized; that it is very likely to create a serious insect problem has not been so generally recognized. If, as seems probable, the full complement of insects on the fallen trees concentrate—they or their progeny—on those remaining, the result may easily be disastrous. And this concerns shade trees as well as those in sugar orchards and forest areas. To some extent at least, the situation must apply to other sections than Vermont.

Danger of this massing of insects applies to borers and numerous other species, but especially, I think, to the forest tent caterpillar. Ironically enough the area where the storm hit hardest in Vermont was the one section in which the maples had not been damaged by caterpillars.

The forest tent caterpillar has appeared in outbreak form in Vermont during each of the past four years. The first case of defoliation reported in the present outbreak occurred in a sugar maple orchard at Bennington in June, 1935, and subsequently that season stripping or near-stripping of maple or oak trees was noted at several other points scattered about the southern half of the state. Reports from adjoining states point to similar occurrences.

Hurricane damage to sugar maple trees at West Newbury, Vt.
(Photo *H. L. Bailey*)

In 1936 the infestation was far more general, with widespread damage throughout many areas of the southern and western counties. Although defoliation was not generally 100 percent, it ran up to 80 or 90 percent and hundreds of sugar orchards looked brown and thin. As is the nature of such outbreaks, heavy attacks by the caterpillar were spotty, even in the areas of greatest prevalence; and frequently heaviest caterpillar abundance seemed to follow along certain ridges, as for instance, on a North-South line for many miles, along the first range of hills east of the lower reaches of Lake Champlain. There were instances, too, where certain sugar places were heavily attacked while there was no noticeable defoliation in the orchards surrounding them. There was a similar variation among towns in respect to shade tree infestation. With diminution in some cases and apparently increase in others, the outbreak continued in 1937 and 1938. How many more seasons it will take for the natural control agencies to overcome it, no one, of course, knows. Though nothing like a complete survey has been made as to egg masses on the twigs at present, I know that there are considerable numbers of them at some points.

Since the shade trees are inextricably tied in with the trees of the whole countryside, so far as concerns the periodical ups and downs of the forest tent caterpillar, it seems best to handle the situation as a whole. There is, of course, the decisive difference from the control angle that while spraying is a feasible and effective control measure in the case of shade trees, it is not so generally practicable in forest or sugar bush areas owing to expense and other obstacles.

Since apparently the range of food plants chiefly favored by this insect varies somewhat with different parts of the country, it may be noted here that in Vermont the sugar maple is the tree most seriously affected. Oak, white ash, poplar and basswood are apparently also prime favorites, but since these varieties seldom grow in solid stands in Vermont and are not much used for shade trees, attacks of the caterpillar on them are of much less importance than are those on the sugar maple. Elm and birch appear to be seriously attacked only when among defoliated trees of other varieties. The red maple and silver maple, if not entirely immune to attack, are very nearly so. I know of a number of instances where these trees have retained full foliage in the midst of sugar maples which were completely stripped.

What are the lasting results from an outbreak of the sort we are having? It is hard to say in any case, but with unusual weather conditions complicating the situation the answer is still more difficult. Two such weather complications have entered into the picture in connection with the present outbreak; the extremely cold winter of 1934 and, of course, the hurricane.

The most severe previous outbreak in Vermont of which we have definite record occurred between 1895 and 1900. This was very completely recorded in a bulletin of the Vermont Agricultural Experiment Station prepared by Dr. George Perkins in 1901. Quotation from this bulletin is interesting for comparative purposes, though the comparison is not one of contrast. Much of Dr. Perkins' 40 year old report fits the present situation almost exactly except that it varies somewhat as to location of outbreak. For instance, he quotes a correspondent as follows:

"I send you a report of the ravages of *Clisiocampa disstria* for the year 1899. It was very much worse than last year, in the village, so that many of the people who last year did not pay much attention to the cocoons on their buildings are very much alive now to their presence. The number of the worms in the village was so great that the village authorities took hold of the matter and had all the trees alongside of the road covered with bandages of burlaps and these were kept well tarred. The trees therefore do not look very badly there. In the woods and sugar orchards the damage has been very great, though some of the places that were attacked last year have gone free this year while other places that escaped last year have suffered severely this year. They have eaten every green tree and bush, I think, except the cut-leaved maple and the sumachs which do not seem to have been touched. The cocoons are on every sort of tree, not excepting these two." This cut-leaf maple is, I expect, the common silver maple which thrives in lowlands of northern Vermont.

Another quotation is of particular interest because of certain points raised. Mr. Lyman Hutchinson of Randolph wrote him thus:

"My sugar orchard was the first to be attacked by forest worms in this section. Two years ago in June (1898) it looked as though fire had burned the foliage over the whole wood lot, and again last year they took what trees survived the first trimming. Now it is a fact that the first year's trimming killed more than two hundred out of eight hundred trees. And the result of the last trimming is that I have not two hundred trees in my orchard that have life enough left to ever run sap for sugar. We have cut from one to two hundred of those maples. The most of them were entirely dead, the rest had only a few lower limbs alive. The wood of these maples turns very dark colored before the tree is entirely dead, which injures it very much for lumber. Two years ago my orchard was about the only one in this section on which the worms worked, but last season they took a clean sweep. Every sugar place around is being cut down as fast as possible."

Commenting on this Dr. Perkins said:

"It is very probable that some other destructive agency has been at work in Mr. Hutchinson's maple grove, for a single defoliation would not alone destroy the trees if they were in good condition at the opening of the season."

Then follows some consideration of the effect of defoliation on life of the tree and maple sap production. Though he appears to be more conservative than some of his correspondents in estimate of damage in both respects, he concludes with this:

"It appears to be certain that Vermont will not produce the accustomed amount of sugar for a good many years to come."

What about this question of damage? Dr. Perkins did not think that one year's stripping would in itself kill trees and he was inclined to discount in part some of the reported disastrous effects of defoliation on the next season's sap run. He felt that other conditions contributed to the effect strongly, though he agreed, of course, that the caterpillar damage was important.

Well, we are still in the dark on some of these things, but there are plenty of men still who remember that outbreak and will tell you that their sugar places were spoiled by the caterpillars. There are plenty of sugar places now with dead tops plentifully showing up, dead branches and weakened condition generally, and there are badly weakened maple and oak shade trees due, I believe, pretty much to forest tent caterpillar work. In some sections, the obvious weakening of the trees through caterpillar attacks has been the deciding factor in causing the owner to sell for timber. That was reported back there too.

Several times, in his bulletin, Dr. Perkins refers to the fall canker worm being responsible for some of the defoliation. We can check with him on this also except that the canker worm involved this time has been Bruce's *Rachela bruceata* instead of *Alsophila pometaria* and their worst work preceded by a couple of years that of the caterpillar. Since they are very similar in general appearance, it seems quite possible that the two had been confused in the reports which Dr. Perkins received.

So far there is close similarity in the outbreak of forest tent caterpillar just preceding the turn of the century and that beginning in 1935. There was one point of difference which I have not mentioned. In the earlier outbreak and in the milder one which occurred around 1912–1915, the infestation, though spotty, was fairly evenly scattered over the state. In the past four years I have known of no defoliation by the forest tent caterpillar in the northeastern quarter of the state.

Why? I don't know. But here is what I consider a strong probability. The build-up of numbers in both species of tent caterpillars resulting in the present outbreak had been occurring generally throughout Vermont up to 1934. It was more obvious, of course, in the case of the eastern tent than of the forest species, because the tents make a noticeable index of prevalence, even where defoliation is not common, but both species had become fairly plentiful after several years of obscurity during which it had been hard to find egg masses of either. Then came the severe cold of the winter of 1934. In the southern and western parts of Vermont, the caterpillars apparently continued on their course. In the northern regions before referred to, tents of the eastern caterpillar were almost a rarity the next spring, even in sections where the roadside cherry and apple trees had been covered by them the year before. Disease and parasitism should be considered in this connection, of course, but judging by the usual "run" of these things and also by conditions elsewhere, I do not think it was time for them to assert themselves. What I do think happened was that the temperature in these colder sections of the state went just below the hair line standing between mortality and survival of the eggs. I think that the great majority of eggs, certainly of the eastern species, were killed in these cold sections and if that were the case it seems reasonable to suppose that eggs of the forest caterpillar went with them. This isn't backed by check and definite record and I realize that it would not stand in the court of scientific experiment, but the winter killing theory does have some backing by observations of John Schaffner of the U. S. Bureau of Entomology and Plant Quarantine and probably of others.

It would make little difference, anyway, were it not for the disquieting possibility it presents. From past experience we have reason to hope that the present outbreak where it has been running for the past four years will subside before very long as the result of natural control agencies. But what of this northern section? If my thesis is correct, and the insects were cut off by something outside the usual control agencies, must we expect that they have been starting over again following the cold winter with a new build-up process and that they are bound to continue on through an outbreak stage willy-nilly? If so, we must look for a period of several years stripping yet to come in these northern areas.

And here is where the hurricane results have their most serious implications. It appears reasonable to suppose that the larvae hatching from egg masses on the branches of the fallen trees, whether or not these trees put out foliage, will find sufficient food to get them into the third or fourth instars and that they will then move to trees which are standing, after doing much damage to the maple seedlings and other young trees in the food plant group. Considerable is being done by public agencies toward timber salvage, but it is probable that many trees will remain where they have fallen through the next year, at any rate—perhaps till they decay away. The effect of this on shade trees may or may not be serious depending on location. Not many larvae would find their way from the debris areas to shade trees except in some rural communities. But if highly concentrated infestations are built up in these areas, it would appear likely that shade trees in nearby cities and towns would get an over-supply of moths at egg depositing time next summer. And the brush from fallen trees, not only in Vermont but anywhere in the caterpillar area stands as somewhat of a menace in this respect.

What may be done about it? First, I should say, increased vigilance in watching the caterpillar, especially in noting the egg deposition on shade trees next summer.

Second, spray wherever any considerable number of the caterpillars have hatched in the spring.

Urge the burning of all brush from fallen trees to destroy the egg masses.

And in selecting replacements consider immunity from this serious pest. If maples are desired, I suggest the soft varieties.

DEALING WITH STORM DAMAGE IN CENTRAL MASSACHUSETTS[1]

By MALCOLM A. McKENZIE, *Pathologist, Massachusetts State College, Amherst*

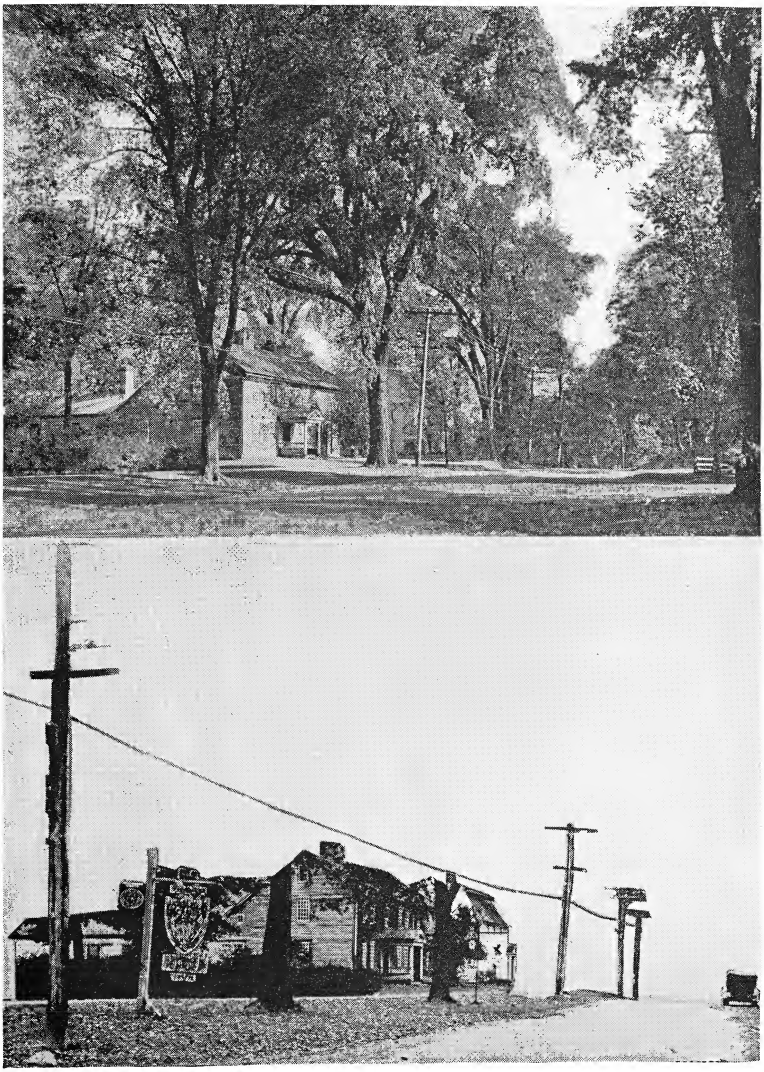
Surveys of the effects of the recent hurricane on shade and ornamental trees in New England have aroused considerable speculation concerning

[1]Contribution No. 328 of the Massachusetts Agricultural Experiment Station.

the explanation for diverse and often apparently conflicting observations of specific tree injuries. However, all reports agree that the large number of trees destroyed by the hurricane is unprecedented and the statement in the press that 100,000,000 trees were down in Massachusetts appears to be a reasonable estimate. Not all of these trees were shade trees by any means since the forest plantings suffered heavily; but the loss of street trees as well as ornamental trees on private property was a major catastrophe.

In Central Massachusetts trees were partially or completely uprooted throughout a rather wide but not unbroken area. In the town of Amherst for example, approximately 1000 trees on public property were uprooted or otherwise destroyed, while in the town of South Hadley about ten miles south of Amherst relatively few trees were destroyed, but the loss included the progressively weakened sycamore which stood out so prominently on the highway approaching Mount Holyoke College from Amherst. In the town of Sunderland the collapse of two huge and vigorous elms long known as landmarks on the east side of the main street left a gap to mar the tranquil beauty of this quaint New England village street. Less than a half mile north of these elms the renowned sycamore, believed to be the largest tree of its species in Massachusetts, escaped serious injury. The destruction of sugar maples in Sunderland was sufficiently extensive to indicate a curtailment of maple syrup products next spring. On the west side of the Connecticut River just across the Sunderland Bridge in the historic town of Deerfield, locale of the early Indian massacre and now a mecca for tourists, with its frequently photographed colonial structures picturesquely framed by stately elms, considerable damage resulted to trees and buildings in that area but fortunately the damage is not beyond repair.

Meteorological conditions for the period preceding the hurricane as recorded by the observatory at Massachusetts State College have an important bearing on the extent of destruction of trees in Central Massachusetts. During a heavy rainstorm from the 17th and terminating with the hurricane on the 21st of September, a total of 11.96 inches of rain fell in a period of slightly more than four days. On September 20, the Deerfield River rose two inches in one hour. During the four days of the storm the Connecticut River rose to a height of 14.9 feet over the Holyoke Dam, which reading is 1.7 feet lower than in the flood of March 1936 and .1 foot higher than in the flood of November 1927. During the month of September the total rainfall was 14.55 inches



The village street in Deerfield, Mass., with stately elms which withstood the storm but experienced some damage

Below: A print from the same negative retouched. The lesson in shade tree value is striking. This latter did not happen in Deerfield

(Photo *M. A. McKenzie*)

being the greatest rainfall during any month since 1836 when records were first taken in Amherst. Barometer readings, when reduced to sea level, were fairly high from September 17 to noon on September 21, dropping only from 30.15 inches to 29.70 inches. At four o'clock on the 21st the barometer had dropped to 28.72 inches and at five o'clock the low of 28.41 inches was reached. The wind velocity rose from 20 miles per hour at three o'clock to 80 miles per hour at 5:17. The wind blew mostly from the north during the storm on September 17, 18, 19, and 20. On the 21st at noon the wind shifted to the southeast and remained in this direction during the hurricane.

When the high wind struck Central Massachusetts it found the stage well set for an all time record of tree destruction. The thoroughly soaked ground freely gave up the root systems supposedly anchored tenaciously by functional and physical laws. Rather close observation of several large trees preceding and during the process of uprooting revealed no thundering crash but rather so relatively slow and measured a fall that huge trees frequently fell with almost no audible indication and in some cases leaned over to rest against structures with a minimum of damage to buildings.

Poorly developed roots, often the result of severe pruning during road construction, poor site, or inadequate water or food, contributed to materially weaken the mechanical support of trees. However, inconsistencies with the theory that inadequate anchorage alone determined victims of the gale wind are too numerous to conclude that a good root system insured tree survival. Likewise the existence today of many avenues of trees in the path of the hurricane which were notoriously weakened at some time in the past by root cutting and mutilation, is evidence that a combination of factors was active in the destruction and survival of trees during the hurricane.

Further analysis of the meteorological statistics has value in surveying shade tree damage, at least in a negative way since some observations of fallen trees are not to be explained by the observatory records. The weather report indicates that the wind was from the southeast during the entire period of the hurricane. This being the case why should trees be blown over in almost every conceivable direction? It is known that the velocity of the wind varied considerably during the storm and it is entirely possible that the hurricane encompassed miniature tornadoes which broke loose in limited areas battering down whatever came within their paths until force was exhausted by friction. If such a condition existed it can be understood why twisted and decapitated trees were found in the wake of the hurricane—an explanation to pacify those persons who seek to understand what they see. Another explanation which might partly account for the nondescript tumbling of trees is the possibility of wind force being sharply deflected following contact with some obstacle.

The salvaging of damaged trees rightly received attention second only to the saving and serving of human life. Uprooted trees had to be reset promptly and extensive work on other tree rehabilitation was urgently needed. The cessation of the rain meant the receding of the rivers but it also meant the hardening of soil, and the drying out of exposed roots. Trees which were reset promptly and given whatever other attention was necessary in the way of pruning and protective painting should recover from the effects of a temporary disturbance none the worse for their experience and certainly not so much shocked as the transplanted tree which awakens in spring in a new environment. However, moving large trees has been conspicuously successful in cases too numerous to permit detailed listing and doubtless with methods for the control of evaporation, such as the use of wax emulsion, resetting uprooted trees will prove successful in cases where proper attention was given to the matter of firming the soil about the roots and the details of routine transplanting including guying. Of course the physical well being of the trees requires attention to the general health of trees such as careful watering and the judicious application of fertilizer if conditions appear to warrant this practice.

Occasionally saving something from a mangled but treasured tree involved cutting out everything but the trunk. This process known as pollarding commonly produces a dense top growth which to a limited extent is a contribution to the landscape.

Time and space will not permit complete elaboration of the multitudinous ramifications of the effects of the hurricane on the entire field of arboriculture. What is to be done about the untreated damage to shade trees on public and private property? Are the evergreens discolored by the effects of salt spray destroyed and how far was the ocean spray carried? Did it reach Montpelier, Vermont? Will evergreens that lost branches on one side or the base produce compensating new growth? Should public utility programs and tree planting programs be more adequately coordinated? Have the conditions since the hurricane been favorable for the recovery of injured trees? What tree diseases and insect pests may be promoted by the effects of the hurricane? These are some of the problems encountered in dealing with storm damage in Massachusetts. Some of these items are to be dealt with individually in other papers and therefore are not discussed here. However, the matter of tree diseases in Massachusetts is most significant. At present, grave concern is felt in Massachusetts for the problem of the encroachment of the Dutch elm disease. Latest reports indicate that the disease is now about ten miles from the southwest corner of the State in New York so that from the standpoint of dealing with the problem the danger is as great as though the disease were present in Massachusetts. The known carrier insects of the causal fungus are already present in Massachusetts and the possibility of the undiscovered presence of the disease fungus must not be overlooked. Although advice on disposing of cut elms has been disseminated widely throughout the State, reason compels the conclusion that an early increase in the bark beetle population is inevitable.

Regarding the relation of utilities and tree planting programs a fertile field is open for imagination and cultivation. In consideration of the statement that falling trees carry utility lines with them, it must be admitted that trees sometimes hold up falling lines and poles, and are not uncommonly used as guys.

The subject of evergreens and their injuries and future welfare deserves complete elaboration which perhaps may be accorded it by others. Studies in Massachusetts reveal that discoloration of evergreen foliage, particularly white pine, was widespread during the past summer. The condition has often been described as "needle-blight" of white pine. Both excess moisture and lack of it have been variously ascribed as causes of this trouble. Commonly the new growth of an entire tree is affected although limited discoloration has been noted also. The salt spray injury to evergreens apparent after the hurricane in some places added to the confusion of evergreen maladies. Injury to plants from salt spray is not a new discovery in regions along the coast where this injury often occurs to a limited extent. In the recent storm, salt was deposited about tree roots in some cases and doubtless more permanent injury to these trees may be expected than in the case of trees sprayed lightly with salt. White pine has commonly been reported as affected by the salt spray but careful observation shows other trees to be injured also. The berries of holly near the coast are scarce or lacking this year presumably because of hurricane effects.

For the most part conditions since the hurricane have facilitated tree restoration work in Massachusetts. Fall planting to replace irreparable losses has resulted in much progress toward rehabilitation although much remains to be done in the way of tree repair. The optimism with which individuals and groups faced the inescapable responsibility of repairing and replacing trees is a most encouraging sign of tree-mindedness on the part of the public. Unrecorded but genuine appreciation of pleasant experiences with trees in the past has stimulated current interest in a sincere desire for tree welfare in the future.

WOOD ROTS AS FACTORS BEFORE AND AFTER THE HURRICANE

By Perley Spaulding, *Senior Pathologist, U. S. Bureau of Plant Industry*

In coming here to talk to you on this subject, I am supposed to know enough about the wood-rotting fungi to pose as an expert on them. I hope you will not leave with too keen a feeling of disappointment.

It may not be amiss to say at once, that in my opinion, the wood rots present the greatest future menace to the normal longevity of wind-damaged trees. Bark is the protective armor of the tree. Injury exposing the wood within is a serious threat to the tree's continued vigor and longevity. Wood-rotting fungi are present wherever trees grow or wood is used. Hence infection of unprotected wounds is about as certain as death and taxes.

Wood can be protected from rot only by impregnating it with substances poisonous to the fungi causing rot, or by keeping it permanently dry so that it contains too little water for fungi to grow, or by keeping it completely water soaked so that there is too little air for the fungi to live. These axioms are the basis for all tree surgery practice which is aimed at the control of rot in living trees.

There is no doubt that a large percentage of our trees are ordinarily affected by rot. The rot may not be extensive enough to threaten the life of the trees so far as we can see, but it may be important in a time of great stress like the hurricane. Examination of fallen and broken trees has revealed many hidden and unsuspected cases of root-rot, butt-rot and rot of trunks and larger branches. Where the full force of the wind swept against them, comparatively few trees of any species, no matter what their condition, escaped serious damage. Where lighter gusts struck them rot was a decided factor in weakening them so that they were seriously damaged. In any case innumerable branches were broken. No one knows yet how many roots were injured or broken—that remains for root-rot to reveal in the future. The tremendous twisting and bending of branches and trunks undoubtedly made numerous invisible cracks in many of which rot will later develop. The effects will come to our attention as long as this generation of trees, from middle age upward, survives.

There are so many fungi causing rot of living trees that it is out of place to call their roll here. There are hundreds of different known fungi which can rot the sapwood where branches have broken. Dozens are known which can rot the heartwood where it is exposed in such wounds. There are known smaller numbers which can rot injured roots. In spite of years of investigation our knowledge of the wood-rotting fungi is far from complete. New instances of fungi which have been considered incapable of spreading into living wood from open wounds are constantly being found aggressively attacking sapwood of living trees. The abnormal abundance of wounds in the trees of the hurricane area must result in many such occurrences in the future. The main thing is to look for and recognize rot and to prevent and remedy it so far as possible.

The tree surgeon has a huge amount of work ahead in remedying the obvious damage as soon and as efficiently as possible. Abnormally high numbers of large pruning wounds must be so treated as to prevent infection by the wood-rotting fungi or at least delay their attacks. Perhaps one of the most important things to be done is to feed valued trees to stimulate maximum growth and hasten healing of wounds, thus decreasing the length of time that exposed wood is open to attack by rot.

The tree owner is very decidedly on the spot. If he cares at all for his trees he must try to put them in as good shape as is possible under the circumstances. Prompt and continued care will tend to minimize extensive decay some years hence, and is the only way by which it can be done. The directions and recommendations given in U. S. Department of Agriculture Farmers Bulletin 1726 entitled Treatment and Care of Tree Wounds by J. Franklin Collins (obtainable for 5 cents in cash from Superintendent of Documents, Washington, D. C.) apply with especial force to the care of trees injured by the hurricane.

In woodlots decision must be made as to what trees can be left with a reasonable expectation that they will survive. If any use is to be made of them, the trees that are down or that will die from their injuries ought to be removed and utilized promptly as dead trees will saprot seriously by the summer of 1940. The vacant spaces then will be occupied by sprouts and seedlings which will not be broken down by later salvage operations.

Special precautions should be taken to use elm before next summer because of the Dutch elm disease, about which another speaker will tell you. Any logs intended for lumber ought to be sawed and the boards stacked by early spring to prevent serious sapstain. Prompt seasoning is essential. Cordwood should be stacked, seasoned, and gotten under cover within a year. The waste material (slash) left in the woods, if not piled and burned because of unsightliness, generally should be scattered flat on the ground so as to rot most rapidly and finally help to enrich the soil. The fungi which rot such waste are not a serious menace to the living trees left standing. In order to reduce the accumulation of too much wood or lumber now, it may be feasible to take out only those trees that are dead or dying and later remove those that are still alive but so badly broken that they are unsightly or are not able to resume normal growth. Many such trees will be found. Deaths among them will occur for several years at least.

This disaster calls for the best efforts of tree owners and tree surgeons to save as many as possible of our older trees. It has taken nearly a century or even longer for the larger trees to attain their size and beauty. It will take another long period to even approximately replace them. Everything feasible should be done to keep the survivors in vigorous condition and free from rot.

(The following short account from a recent news release is included because of its practical bearing on existing conditions. Ed.)

COMBATING INFECTION OF STORM-DAMAGED TREES

By Rush P. Marshall, *Pathologist, Division of Forest Pathology, Bureau of Plant Industry, in Cooperation with Osborn Botanical Laboratory, Yale University*

Heroic work has done much to right the hurricane damage to shade trees. The highways have been freed of fallen timber, most of the unsafe trees and branches have been taken down, enormous quantities of debris have been removed, and in many cases major injuries of the trees have been treated. So rapidly and efficiently has this early clean-up work progressed, that to the non-professional popular mind the task seems quite or nearly finished. This, however, is really an illusion, for careful inspection of both ornamental and roadside tree shows that the remedial measures, excellent as they are, have only been commenced.

Broken branches, open crotches, and splintered wood abound. Roots have been broken and torn loose from the soil. Trees have been racked and twisted by the wind. Such injuries, even where they are slight, tend to open the bark. This natural armor of the tree no longer protects its wearer with an impregnable coat. The exposed wood is vulnerable to attack by harmful fungi. Even under normal conditions wood-rotting organisms constitute a serious tree problem. Therefore it is highly important that we do all that is possible to guard our trees against infection to which they are now dangerously exposed.

Wood-rotting fungi are legion and varied. Most of them belong to a group called the "Basidiomycetes." Some of their best-known types of fruiting bodies are popularly referred to as "mushrooms" and "toadstools" when umbrella-shaped, and as "punks" and "conks" when bracket-shaped. Such fruiting bodies discharge myriads of spores, which are carried by the wind to open wounds where they start new infections. Certain of these fungi do not confine their fruiting to the normal growing season of the deciduous plants. On the contrary, their spores may be discharged in winter as well as in summer.

The hurricane occurred at the season when the deciduous tree is least able to protect itself from infection. This is because the formation of callus does not take place during the dormant season, nor is there any appreciable plugging of the wood vessels by wound gums and tyloses, when the tree is not in a growing condition. Until next spring, wounds will remain unprotected by callus and unsealed by natural plugging, except in the case of such trees, particularly the conifers, as exude pitch or gum to form a natural wound dressing.

We are then faced with the problem of protecting the trees against a really serious threat, even though the wounds themselves may seem of minor importance. Immediate treatment of these injuries may prevent great damage to our trees in years to come. Although, of course, no one can prophecy exactly what the results will be, it certainly appears easier to take measures for preventing infection than to check wood-rot after it has become established.

Smoothing to remove jagged wood and particularly the exercise of care, when removing broken branches, to make flush cuts which do not leave any parts isolated from lines of sap flow, are essential to preventing infection. Although small wounds can become infected, it is generally the larger more slowly healing wounds which give the most trouble. Hence, special attention should be given to the protective dressing of all but the smallest wounds.

No one type of wound dressing appears to be perfect for this purpose. Each has its own good and weak points. Asphalt paints made especially for tree work, or similar products used in roofing, are probably the most used and most popular type of dressing. They adhere well. They do not kill back the cambium. They promote callus growth by keeping the margin of the wound from drying out. They give less protection to the wood than do the dressings described subsequently. Zeller's Bordeaux paint is another excellent dressing. Unlike the asphalt paints, which are procurable at most paint and hardware stores, this material will have to be made when required. This is easily done by stirring together equal parts by weight of raw linseed oil and commercial Bordeaux powder. When first mixed the product should be thick. After standing an hour or two it thins to a heavy creamy paint. It is best not to mix more than will be needed for the day's work. When used it should be applied generously and not brushed thin. The principal disadvantage of this material is that it does not adhere well to wet wood. Callus develops less satisfactorily beneath a coating of Bordeaux paint than under asphalt paint. Bordeaux paint is, however, considered by the writer as more effective than asphalt in protecting the wood from attack by fungi. Creosote and tar mixtures containing creosote represent another type of wound dressing designed to preserve the wood. When using such material care should be exercised to keep it away from the margin of the cut as it is sometimes injurious to the living tissue of that region. If such injury is feared, the margin can be protected with a ring of shellac or some similar substance before applying the creosote. Regardless of what dressing is used the work should be periodically inspected and the wound repainted when necessary.

As related to the repair of storm-damaged shade trees and not to the problem of salvage in the forest, the rush of the first clean up is slackening. Most of the fallen debris and the more dangerous trees and branches have been cared for. This is the season which is normally the slack period. If you have been unable to get help during the past several months you are in a far better position to get it now. Periods of mild weather may be utilized for this work. With the coming of spring commercial tree experts will once again be faced with the rush of spraying and extensive feeding. Those who are still unable to get service and those who prefer to give this first aid themselves, will find that Federal and State departments of agriculture, experiment stations, foresters and tree wardens will be only too glad to give helpful advice. The U. S. Department of Agriculture will send Farmers' Bulletin No. 1726. "Treatment and Care of Tree Wounds" to all who request it.

THE RELATION OF INSECT WORK TO HURRICANE DAMAGE

By S. W. Bromley, *Bartlett Tree Research Laboratories, Stamford, Conn.*

Hurricanes are among the most destructive natural agencies affecting trees. In a few hours more trees may be destroyed than are cut down by man in several years. Insects over a period of 100 years probably kill many more trees than a hurricane. Insect damage, combined with that caused by a hurricane, one supplementing the other, produces conditions presenting far reaching and serious possibilities.

While no portion of the Atlantic coast of the United States is exempt from these tropical storms, New England, since colonization, judging from the records, has been visited by only three major storms that could be classified as hurricanes, of which that of September 21st last was the most destructive to life and property. These storms occurred over a period of 303 years and were more than a century apart. The south Atlantic states are buffeted by tropical storms much more frequently and here the correlation of insect damage and storm destruction has been more widely noted. Occurring a hundred years or more apart, hurricanes have allowed an extensive period of recovery to New England trees in the past. They have in fact been so infrequent, and the one prior to the last so long ago that insect conditions contingent upon the storm were not recorded or had dropped from memory.

The violent wind of the September 1938 storm, varying greatly in its intensity but reaching maximum velocities of gusts of 90 miles per hour on the News Building in New York City, 163 miles per hour on Mt. Washington, and about 186 miles per hour on the Blue Hills Observatory, overthrew or badly damaged a million or more large shade trees in its path. Including woodland and other trees not properly classed as shade trees, probably 150,000,000 trees are down or badly injured as a result of the storm in southern New England, comprising Massachusetts, Rhode Island and Connecticut. This tremendous number of trees destroyed or damaged and probably as many more weakened is bound to have a far reaching effect on the insect population of those species breeding in dying or weakened trees as well as having the effect of concentrating populations of leaf-feeding insects on the surviving trees another season.

Structural weakening of many trees is due, directly or indirectly, to insect attack. It was notable that trees in the open country escaped storm damage to a perceptibly greater extent than city or town trees. It is believed that a part of this exemption is due to better growing conditions and relative freedom from insect attack in the case of the trees in the open country. In general, the well-cared for tree, free from structural defects, or properly braced and cabled, with a deep strong root system, was, other things being equal, the tree that fared best during the storm. The hurricane was a great detector and selector of weakened trees, culling out a high proportion of these in the areas where the storm was most violent.

What are some of the factors that have operated over a period of years to bring trees to a condition so devitalized that they easily succumbed to the hurricane? Damage by insects has been a major contributing influence. Defoliation or partial defoliation of shade trees is well known as a factor contributing to weakening them. That the full effect of such weakening may not be consumated for many years was demonstrated by conditions attending our last hurricane.

Shade trees in cities and villages in many parts of the hurricane area have during the past 40 years suffered from such leaf feeding insects as the Gypsy Moth, probably the most destructive general tree feeder in New England where it has caused millions of dollars worth of damage in the past and where during the past few years it has been increasing and extending its range; the Canker Worms, both spring and fall species, which have defoliated thousands of elms, oaks, hickories and other trees in southern New England and southeastern New York state during the past decade; the Elm Leaf Beetle, the outstanding leaf-feeding insect attacking elms, an introduced pest which has been present in this country for more than seventy-five years, and which, where spray measures are not practiced, still defoliates many trees; and others. The Elm Leaf Beetle became destructive in the Connecticut River Valley and eastern Massachusetts in the early 1900's. Spraying to protect shade trees from these pests was little practiced during the early part of this period and many city and village trees that lay in the storm area have suffered greatly from elm leaf beetle attack over much of the past 40 years.

Repeated defoliation results in dying branches and the eventual death of the tree. Dying branches, unless there is systematic pruning and protection of the cut surfaces with the proper type of wound dressing, means early invasion by wood rots. Too frequently such care is wanting. It is significant that about 90 per cent of the shade trees severely damaged by the storm had been invaded by wood rots. Furthermore, repeated destruction of leaves weakens the tree to the extent that a poor root development with consequent inability of the tree to resist high winds is the result. It is very probable that repeated attacks in earlier years by elm leaf beetle in cities and villages has been an important contributing factor in the destruction of so many magnificent shade trees last September.

The weakening effects of repeated defoliations by no means end here. The next step in the vicious circle is the invasion of cambium borers and bark beetles which further contribute to weakening. The menace of borers to tree sturdiness is further complicated again by the entrance of wood rot producing fungi.

Among the borers which have produced these conditions in the past are the Two-lined Chestnut Borer, a cambium borer of the family of flat-headed beetles, which has in southern New England killed thousands of weakened oak trees which had been previously defoliated by cankerworms or leaf-rollers or weakened by drought, injuries incidental to construction of houses or roads, or changes in the water table produced by a variety of causes, during the past ten years; the Hickory Bark Beetle, which in both New York State and New England has damaged or destroyed during the past 20 years thousands of hickories where drought or defoliation by canker worms had paved the way for its attack; the Bronze Birch Borer, a beetle related to the two-lined chestnut borer, an exceedingly lethal pest of ornamental birches as well as native birches left exposed in woodlands following cutting or lumbering operations; and the Spotted Hemlock Borer, another beetle of the flat-head family, which attacks hemlocks weakened by drought or by foliage damage resulting from the feeding of such caterpillars as the hemlock spanworm. Elm trees have been injured structurally following defoliation by invasions of the European elm bark beetle and the leopard moth.

The Fall Cankerworm and the Pin Oak Leaf-Roller have been particularly destructive to shade and woodland trees in Connecticut. Repeated defoliations by them have killed many trees outright and a much larger proportion have been greatly weakened by their attacks.

It may thus be seen that insect conditions in the past have paved the way for destruction of trees by the storm. The hurricane has in turn produced conditions favorable for the increase of bark and timber insects, the full effect of which will probably not be appreciated for several years. Trees or parts of trees weakened by the hurricane offer conditions favorable to the increase of the destructive cambium borers. Again such of these pests as the two-lined chestnut borer, the hickory bark beetle, the bronze birch borer and others will find conditions favorable for their increase with the result that further tree damage may be expected.

Hanging branches offer favorable conditions for the European Elm Bark Beetle; limbs which have been twisted or weakened are attractive to the Two-lined Chestnut Borer and the Hickory Bark Beetle, and many leaning or racked trees may have had their roots torn to such an extent that the entire tree may be weakened so greatly as to facilitate invasion by one or more of these borers.

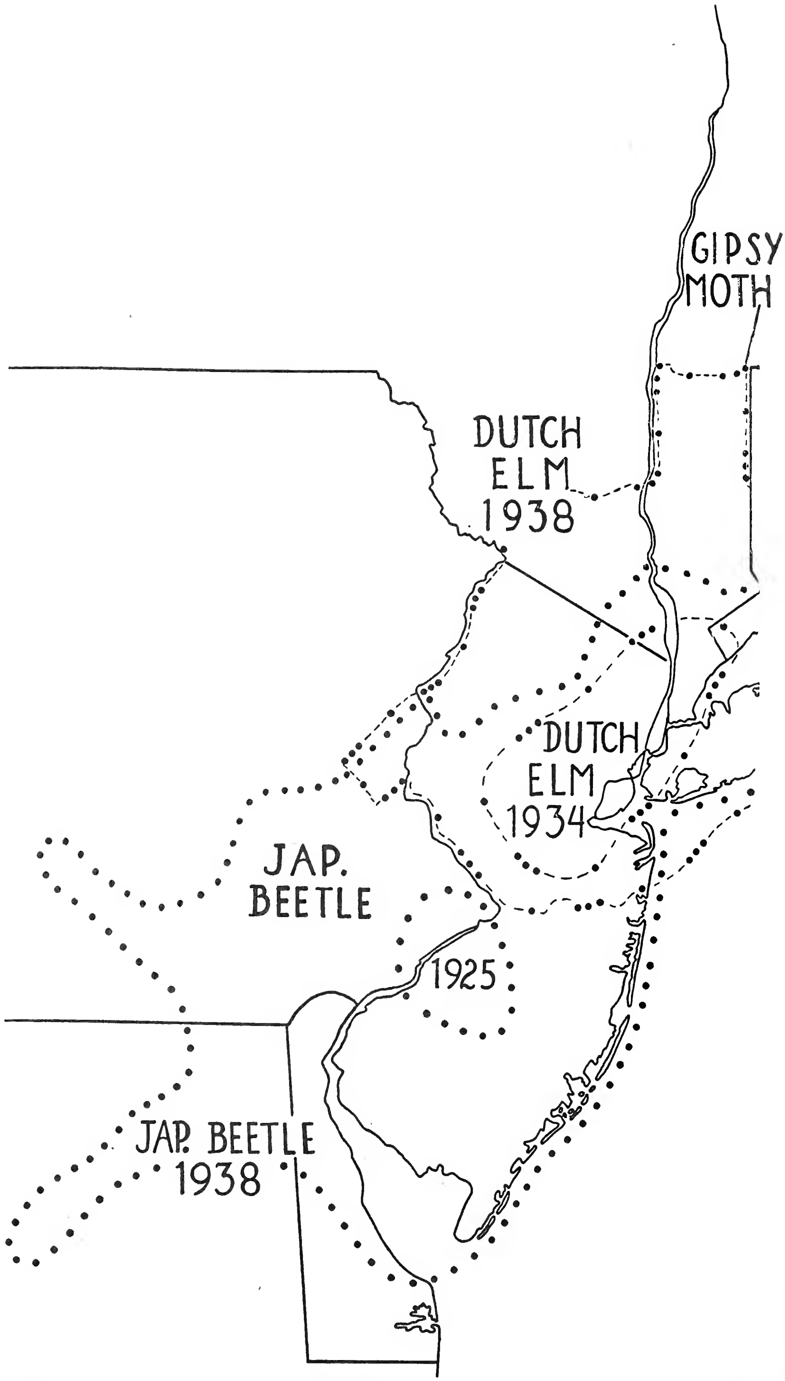
The condition is particularly important in its relation to the spread of the Dutch elm disease. There will undoubtedly be an increase in the numbers of the European Elm Bark Beetle, the principal carrier of the Dutch elm disease. Available evidence indicates that *Scolytus sulcatus*, a native species of bark beetle which develops in apple, plum and elm may also be a vector of this destructive elm disease. The present situation makes it extremely desirable that so far as possible all weak elm wood, trees or parts of trees, be cut and burned or at least barked before April 1st next in order to reduce the numbers of the principal carrier of the Dutch elm disease. Such measures are especially important in areas where the disease is known to occur and advisable in other sections.

In addition to these sanitary measures, another weapon has been developed in recent years which may aid materially in combatting the European Elm Bark Beetle. It has been shown by experiments that timely and thorough applications of arsenate of lead to the twigs of elms reduces to some extent at least the danger of European elm bark beetle attack, and possible later infection by the Dutch elm disease.

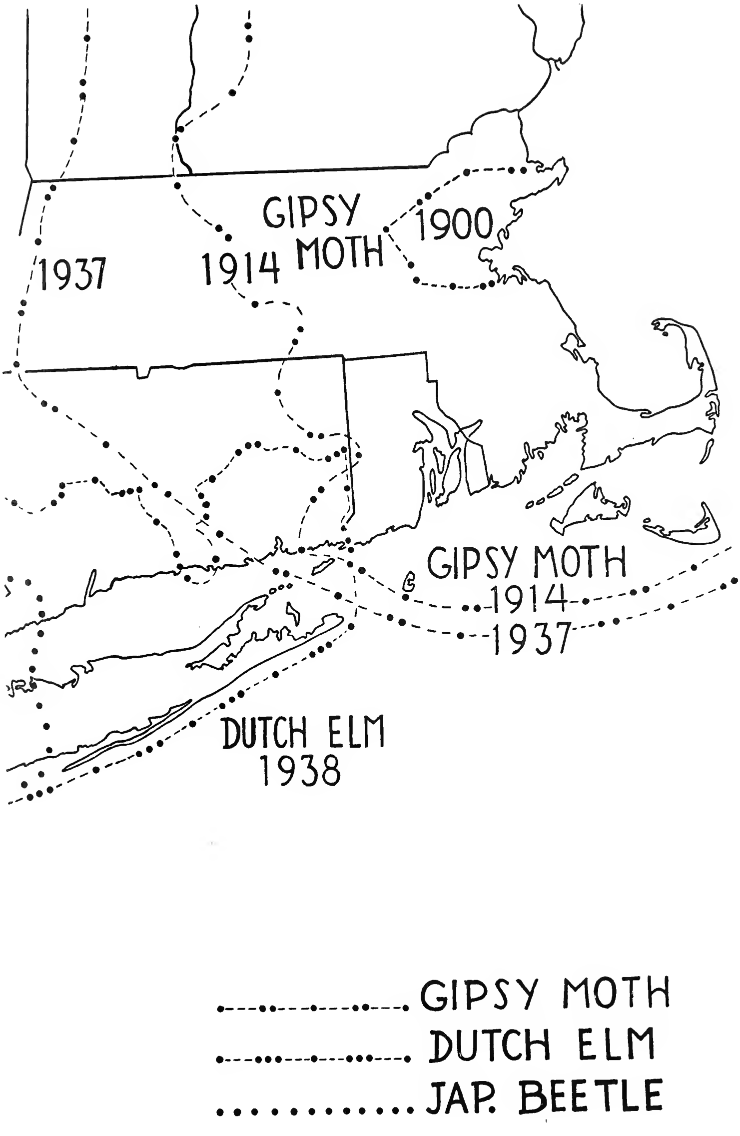
Soft woods such as the white pine and Norway spruce suffered much more in the storm than is the case with the southern hard pines during a hurricane. The white pine groves of Massachusetts were particularly seriously damaged. In many instances all that remained standing were the very youngest trees up to 20 years old and the very largest oldest pines which had been the parent seed trees for the groves. Thus pine reforestation was set back 40 to 60 years. This means that within the next few years a young growth of oak and birches is likely to spring up in place of many of the fallen pines, furnishing ideal breeding grounds for the Gypsy Moth, a major shade tree as well as forest pest. This instance is cited to indicate the relationship of the development of insect outbreaks in the woodlands to the shade tree insect problem.

Pine stumps and logs are favorable to the development of certain weevils and small ornamental pines in the vicinity of such material may be attacked later by the Pales Weevil, which, emerging from pine logs and recently cut stumps, attacks young conifers and causes damage by gnawing the bark and this injury may be followed by that of the grubs mining the bark and cambium below the surface of the soil; the Pine Trunk Weevil, which, closely related to the White Pine Weevil, attacks the bark of the trunks of young conifers instead of the leader of the tree and thus causes greater damage or death to its host; and possibly the Pine Root Weevil, related to the Pales Weevil and causing serious injury to young Scotch and other pines by attacking the bark and cambium at the ground level and below. Prompt disposal of pine logs and stumps in the vicinity of young conifers is of great importance.

There is need of fuller recognition of the part played by larger wood borers, such as the Sugar Maple Borer, one of the most dangerous and insidious of the insect enemies of this maple, its tunnels frequently resulting in girdling and death of young trees and serious weakening of the older trees; the Locust Borer, a beetle belonging to the same family as the Sugar Maple Borer, but whose attacks are confined to the locust, to which it has been causing increasing damage in late years following serious winter injuries to these trees in the northern part of their range as a result of the extremely low temperatures of the season of 1933–34; the Leopard Moth, an introduced borer which is an important pest in the northeastern states of soft maples, elms, horse-chestnut, apple, beech, birch, dogwood, hickory, oak and even walnut, tunneling the branches or upper portions of the trunk and causing structural weakness; the Carpenter Worm which breeds commonly in oak and sugar maple and is the larva of a moth of the same family as the leopard moth, and which breeds commonly in oak, sugar maple and locust, tunneling the trunk and larger branches and thereby lowering their resistance to wind damage; the Callous Borer, also the larva of a moth, breeding in soft maple, and other similar borers, all of which presumably have been important in producing conditions favorable to invasion by wood rots, and may thus extend damage to trees for many years after a violent storm. The weakened branches and trunks resulting from the recent hurricane are likely to favor a considerable increase in the number of these pests.



Outline map showing the approximate boundaries for various years of the areas
and the Dutch Elm Disease with the



thickly infested with the Japanese beetle, the distribution of the Gipsy moth quarantine line of the latter for 1938.

Hurricanes in the south Atlantic states are usually followed by a great increase in the numbers of several borers, particularly the bark borers of the genus *Dendroctonus* which work under the bark in various species of the southern hard pines. In fact, in the case of these southern hard pines, the number of trees succumbing to the beetles may be much greater than the original number killed by the storm. A somewhat similar development may take place in the pines of New England unless the fallen timber is cleaned up this winter, through increase in the number of related bark beetles and there are also likely to be great numbers of long horned borers which produce the large grubs known as Sawyers so commonly found in pine logs. In fact, down pine timber may be rendered valueless by insect attack if not salvaged before the first of June.

The weakening from storm injury may be expected to produce conditions analagous to fire damage and there may be a considerable invasion of sugar maple, flowering dogwood and other hard woods by flat-headed borers which ordinarily attack these trees in great numbers when they have been weakened by fire.

Another type of storm damage in the area where the wind blew directly from the sea was that produced by salt spray. The high wind carried water laden with salt to a distance of 50 miles or so from the coast suddenly turning green foliage to a scorched brown. While this may not be serious in the case of broad leaved trees, especially as the high winds were followed by considerable rain and as the normal dropping of the leaves was close at hand, in the case of many evergreens enough salt was deposited to severely burn the needles. Many white pines and others have shed their foliage and will be in a weakened condition for a year or two as a result of this type of damage. This means a likelihood of invasion by such insects as the pine trunk weevil and the pine root weevil.

The considerable reduction in the number of trees in many country and urban areas means in the case of the elm leaf beetle more insects to attack the surviving trees another season. This is also likely to be the case in areas where the Japanese beetle and canker worms are numerous.

While the evidence of the damage caused by the hurricane is fading into the past, the full effects so far as shade tree insects are concerned are yet to be felt. The situation calls for more extensive shade tree care and for a realization of the possibility of increased damage by insects and the application of proper methods of controlling or limiting these destructive factors.

THE JAPANESE BEETLE AS A SHADE TREE PEST AND ITS CONTROL IN THE EAST

By C. H. HADLEY, *Bureau of Entomology and Plant Quarantine, United States Department of Agriculture*

The Japanese beetle (*Popillia japonica* Newm.) continues to be an insect of much concern to those interested in tree protection, particularly in the eastern part of the United States. The beetle is not a pest of woodlands or forests, but is often a serious pest of shade and ornamental trees, as well as of fruit trees, especially in farming and suburban residential sections.

DISTRIBUTION. In considering the present distribution of the Japanese beetle, the entire area over which beetles have been found may be roughly divided into two zones or areas, namely, the area of *general distribution* and the area of *isolated colonies*. In the area of general distribution, beetles occur generally throughout, although the density of the beetle population varies more or less according to local environmental conditions. In some localities, beetles are rather scarce and of little economic importance; in others the population has built up to a point where severe damage to vegetation and crops occurs, while in still other localities the peak of infestation and damage has been reached and followed by a subsidence with comparable decline in the amount of injury caused and the relative economic importance of the insect. This area at the close of the 1938 season occupies approximately 15,000 square miles along the Atlantic Seaboard and is roughly bounded by the following points: Lewes and Milford, Del.; Barclay and Baltimore, Md.; Delta, Harrisburg, Manheim, Hamburg, and Portland, Pa.; Andover and Pompton, N. J.; Suffern and Peekskill, N. Y.; and Ridgefield and Westport, Conn.

The area of isolated colonies includes the states of Georgia, South Carolina, North Carolina, West Virginia, Ohio, Indiana, Illinois, Michigan, and the states to the east. In this area, the colonies or points of infestation are for the most part of a minor character, quite localized, and widely separated.

Obvious tree injury is limited for the most part to those portions of the area of general distribution wherein the beetle population is rather abundant. However, instances of rather severe foliage injury have been noted at some of the older localized infestations in southern New England, where the beetle populations have built up to a considerable extent as a result of very favorable local conditions.

Tree Preferences of the Beetle. Experience has shown that in its choice of food, the Japanese beetle shows a marked preference for certain forms of vegetation and more or less avoids, or but rarely attacks others. Among shade and ornamental trees, it is especially fond of sweet and ornamental cherries, linden, Lombardy poplar, plum, horse-chestnut, sassafras, willow, apple, and elm. Where the beetles are extremely abundant it frequently happens that all or the greater part of the foliage of such trees will be completely riddled and turned a rusty-brown tint, suggestive of conditions in late autumn. Other trees, such as buttonwood, birch, Norway maple, and certain varieties of oak, namely, pin oak, chestnut oak and white oak, are often extensively attacked, but rarely so frequently or so severely as those first mentioned. Among broadleaved deciduous trees the Japanese beetle either does not attack at all, or at most only very rarely, the foliage of such shade trees as most maples and poplars, the ash, magnolia, mulberry, sweet gum, sour gum, tulip tree, hackberry, and beech. As a rule conifers are untouched, but there are occasions when the beetles injure quite severely the fresh and tender needles of bald cypress and larch.

The usual food preferences of the beetle are often modified by local conditions to such an extent that a species of tree usually preferred may be only incidentally attacked, while a tree which is ordinarily but slightly fed upon may be very seriously attacked. Trees in closest proximity to favored breeding grounds, such as lawns and golf courses, from which beetles are emerging in numbers, are usually attacked first, even though they are of the less favored "occasionally attacked" group. The extent to which a tree is exposed to sunlight is a very important factor causing variation in species susceptibility to beetle attack. Other factors being equal, trees standing alone are more liable to attack than the same species when in groups. In group plantings, the inner trees being shaded and protected, are seldom if ever attacked to any extent, while the outer trees, especially those most exposed to sunlight, may be severely attacked. In the same way, trees in wide thoroughfares exposed to sunlight during the middle of the day are more susceptible to attack than those on narrow, shaded streets. In general, a shady environment is not only less attractive to beetles, but at times may be very repellent.

Recommendations for Shade Tree Protection. It is not a difficult matter to protect most healthy, vigorous shade trees from attack by Japanese beetles, provided suitable equipment is available, proper materials are used, and the work is properly done. Diseased and poorly nourished trees and plants are more susceptible to attack than those in a healthy condition. Obviously, therefore, the first rule is that the health and vigor of shade trees and ornamentals should be maintained by proper pruning, fertilizing, and other appropriate measures.

The foliage can be protected by maintaining a deposit of spray residue on all portions of the plant or tree subject to attack, during the few weeks that the beetles are flying. The spray largely repels the beetle and prevents extensive feeding, the protection being obtained primarily by making the foliage non-attractive rather than by poisoning the insects. To apply the sprays properly to shade trees and the higher ornamental shrubs, high-power sprayers and spraying equipment are absolutely essential.

Timeliness and thoroughness in the application of the repellent sprays are very important. As a general rule, and especially in localities where the beetles are very numerous, the first sprays should be applied when the beetles begin to appear in the vicinity, before they become established on the trees or shrubs. In central New Jersey, the first application should ordinarily be made between the 20th and 25th of June; in other parts of the area, earlier or later according to the locality and seasonal conditions. In localities where the infestation is not so dense, the first application may if necessary be delayed until the beetles begin to appear on the plants to be protected, but if the infestation becomes heavy, it may be very difficult to prevent injury after the beetles have once commenced feeding.

The foliage of shade trees and ornamental shrubs that are subject to attack by the Japanese beetle can be protected by spraying with 6 pounds of acid lead arsenate and 4 pounds of wheat flour in 100 gallons of water, or with 6 pounds of acid lead arsenate and 1½ pints of light-pressed fish oil in 100 gallons of water. The lead arsenate spray being a stomach poison will also be of additional value in controlling other leaf-feeding insects. Sometimes people object to using arsenical sprays in close proximity to residences; in such cases, a lime and aluminum sulphate mixture, consisting of 3 pounds of aluminum sulphate and 20 pounds of hydrated lime in 100 gallons of water, may be substituted but this spray is not as effective as the lead arsenate spray under conditions of heavy infestation. These spray residues adhere well to the foliage, but it may be necessary to make a second application 2 or 3 weeks later after the initial treatment, to cover new growth and replace the deposit removed by rains.

THE SPRUCE SAWFLY (*Diprion polytomum* HTG.) AND THE EUROPEAN PINE SHOOT MOTH (*Rhyacionia buoliana* SCHIFF.)

By R. B. Friend, *Agricultural Experiment Station, New Haven, Conn.*

This meeting is devoted to the discussion of shade tree problems, and my remarks about these two pests of conifers, the spruce sawfly and the pine shoot moth, will be confined largely to their importance to shade trees rather than to forests. Both species are European in origin, and both can seriously affect the appearance and vitality of their hosts.

The pine shoot moth infests most native and exotic pines to a greater or less extent. Red, mugho and Scotch pines are the favorite hosts among our common species. Austrian and Corsican pines are sometimes well infested, although rarely to such an extent as the two species just mentioned. White pine has never been found badly injured, and the effect of the insect on this tree is of no significance. Ponderosa pine, a rather rare tree in this region, has been found a good host plant in the few cases which have come under observation.

The adults of the pine shoot moth fly in June and the first half of July, the peak of flight occurring the last week in June. The eggs are laid on the twigs near the tips and hatch in about 10 days. During the early summer the larvae bore into the bases of the needles at the tips of the twigs, and the presence of dead tip needles at this time is an indication of infestation. After a period of about three weeks in the bases of the needles, the larvae crawl to the tip of the twig and bore into the buds. Their presence is indicated by masses of pitch which exude from the tunnels. In the buds or under pitch masses on the buds they spend the winter. In the spring the bored buds are vacated and growing shoots are attacked. An infested shoot bears a mass of pitch on one side, becomes characteristically curved, and in the majority of cases, but by no means always, dies. If the shoot survives, it is distorted, and as far as observations in this country show, the crook is permanent. The pupal stage occurs in the shoots in May and June.

The injury caused by the shoot moth to pine trees is influenced by several factors. The tops of pines are more heavily infested than the lower branches, and isolated trees are more heavily infested than trees planted so close together that their branches touch when a height of 10 feet is reached. Even closely planted trees are subject to heavy infestation when small, being then isolated for all practical purposes. If a group of closely planted trees is infested after the branches close, those on the periphery of the group suffer more than those inside. Slowly growing trees are more seriously affected than those growing rapidly. The death of terminal buds and shoots causes latent buds to develop below the tips, giving the tree a bushy appearance. The shoots produced by these latent buds become infested in turn, and the bushiness may become accentuated. Moreover, if the infestation persists, shoots are killed more rapidly than they are produced, and loss of foliage and height growth ensue. Pines on poor soils become bushy and stunted more quickly than vigorously growing trees. Distortion of the bole of the tree, a result of shoot injury in the spring, is quite common. A heavy infestation may kill all the needles in the upper foot of the terminal of the tree, resulting in the death of this part of the main stem. It has been estimated that a population of 50 to 80 larvae per tree in the fall, or about 25 adults per tree in the spring, is sufficient to severely injure a red pine of any size from 6 to 25 feet. The concentration of larvae in the tops of the trees accounts for the severity of the attack on large specimens. It takes from three to five years for the shoot moth, once established, to reach this population density on red pine.

On mugho pines the infestation is commonly heavy but the effect is frequently less severe. This is due to the bushy type of growth in this tree. That is, it often does not look so bad as red pine when several shoots are killed. However, mugho pine is often badly disfigured by an abundance of dead tips.

The cold weather in winter has a marked effect on the survival of larvae. When the temperature drops below –10° F. the larval mortality is high, and at –17° F. it may be complete. This limits the abundance of the insect in northern New York and New England.

Control on shade trees may be attained by spraying or by removing infested buds and shoots. Two applications of a mixture of one pound of powdered skim milk and four pounds of ground derris or cubé in 100 gallons of water, the first application during the last week of June or the first week of July, the second 10 days later, have given excellent results on red pine. If the trees are so low that all parts can be reached from the ground, and are few in number, the infested buds and shoots containing the larvae may be removed and destroyed. This is most easily accomplished in May, when the infested shoots are conspicuous. It is practically impossible to successfully treat mugho pine in this manner at any other time, because there is a natural exudation of pitch from the buds, and the pitch flow resulting from larval injury may be easily mistaken for this. If control measures against the shoot moth are efficiently carried out, treatment of the trees every other year should suffice unless there are untreated infested trees in the immediate vicinity.

The recovery of root-injured pines, and new plantings should be considered. Any form of injury which retards the growth of trees susceptible to shoot moth attack tends to increase the severity of the injury caused by the insect. This is particularly true of red and Scotch pines. If pines are to be planted in the region where the shoot moth is abundant, species highly susceptible to the shoot moth, as red and Scotch, should be avoided unless proper care of the trees in the future is assured.

The spruce sawfly is a defoliator of native and exotic spruces. In the forests of eastern Canada and northern New England it is a very serious pest, often completely stripping the foliage from the trees. In Connecticut the insect is found throughout the state, and several ornamental Norway spruces in the state park at Kent have been entirely defoliated. Partial defoliation has occurred on spruces elsewhere.

This insect has three generations a year in southern New England. The adult female lays its eggs in slits in the needles, and these hatch in about a week. The larvae, which are light green in color when young, and green with longitudinal white stripes in the last two feeding stages, eat the needles, confining their attack to old foliage the first part of the summer but feeding on the needles of the current year late in the season. The cocoons are brown in color and are found in the litter under the tree. The winter is spent by the larvae in these cocoons, and some of the larvae may remain in the cocoons up to five years before pupating. This tendency to prolong dormancy results in the reinfestation of spruces by the same generation over a considerable period of time. Where three generations a year occur, the peak of attack comes late in the season. The preference for old needles often results in the partial defoliation of spruce, accompanied by weakening of the trees, for several years before death occurs.

Sawflies are very susceptible to arsenical poisons, and spruces can be protected against this insect by spraying with a mixture of 3 pounds of lead arsenate and 12 ounces of fish oil in 100 gallons of water. The application should be made when an infestation is found.

If an attack of the sawfly on a spruce tree is accompanied by a gall aphid infestation, and these two factors are added to any other condition inimical to vigorous growth, the result is a tree which survives with difficulty. This is not a hypothetical case, for Norway spruces have been observed which were struggling against the combined infestation of the two insects and a poor site, much to their detriment. The presence of the sawfly emphasizes the care necessary to maintain ornamental spruces in a state of good health.

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THE GYPSY MOTH AS IT APPROACHES THE BARRIER ZONE

By A. F. Burgess, *United States Bureau of Entomology and Plant Quarantine, Greenfield, Massachusetts*

In 1923 an area which is known as the barrier zone was selected in territory between the Canadian border and Long Island Sound east of the Hudson River and covering a similar area adjoining it in Vermont, Massachusetts, and Connecticut. The purpose of the selection of this area was to give it periodical inspections and clean up colonies of the insect that might be established in it, so as to prevent westward spread of the pest to adjoining and distant states. Most of the work in New York state has been done by the Department of Conservation in cooperation with the Bureau of Entomology and Plant Quarantine.

Since that work began many colonies have been found and exterminated which were scattered throughout the zone, millions of acres of tree growth including forests have been examined one or more times. As a result of the intensive methods that have been employed in cleaning up infestations, territory in New York state aggregating 511,000 acres on the western border of the zone has been eliminated from further inspection, and additional territory on the east side of the zone in the northern part of Vermont aggregating 686,000 acres together with two smaller areas contiguous to the zone in Connecticut covering 102,900 acres, have been added to the zone. Based on the work that was finished during the past year towns along the western border of the present zone in New York aggregating 521,000 acres, together with towns similarly located on the western border of the zone in Vermont covering 398,000 acres have been designated as towns that will not require further inspection. There are at the present time small infestations in three towns on the eastern border of the zone in Vermont and scattered infestations which require treatment in the southern half of the zone in New York. The southern half of the zone in Connecticut is not known to be infested, but scattering infestations which require intensive treatment occur in the northern half of the zone in that state and in the southern part of the zone area in Massachusetts.

During the fifteen years since the barrier zone work started, 44 infestations, most of them small in area and intensity, have been found outside the zone in New York state. Forty of these have been exterminated, more than one half of them being located on Long Island. In recent infestations in Hague, Warren County; Shawangunk, Ulster County; and New Castle, Westchester County; as well as near Roslyn, Nassau County, additional work will be required.

About the time work was begun in the zone, an area in northern New Jersey covering over 2300 square miles was found to be infested by this insect and intensive treatment was necessary in the central part of this area embracing over 400 square miles for the purpose of eliminating the pest from that state. Few isolated infestations were found in territory outside of the generally infested area and they were promptly cleaned up. Federal work in New Jersey was completed in 1932 but the discovery of a few egg clusters along the northern rim of this area has made it necessary to do additional work during the past three years. At the present time the insect is not known to exist in the state.

The most serious outlying infestation at the present time was found in northeastern Pennsylvania in 1932 in territory surrounding the cities of Scranton and Wilkes-Barre. Work has been necessary in an area of 2500 square miles. The central area which is generally infested and covers 236 square miles, is surrounded by a lightly infested area of 800 square miles, and scattered isolated infestations have been found outside this area embracing an additional territory of 1500 square miles which has been examined and treated but must be rechecked before inspection work can be discontinued. Progress has been made in reducing the abundance of the insect and the pest has been exterminated in many isolated localities, particularly in the outlying territory.

During the last fifteen years the states of New York, New Jersey and Pennsylvania, except in the sections already mentioned, have been relieved from the expense of treating for this insect, or of suffering serious losses to shade, park and forest tree growth. Protection has also been accorded to the states adjoining or more remote from those already mentioned, as the insect would have undoubtedly become established and flourished prior to the present time in remote areas and possibly in distant states, if work in the barrier zone and the outlying colonies, together with careful inspection of products that might carry the pest, had not been vigorously enforced. This statement is corroborated by the fact that in the year 1912 a vigorous colony was found in Geneva, New York, another near Pittsburgh, Pennsylvania in 1920, and a third in Cleveland, Ohio in 1914. All of these colonies were promptly exterminated but if no protective work had been done the insect would have been present over a very large portion of the eastern United States at the present time.

It is obvious that the heaviest infestation of this insect is in the regions nearest the Atlantic seaboard, particularly in eastern Massachusetts where the insect first became established, and in New Hampshire and Maine where it spread shortly after 1900. Prior to 1933 the insect did not occur in large numbers west of central Massachusetts or west of central New Hampshire. It is true that small infestations have been found in many towns west of this area but a sufficient amount of treatment was applied, or climatic or other conditions prevented abundant increase of the insect. Since that year weather conditions during the winter have been on the average unsually favorable for the protection of the insect which caused a heavy increase during the summers which followed. In the winter of 1933–34 the temperature in most of this area and particularly that to the north and northwest, dropped to a point below –20° F. which in most cases will destroy egg clusters, but heavy snow and ice afforded effective protection. The increase in the number of egg clusters was accompanied by an increase in the acreage of defoliation the following summer and fear was expressed as to the conditions existing in the territory between the eastern boundary of the barrier zone and the Connecticut River in Vermont, Massachusetts and Connecticut.

As soon as emergency funds were available in 1933, examinations were made in much of this territory which indicated that the infestation there was more general than had been previously anticipated. Further emergency funds were not allotted for this work until 1935 at which time the regular funds of the Bureau for Gypsy Moth work were insufficient to carry on the scouting and cleanup work in the field except from emergency allotments. Men in C.C.C. camps were also detailed for work east of the barrier zone.

In the area from the Connecticut River as far east as the city of Worcester, Massachusetts, serious defoliation occurred in a number of widely scattered towns in the summer of 1934. It increased until 1937 when more than 60,000 acres were defoliated. The acreage was somewhat less in 1938 than during the previous year. In towns adjoining the Connecticut River on the west, a moderate amount of Gypsy Moth feeding was noted in a few towns from 1934 to 1936. In 1937 defoliated areas were noticeable in a number of towns contiguous to the river and there was a substantial increase in 1938. During the summer, a heavy deposit of egg clusters was found in the towns of Montgomery, Russell, Granville and Southwick, Massachusetts, and Granby, Canton and Simsbury, Connecticut. During the summer of that year more than a thousand acres were defoliated in the towns mentioned in Connecticut, which is the largest acreage that has ever been reported in any year in that state.

As a result of the work done in territory between the Connecticut River and the barrier zone, the increase of the insect was greatly reduced and the normal increase of the insect prevented. Hundreds of small infestations were eliminated and in many towns no noticeable feeding of the insect was apparent. This was accomplished in spite of the fact that all emergency and C.C.C. forces have been constantly reduced.

In 1937 owing to heavy curtailment of emergency funds, all work east of the barrier zone was discontinued by the W.P.A. force, except in a limited number of localities that were particularly threatening to the zone. During the present year the number of C.C.C. enrollees have been reduced owing to the abandonment or discontinuance of various camps and at the present time, on account of the tremendous damage to tree growth as well as to roads and bridges on account of the hurricane and accompanying flood, this force has been reduced by transfer to approximately 200 men.

With the discontinuance of W.P.A. work in a territory east of the barrier zone in the fall of 1937, it was impossible to carry on the volume of work that was necessary to retard the increase of the insect in some sections of this area, and that coupled with the decrease of C.C.C. men, and the relatively mild winter of 1937–1938 made conditions favorable for increase of the pest. It is true that in the spring of 1938, owing to unfavorable weather conditions, there was heavy mortality of Gypsy Moth larvae in many isolated areas, but in general the increase in the territory between the barrier zone and the Connecticut River was greater than normal. As a result there was more defoliation in this strip of territory than had ever previously been reported, and the area where it was most severe and threatening to the barrier zone embraced territory in the towns of Montgomery, Russell, Westfield, Granville, and Southwick, Massachusetts; Granby, Canton, and Simsbury, Connecticut. In fact the extent of infestation and the area of defoliation in these three Connecticut towns was greater than had ever previously been reported in that state.

So far as funds and man power will permit the work is being concentrated in the area most threatening to the zone. Scouting work during the past year indicated definitely that some of the isolated colonies which have been found in the barrier zone in northwestern Connecticut and southwestern Massachusetts originated from windspread and it is probable that some of the infestation came from heavily infested spots east of the zone. It is hoped that winter conditions will be sufficiently severe this year so that material assistance in reducing the abundance of the insect may result, as this would be extremely helpful and assist in preventing the spread of the pest.

Injury to tree growth by the hurricane which overturned and broke down thousands of acres of forests, as well as a large number of valuable shade trees in parks and along the streets and on the property in residental and farm areas, is difficult to estimate. In addition to this, flood conditions due to abnormal rainfall which accompanied the hurricane, uprooted many trees, caused heavy damage by water and in some sections injured many of the less traveled roads to such an extent that many of them never will be rebuilt. Some of these conditions existed in territory west of the Connecticut River, but the areas were smaller than in the territory farther east. There are many thousands of acres of woodland, particularly pine, that has been blown down, and the ground conditions are such that in spite of the salvaging operations that may be carried on, the area is almost impassable unless a thorough cleanup and burning of slash is done.

In addition to this, with the egg deposit which was at least normal, and the scattering of many eggs due to breakage of the tree growth by the violent wind, there is every probability that in territory east of the Connecticut River there will be normal, or above normal, hatching next spring. Even if tremendously low winter temperatures should result they will not be very effective in areas where trees have been blown down, unless there is proper salvaging and burning of debris. Salvage operations can be of great service in cutting down the Gypsy Moth population, if in addition to logging, cleanup and burning of debris can be done.

DUTCH ELM DISEASE CONTROL IN NEW YORK STATE

By W. H. Rankin, *Supervising Horticulturist, State of New York Department of Agriculture and Markets, Albany*

Upon the finding of the large area invaded by the Dutch elm disease in and around New York City in the fall of 1933, it was recognized that the future existence of the elm in the United States was seriously threatened. Large monetary losses were indicated in the near future in public and private property values, as well as the heavy cost of removals and replacements in residential areas if the disease was allowed to spread out of control.

The loss of the American chestnut was a recent object lesson which forewarned that such an event could happen and that we should not hesitate to do what was possible in an attempt to prevent the passing of the most valuable of all of our ornamental tree species. In the face of theoretical uncertainties on the possibility of eradicating the disease it was decided that the attempt should be made. It was believed that the public expected their State and Federal government agencies to determine the possibility of eradicating the disease by action rather than by debate before surrendering the elm to extinction and writing off the millions of dollars loss that such a decision would entail.

It was in this spirit that New York State assumed its responsibility to cooperate with the Federal Department of Agriculture in prosecuting an eradication program. Since 1933 New York State has appropriated for this work over $700,000 including the research project under the direction of the New York State College of Agriculture.

The Program. The objective of the program from the beginning has been to find and destroy by burning all sources of spread in so far as practicable and by this means prevent the enlargement of the infected area and reduce the incidence of the disease to a point where complete eradication might be found possible.

The method for attaining the objectives has been to find and burn promptly in the summer all elms that are being killed by the disease to prevent local spread and to destroy in the winter the principal and larger dead elm material breeding elm bark beetles.

The field program as conducted by the Federal Department of Agriculture, because of dependence on W.P.A. funds, has fallen far short of applying these methods effectively, both from the standpoint of systematic and timely coverage of the area and from the standpoint of the essential efficiency and skill in the field employee that is necessary in examining elms to locate those dying of the disease. For example, during the past summer W.P.A. funds failed for various reasons to provide for 64 per cent of the man-days needed to inspect and sample the elms of the New York infected area. As a result large sections were not scouted and Westchester and Rockland Counties received only one systematic inspection which was not finished until the middle of August. Furthermore, a large part of the man-days put in were non-productive. The errors of omission and commission in locating diseased elms that will become centers of spread are increased greatly by using unskilled labor and by delay in covering the territory beyond the season for best symptoms expression.

The New York State Department of Agriculture and Markets under State law arranges for the conduct of the work on private and public lands. Permissive agreements for the destruction of designated items are sought by personal contact where possible or by letter and if necessary official orders requiring the destruction are served. Exceptionally satisfactory owner response has been developed and zealously guarded. Besides these property owner relations, the State has assumed responsibility for the functions that require a skilled and experienced personnel to insure careful attention to preventing spread from known diseased locations. These activities are:

1. Removing and destroying all diseased elms and completing the sanitation for possible root-grafted elms and beetle breeding material within 50 feet.

2. Inspection of all recent diseased locations for local spread every two weeks in the summer months.

3. Special sanitation for 500 feet around the current diseased locations including pruning of beetle breeding wood.

4. Planning and supervising selective sanitation in dense stands and swamps near diseased locations to leave only healthy elms.

5. Also the State, to the extent that funds permitted, has employed experienced men to assist in the summer scouting of the heavily infected zone east of the Hudson River in order to gain the greatest headway possible in reducing the rate of spread.

RESULTS. The Federal work program as amplified by New York State's efforts has given the following results:

1. East of the Hudson River in the heavily infected zone of 1934, the incidence of the disease has been reduced annually by 30 per cent to 40 per cent; but to the north in upper Westchester, Putnam and Dutchess Counties the area of light infection has greatly increased in size and the numbers of diseased elms have increased annually throughout this area.

2. West of the Hudson River, adjacent to the heavily infected territory in New Jersey and with local swamp problems of considerable magnitude, the incidence has not been reduced below the 1935 figure and the lightly infected territory to the north covering most of Orange County has slowly increased in size and numbers of diseased elms annually.

The known infected area in New York State over which scouting for diseased elms and sanitation for bark beetle material must be done each year has increased as follows: 1144 square miles in 1934, 1402 in 1935, 1706 in 1936, 1867 in 1937 and 2460 in 1938. These figures show the failure of the eradication program to prevent the disease from spreading into increasingly larger territory.

In other respects, however, the eradication program has shown results that are highly encouraging. For example, in both the heavily infected and lightly infected zone east of the Hudson River it is definitely demonstrated that prompt removal of the diseased elms and local sanitation will prevent recurrence of the disease in the immediate vicinity.

This is shown by the results in New York City with an area of 300 square miles and an estimated population of 50,000 elms over 5 inches, where the incidence has been reduced as follows: from 1320 diseased elms in 1934, to 627 in 1935, to 269 in 1936, to 128 in 1937 and 61 in 1938. This past summer no diseased elms were found in Manhattan and Brooklyn and only 3 were found in Queens. The drop to 21 diseased elms on Staten Island in 1938 from 716 in 1934 in an estimated population of 10,000 elms over 5 inches, and the reduction from 465 in 1934 in the Bronx to 36 in 1938 in an elm population of at least 20,000, shows the effectiveness of the eradication method. The 61 diseased elms found this year in New York City represent a loss of only about one-tenth of one per cent of the estimated number of elms over 5 inches which gives a high rating to the eradication method as a control measure.

North of New York City in the residential area of lower Westchester

County in an area of 140 square miles and a population of about 240,000 elms over 5 inches, the incidence has been reduced from 1032 diseased elms the first year to 280 in 1938. In this region the disease had gained considerable headway by 1934, when many areas showed 10 to 30 or more diseased elms to the square mile. Estimates at that time indicated that the rate of increase was about 5 times annually. The 36 per cent reduction in this region in 1937 below the 1936 figure, and the 40 per cent reduction in 1938 below 1937, indicates that additional progress can be made here and that the eradication method can be depended on to hold the incidence to its present low figure of about one-tenth of one per cent of the elm population in this region of high elm values.

The effectiveness of the eradication measures in preventing local spread is best shown by the results obtained in northern Westchester County, in an area of 234 square miles where the number of diseased elms found has increased annually as follows: 9 diseased elms in 1934, 20 in 1935, 67 in 1936, 138 in 1937 and 136 in 1938. Delay in scouting this area in most summers until August may account for these increases. The record is definite, however, that the prompt eradication of the diseased elms found each year and local sanitation has been effective in 87 per cent of the cases in preventing any further occurrence of the disease in the vicinity. Of the total of 150 locations where single diseased elms or groups of diseased elms were found only 22 have ever showed recurrence of the disease within a 500 foot radius. Of the 22 cases that did show apparent recurrences only one showed infection persisting into the third year. These records for a large rural area of light infection as well as those for the southern portion of Westchester County in a residential area show the striking effectiveness of finding the diseased elm, destroying it and sanitating for beetle breeding material. The large majority of the diseased elms found each year both in the heavy and lightly infected zones occur in new locations that have no connection with past known cases or any failure to prevent local spread from known locations.

These facts indicate that the future success of the eradication program, if it is to accomplish more than suppression and local control, depends on the development of better detection methods to find sources of spread that are now being over-looked. Whether a more efficient personnel and timely coverage of the territory would detect these sources as trees showing symptoms or whether there may be a persisting residue of hidden sources of spread, should be determined as soon as possible because on that one factor will depend the possibility or impossibility of the actual eradication of the Dutch elm disease. The answer to this question and the results in the next year or two in preventing the further extension of the infected territory will decide whether it will be practicable to eradicate the Dutch elm disease or whether we will have to live with it and depend on local suppression measures for regions where elm values will warrant the costs.

At least three important assets have accrued in New York State from the eradication program to the present time; first, the elm values of metropolitan New York have been saved by reducing annual losses to about one-tenth of one per cent; second, eradication measures have been developed which can be economically applied to maintain these elm values in metropolitan New York at a cost of about 15 per cent of the total cost of removing the elms in important locations alone, if they were allowed to die over a ten year period; and third, the experience gained and possible research developments to come, furnish reasonable hope that protection can be given to smaller residential areas where elm assets warrant the cost of inspection and sanitation for bark beetle breeding material.

DUTCH ELM DISEASE ERADICATION WORK IN NEW JERSEY

By E. G. Rex, *Supervisor, Plant Pest Control, N. J. Department of Agriculture, Trenton*

The first Dutch elm disease infected tree was found in New Jersey in the spring of 1933. During the years of 1933 to 1936 inclusive there was a progressive annual increase in the number of Graphium trees found in the State. In the year 1937 the number of Graphium trees located was less than the number detected during the season of 1936 and we, probably optimistically, assumed that we had reached the peak of Graphium incidence in the year 1936 and were now gloriously coasting to our objective of eradication. However, with an increase of 200 per cent of confirmed Graphium trees in 1938 as compared to 1937 we were promptly disillusioned of the trend, temporarily at least, of our success in the eradication venture.

Having the sudden increase of 200 per cent in the incidence of Graphium in the State of New Jersey could readily lead to despair. However, such a spirit of resignation should not be adopted without a struggle.

Accordingly, we attempted to analyse all the available data pertaining to the work of the season of 1938 hoping that we might unearth some definite plausible reason for the sudden increase in the number of Dutch elm infected trees.

During the fall of 1936 this project became deluged with a considerable number of W. P. A. workers, many of whom were of questionable acceptability. However, an attempt was made to make the best of this situation. Furthermore, an examination of some research data pertaining to tree injection work led to the adoption of a procedure, known as "silviciding" which should serve as a short cut to our goal. The purpose of the silviciding operation, which is the introduction of chemicals into a tree for the purpose of killing it, was to eliminate both from the standpoint of further scouting and from the standpoint of beetle multiplication, trees located in swampy areas or difficult mountainous terrain. This object was certainly commendable and judicious. Accordingly, during the fall of 1936 and the spring of 1937 approximately 600,000 trees located principally in swamps and mountainous areas were chemically treated for the purpose of eliminating them from the Dutch elm disease eradication program. Unfortunately the employed procedure was not 100 per cent effective in the killing of the trees so treated. Many of the trees treated served as suitable habitats for bark beetle multiplication and it was predicted that we should expect an increase in the number of Graphium trees in 1938.

About two weeks after the scouting season of 1938 had been under way reports from the various county offices reporting to our Bloomfield office, indicated that many confirmed Graphium trees occurred in close proximity to previously silvicided areas. This information immediately led to investigation as to the probable part played by these silvicided areas in the Graphium increase for 1938. Accordingly, a questionnaire carrying several requests for information was distributed to the field men soliciting information pertinent to the occurrence of Graphium trees in these areas. We attempted to ascertain the number of Graphium trees occurring within a one-mile wide band around each of the clean-cut silvicided areas. We also ascertained the number of Graphium trees occurring within the limits of D. T. silvicided areas. Of the total number of 16,000 Graphium trees for the State of New Jersey in 1938 approximately 10,500 occurred within the areas delimited above. An interpretation of these data will reasonably permit the conclusion that the bark beetles emanating from the silvicided areas to trees in the adjacent areas were responsible for the increase in Graphium of this year. Upon receiving this field information from the various county supervisors we were incidentally informed that the one-mile wide band which was used as a basis for the collection of the data should be divided into an inner one-half mile band and an outer one-half mile band. In so doing we ascertained that approximately 80 per cent of the Graphium trees occurring within the one-mile wide band around clean-cut silvicided areas occurred within the inner one-half mile band. This information indicates that the beetles emerging from the silvicided plots did not, generally speaking, fly very far beyond the limits of the first available elm trees.

As previously stated this silviciding work was, almost in its entirety, confined to swampy areas and mountainous terrain, therefore, the trees involved in the Graphium confirmations around these areas were in rural woodland areas. Very few ornamental trees were involved. The average D. B. H. of the Graphium trees around these silvicided areas was six inches.

Having thus analyzed the silviciding data and arrived at the conclusion that this operation was in part, if not in entirety, responsible for the increase in Graphium for the year 1938, the question still remains how much longer these trees will provide facilities for bark beetle multiplication. A careful examination of representative areas of silvicided trees indicates that not more than 4 per cent of the 600,000 silvicided trees will liberate beetles next spring. No attempt has been made to predict the inroad which will be made by woodpeckers on the remaining bark beetle population this winter. It is known that the population of woodpeckers in the Dutch elm disease area in New Jersey has been significantly increased. We can, therefore, assume that the silvicided trees in the State of New Jersey will become practically functionless so far as the dissemination of the Dutch elm disease is concerned.

In consideration of the Dutch elm disease eradication work in New Jersey there is one more factor of which I speak reluctantly and yet which cannot be ignored if a complete picture is to be established. I am making reference to the non-acceptability of W. P. A. labor for scouting and supervision work. At the beginning of each calendar year a work program for Dutch elm disease eradication work in the State of New Jersey is constructed. This program calls for a certain number of supervisors, a certain number of scouts and a certain number of laborers. At no time has this program requisition been met. Ofttimes the number of scouts, to say nothing of their aptitude for the work to which they are assigned, is considerably less than the number required to cover the ground in the allotted time. It must be borne in mind that the scouting for Graphium trees is distinctly a seasonal operation which cannot be postponed so as to conform to the availability of labor. The best season for the scouting of Graphium trees is from the middle of June to the middle of September and during that period an adequate supply of acceptable trained men should be available. In the State of New Jersey no more than two-thirds of the infected area was adequately scouted in 1938. The Federal people, however, shrewdly directed the available effort into the localities where the disease is known to be the more seriously established.

Prophetically, it is rather difficult to venture an opinion regarding the success of our eradication endeavor. The program which has for its objective the eradication of the Dutch elm diesase, has never been fully enforced and, therefore, we have before us no satisfactory criterion regarding the possibility of attainment of efforts which we may put into the project. Recent conferences in Washington, D. C. have radiated considerable hope in that the administration of the Dutch Elm Disease Eradication Project may become unshackled from the W. P. A. restrictions and shortcomings and enable us to make a sincere progressive effort to attain the eradication which we have espoused for the last five years.

THE DUTCH ELM DISEASE SITUATION IN CONNECTICUT

By W. O. Filley, *Forester, Connecticut Agricultural Experiment Station, New Haven*

Now that the scouting season of 1938 is ended, the results look rather discouraging as compared with previous years. The total number of Graphium trees found in 1938 is 536, while that for the four previous years was only 361. Furthermore infected trees were found in five new towns in 1938 and there were only two towns in which infected trees had been previously reported but where none were found this year.

However, the total of Graphium trees for five years in Connecticut is only 897, as compared with 9,086 in New York State and 39,932 in New Jersey. It is obvious that Connecticut cannot be discussed separately in this matter but must be considered as a part of the generally infected area around New York City. Less than 2 per cent of the Graphium trees found in Connecticut have been outside the 60 mile circle which includes Westchester County, New York, and most of the infected area in New Jersey. If Fairfield County, Connecticut, is considered as an outer segment of the generally infected area, the increase in numbers of Graphium trees does not loom so large, and the fact that infected trees were found in five new towns this year does not seem so discouraging. Analysis of the figures shows that 86 per cent of infected trees found in 1938 were in the five towns nearest New York City (i.e., Greenwich, Stamford, Darien, Norwalk and New Canaan). These towns are also credited with 89 per cent of the total of infected trees for the entire five year period of scouting.

So far as can be determined, the increase this year seems to be due very largely to the maintenance of wood piles by landowners who had cut down their own elm trees. These provided ample breeding material for bark beetles, with new centers of infection as a result.

The most encouraging feature of the Connecticut situation is the fact that no Graphium trees were found in Old Lyme this year. The total for previous years was seven and it seems probable that this outlying infection center has been eradicated, although the finding of another infected tree or two is still a possibility. No more infected trees were found in Guilford, but three more were located in Branford and three in the neighboring town of North Branford. This looks like another outlying infection center within ten miles of New Haven. It is more than twenty miles from Branford to Old Lyme and almost as far to the nearest known infected tree to the west in Stratford. The Branford infection is therefore as difficult to account for as was the one in Old Lyme. Every effort will be made to clean up this area next year, but it will be much more difficult to handle than the Old Lyme area, because of the hurricane results.

This is true throughout most of the so-called infection area in Connecticut. The main problem for the coming season is to prevent a staggering increase in the population of elm bark beetles by getting rid of the tremendous amount of hurricane felled elmwood which will otherwise provide beetle breeding material. Although this problem is a serious one in the shore towns of Fairfield County, it is much worse further east. Fortunately *Scolytus multistriatus* has been found in only one Connecticut town east of the River, although Hylurgopinus is abundant everywhere. In the vicinity of New Haven and Branford, the smaller Scolytus beetle is quite common and it is there also that the complete destruction of elmwood is difficult to ensure. Although city and town authorities have endeavored to prevent the storing of elmwood, the task was too great and it is believed that many wood piles will provide beetle breeding material in abundance. In addition, there are many woodland areas in which wind-felled elms will be left on the ground. Every possible effort will be made to clean up such material before spring, but it seems highly probable that the bark beetle situation will be the most important factor in the Dutch elm disease work in Connecticut for the next year at least.

However, much has been accomplished during the past five years by the Dutch elm disease eradication forces, in spite of many handicaps and obstacles. If the Bureau of Entomology and Plant Quarantine can be supplied with adequate budgetary funds to provide for proper scouting and supervision, the extra hazards created by the hurricane will not prove insuperable. It seems to me that the results already secured in Connecticut, plus the encouraging results secured in New York State, warrant optimism for the future.

STUDIES OF ROOT SYSTEMS OF TREES

By D. T. MacDougal, *Coastal Laboratory, Carnegie Institution of Washington, Carmel, Calif.* (Read by W. J. Robbins)

Systematized information as to stature and disposition of roots of trees beyond the seedling and nursery stage is very fragmentary. The trunk and crown are under constant observation and much is known as to the changes which are important in the physiology of the tree, silviculture, timber production, and ornamental planting. Similar delineation or measurements of the development and maturity of root-systems are extremely scanty and very few generalizations may be founded upon them.

In my own studies of the Monterey pine, measurements of root-systems could be made only by excavations at a cost of $15.00 to $25.00 per tree of an age over 20 years. A dozen large trees were thus dug out and a number which had been uprooted by storms were also available. The arrangement of the results made it possible to conclude that of the woody material constructed from the leaf-products of this pine tree as much as one-fourth or as little as one-seventh of the total amount in trunks and branches was used in the construction of the root-systems[1].

[1]See MacDougal, Life History of a Pine Tree. Chapter VIII, Tree Growth. 1938. Leiden.

Taken in connection with dendrographic studies, it became apparent that the flaring bases of trunks and the abruptly enlarged basal portions of attached roots constituted a distinct physiological unit, or well-defined region so far as period of seasonal growth, activity of the cambium and concentration of growth promoting substances were concerned. Its individuality becomes more marked with age and it is to be noted that it is this mass of woody material which undergoes maximum stresses from the flexion of trunks swayed by the wind. Some of these features are reflected in the results of tests for specific gravity, crushing strength and modulus of rupture in the engineering laboratory.

Of the estimated million trees reputed to have fallen in the great storm in New England, it seems highly probable that a few hundred or a few thousand representing several species have been uprooted in such manner as to render possible studies of the development of root-systems with respect to

a. Corresponding stage of the crown.
b. Nature of the substratum or soil-formation.
c. Character of stand and associations.
d. Extent and volume of root-system.

Systematized information as to the above features would constitute a contribution of permanent value in the physiology of trees, in forestry, horticulture and in all kinds of silviculture and ornamental planting.

Definite schemes of measurement should be formulated, in which the principal part of the work would be done in the field. Whatever anatomical studies were seen to be important could be carried out in the laboratory in connection with pathological work. A committee to make out a working plan and to supervise its execution should be set up as a necessary first step in the movement.

THE BROADER ASPECTS OF HURRICANE DAMAGE

By E. P. Felt, *Bartlett Tree Research Laboratories, Stamford, Conn.*

It is by no means easy to express in a few words just what the hurricane has done to the shade trees in the storm swept area. The damage was by no means uniform throughout the territory. It is more than probable that the interpretation of one man may vary from that of another and that a reasonable measure of fact may be true of both accounts. It is possible to find exceptions for almost any statement in regard to storm damage. The area affected is large and the force of the wind varied greatly even within short distances.

We have yet to see a community where all the shade trees were destroyed by the hurricane and even in sections where there was the greatest damage, the proportion of uprooted or badly damaged trees rarely overran twenty-five per cent and in most cases this was limited to parks, business centers or similar areas. The Main street elms of East Hampton, L. I., were most unfortunate. One hundred and thirty-nine big trees were blown down and one hundred and eighty-seven remained standing, a loss of a little over forty per cent. This was practically a duplication of the local damage from the hurricane of 1815 except that in the earlier storm there were fewer buildings. Available records indicate that the 1815 storm covered practically the same area as that of last September. There was no damage then to wire lines because they were non-existent. There is a still earlier major storm, that of 1635. The sole record relates to conditions at Plymouth, Mass., and gives no indication of the area covered by the storm.

We have been curious as to why there should be markedly greater damage to shade trees in community centers as compared with equivalent trees in the open country. Note at the outset that there are marked differences in storm effects on forest trees compared with shade trees and that this account is limited to shade trees. It is our conviction after traveling over a thousand miles in the storm swept area that a decidedly lower proportion of the larger shade trees along country highways or even on lawns of country residences were severely damaged by the storm compared with those in thickly settled localities. There were places here and there in the country where trees or groups of trees were uprooted or badly broken and yet the proportion was considerably less in our judgment than in cities and villages. It is our opinion that this is most reasonably explained in part by the generally better growing conditions for trees along country roadsides than in the thickly settled places. The country trees are usually more distant from the road and therefore have suffered less from the installation of the macadam or concrete roadbeds. They have escaped almost entirely the hazards to roots of ditching incident to the installation of water, sewer and gas pipes. It is also probable that the building in cities and villages deflected the fiercer storm blasts in such a manner as to increase the damage to nearby trees.

It may occur to some that such explanations have little bearing upon many park trees or trees growing under park-like conditions as, for instance, on the village green where they may be moderately distant at least from buildings, modern roadbeds and accompanying services. Many a tree was blown over or broken in these park-like areas and in not a few cases the ball of earth upturned with the roots was remarkably small. It has been generally assumed that such trees are growing under almost ideal conditions and little thought has been given to the fact that in such places there is rarely enrichment of the soil either by systematic application or incidentally from the pasturing of animals. This latter was common on village greens in earlier days. Fertilizing for the rich, shortly clipped sod of today is supposed to provide adequate plant food for the trees. The hurricane effects suggest that there may be an error in this assumption and that the grass of the lawn takes up most of the plant food and prevents much of it from working down to the tree roots.

Another condition which attracted notice was that for the most part damage to shade trees was limited to those 50 to approximately 100 years old. The younger trees, those about 40 years of age or less, largely escaped storm damage and this was true also of the trees which had entered the second or third century of their existence. The reason probably is that the younger and therefore smaller trees had more vigorous root systems and the tops being lower offer less resistance to the winds than those in the 50 to 100 year class whereas the older trees were mostly growing where conditions were excellent and consequently these trees had developed the greater vigor of root and branch necessary to storm resistance. It was easy to note here and there giant elms which had successfully resisted the storm although lesser trees, not the smaller ones, had been seriously damaged. The same storm resistance of larger trees was also seen in white pine and Norway spruce. Many of those up to approximately 70 years of age were snapped off in areas where the storm was most severe while larger and older trees mostly weathered the storm. In this particular case, it is our belief that the outer and thinner wood rings of the aged trees are tougher than those produced in the first 70 years. There are exceptions but they are relatively few. The trees in many cemeteries were badly damaged by the storm. This was due partly to their being in exposed locations, partly to root injury incident to interments and erection of monuments and also to the extensive planting in some of the cemeteries of white pines and Norway spruce. There was also severe damage in cemetery areas established in partly cleared forest due probably to poor root systems as well as to digging for graves.

The uprooting of trees, greatly aided in this storm by excessive and

Trees on Dale Street, Worcester, Mass., after the hurricane. Note that all have fallen toward dwellings and the relatively small rootage

The base of a Norway maple some 18 inches in diameter showing the numerous roots cut when digging a ditch for the installation of a curb. The edge of the ditch is within 9 inches of the base of the trunk of the tree. The Dale Street trees (Plate 7) were probably weakened earlier in a similar manner protracted rains, is purely a physical problem. It depends upon the thickness of the top or the related wind resistance and the strength and extent of the root system. A dense top on a tall tree is a potential storm hazard, the taller the tree the greater the danger from wind storms. These was a case at Westport, Conn., in 1931 where several tall Carolina poplars with trunk diameters of about three feet were blown over whereas a nearby tree which had been headed back a few months before was practically undamaged and the nearby cottage escaped unharmed. Undoubtedly many such cases could be found in the storm swept area of last September. The extent to which heading back is justified depends much upon local conditions. This is one method of reducing the probability of hurricane damage. The effects of street curbs are shown on plates 7 and 8.

The development of a more adequate root system is surely worthy of consideration. Neglect of this may be costly. A recently published item stated that $100,000 is needed to repair side walks broken by uprooted trees in Queens County, N. Y. It is well known that deep rootage is impossible in a shallow soil, on rock and in a soil where the water table or a heavy clay or hardpan is near the surface. The obvious thing is to recognize these conditions and use low growing trees in such areas or head them back to offset to some extent the manifest root limitations. It is known that the roots of most trees reach out after plant food and even in areas where deep rootage is impossible, it is believed that judicious feeding may result in a material extension of the root system, thus giving the trees a firmer hold upon the soil.

The inadequate root systems of many trees in parks and park-like areas may be corrected to a large extent by deep feeding, preferably by the bar hole method, since this is the more economical and certainly an efficient method of stimulating root growth and inducing a deeper penetration of roots in the soil. Recently our attention was brought to a series of "root casts" so to speak which had developed after the feeding of an elm some two years previously. The plant food in 15 inch bar holes had been so thoroughly invaded by tree roots that they occupied practically the entire space and since these holes were in heavy clay ordinarily not invaded by the roots to any extent, it is obvious that these "root casts" greatly increased the hold of the tree upon the earth. The same thing would result in lighter soils though the root concentration might not be so evident. The important point is that deep feeding is favorable to the development of deeper roots and greatly increases the chances of trees successfully resisting a wind storm. Also, trees with such a root system are less affected by drought extremes.

Many otherwise valuable trees were seriously damaged and in some cases ruined because one or more major limbs were torn away by the fury of the storm. Many of these cases were due to what is termed structural weakness, namely a poor union between the limbs and the trunk. This condition can easily be corrected by the installation of cables.

Wood rots were important factors in promoting storm damage in that large limbs or even trunks were badly weakened by these troubles. There were some, really very few, giant elms twisted off a few feet above the ground, the long fibers suggesting little or no wood rot. Most of the trees damaged in this way had been invaded by these weakening agencies. This was particularly true of many of the larger branches. Probably ninety per cent of the seriously damaged trees had been invaded to a greater or a less extent by wood rots. It is well known that these can enter only where the wood is exposed or through dead limbs. The conditions disclosed by the storm show a general need for systematic pruning and the prompt treatment after pruning of all wood surfaces with a wound dressing in order to exclude wood rots so far as possible.

Recently issued figures of the New England Telephone and Telegraph Company indicate that the total cost of repairs following the recent hurricane will amount to approximately $6,000,000. It is obvious that a very considerable proportion of the damage to wires, both communications and power, was caused by falling trees and while the enormous loss just mentioned falls primarily upon utility companies, in the final analysis it must be paid by the public. Probably seventy-five per cent of this damage and possibly more was due to fallen trees. It is entirely feasible to greatly reduce probable losses of this nature by keeping trees near wire lines in reasonably good condition and by avoiding in the future, so far as possible, planting or growing in such places trees which are most likely to suffer from the storm, especially the soft maple, Carolina poplars, Norway spruce, and white pine. The same precautions may well be observed in relation to trees growing along highways.

Uprooted and wrecked trees are only a part of the damage caused by the storm. There are literally thousands of trees which remained approximately upright because they were supported by others or had been wrenched to such an extent that they were unable to retain a normal vertical position. Some of these are seriously weakened and may fall with little or no warning. The roots of such trees may be broken or greatly loosened and all affected or supposedly affected in this way should be carefully examined and either removed, or, if sufficiently valuable, drawn back to the perpendicular, guyed in place, pruned to offset root injury and fed as soon as possible, especially on the side where root damage is presumably greatest and a little outside the broken or damaged roots in order to stimulate the extension of the root system as well as its development.

There are also the strained and in many cases decidedly weakened branches which should be removed or securely fastened in place with cables or screw rods. It is presumably unnecessary to mention the numerous broken stubs and hideous scars. The normal procedure of cutting back stubs, trimming all exposed wood to a smooth surface and the protection of this with a wound dressing is apparent to all.

Salt spray injury was a minor though striking feature of the storm in eastern Connecticut, Rhode Island and portions of eastern Massachusetts. Much of the area from Ivoryton in Connecticut, east to Providence, R. I., and northerly in the Quinnebaug Valley to Danielson, Conn., and Webster and Charlton, Mass., some 50 miles from the sea, showed a week after the storm a general grayish discoloration markedly different from that of normal foliage in late September. The foliage of white pines even 15 miles from the shore was badly burned by the salt spray and many pines dropped most of their needles.[1] Spraying with Latex or a thin wax solution will check evaporation through the winter and is recommended as the most promising method of protecting such trees.

There is also probability of root injury developing in areas inundated by the storm wave or even in sections where considerable salt spray was carried inland. Soils flooded by sea water for two days still contain considerable salt. It has been stated that following the September 23, 1815, storm the saltness of wells remained until November, some not becoming fresh for two years.

It is gratifying to state that the early impression of utter desolation and destruction in areas where the hurricane was most severe has been modified by subsequent developments. It is true that to a certain ex-

[1]In discussion following the reading of this paper, Mr. H. L. Bailey of Vermont reported a white deposit on windows washed shortly before the hurricane and which proved on analysis to be common salt or sodium chloride, evidently dried salt spray wind-borne to Montpelier 120 miles from the ocean.

tent there are wide gaps in what were formerly beautiful rows of trees on streets and in parks. On the other hand, the early appearance, particularly the abundant logs and brush, gave an erroneous opinion of the actual damage to shade trees. There is a great amount of wood in one large shade tree. It is the belief of the writer that with the coming of another season and with proper care for the remaining trees, that the damage will not be nearly so great as seemed at the outset. Undoubtedly there are places where vacancies must be filled and in some cases it may be possible to thin by moving from a really too thickly planted row of trees.

The problem of the narrow street is one which has existed for many years. It is practically impossible to provide suitable growing conditions for trees on narrow village streets and maintain adequate public services such as water, sewer and gas. The laws of Massachusetts permit expenditure of public funds for the planting and care of shade trees on private property adjacent to public ways. The owner is required to sign an agreement permitting the city or town to care for the trees prior to any such planting. Such trees must not be more than 20 feet from the edge of the owners property. This appears to be the most practical way of dealing with shade trees on narrow streets.

The hurricane supplies striking evidence of the value of a program providing for judicious pruning, cabling and feeding through a series of years. Such treatment has enabled many shade trees in the track of the storm to survive with comparatively little damage. The hurricane has also shown the general occurrence of conditions which rarely has been suspected and has brought to light sufficient evidence to justify the belief that most well grown trees can withstand all but the extremely severe wind bursts and these ordinarily occur in relatively small areas.

It is our judgment that more rather than less should be expended on the shade trees of the country. Weak trees are expensive luxuries. The problem is primarily one of growing better, that is stronger, trees especially in parks and highways in the interest both of public safety and beauty. The measures advocated may be summarized as follows. Judicious pruning will do much to reduce wind damage and prevent invasion by wood rots. A thick high top makes uprooting of trees relatively easy.

The structurally weak tree is easily strengthened with one or more cables and then it is decidedly storm resistant so far as limb breakage is concerned.

A tree needs good anchorage and feeding for the development of a deep and a well extended root system is the most satisfactory solution. Even in the case of trees growing where deep rootage is impossible, it is often feasible to obtain a considerable extension of the roots by feeding and a corresponding increase in stability.

Do not allow the more brittle trees to grow where they are likely to jeopardize public safety or property interests.

Healthy trees and therefore strong trees can be secured only by protecting the various parts, especially the leaves from attack by insect pests and fungous diseases and the trunk and branches from invasion by borers. The work of the last greatly facilitate invasion by the dangerous wood rots.

The shade tree needs care throughout its existence in much the same way as the fruit tree.

There are numerous excellent articles in current publications on the damage caused by the hurricane. No attempt has been made to list these. There are a number of special illustrated booklets covering various phases of storm damage and since these are not readily located, they are listed below:

New England Hurricane, Federal Writer's Project, WPA, nearly 500 illustrations
New England Hurricane, Federal Writer's Project, WPA, nearly 500 illustrations
with brief descriptive matter, Hale, Cushman & Flint, Boston, $1.50.

Photo Record, Hurricane and Flood, 200 illustrations, New England Historical Events Committee, 30 Rockefeller Plaza, New York City, Edited by The Connecticut Circle Magazine Staff, sold on newstands, 35c.

1938 Hurricane, New Bedford and Vicinity, 119 quarto pages of illustrations, Reynolds Printing Company, New Bedford, Mass. 50c.

The Great Hurricane and Tidal Wave, over 400 illustrations, Rhode Island, September 21, 1938. Providence Journal Company. 35c.

SOIL FERTILITY AND ROOT DEVELOPMENT

By Carl G. Deuber, *Yale University, New Haven, Conn.*

The New England hurricane completely destroyed many thousands of shade trees, it also left a greater number severely injured and weakened. The shade tree problems in the next several years will unquestionably be complicated by the greatly increased number of weakened trees with various degrees of damage to the top and root systems. The trees blown down and reset and those which were blown to a leaning position and which have been pulled upright will have many large anchoring and supporting roots broken as well as numerous smaller roots torn off or dried out. The extent of the damage to the roots of trees that withstood the storm but were fiercely lashed and rocked by the terrific gusts of wind is impossible to predict. The straining and wrenching to which the roots of these trees were subjected probably resulted in a very considerable amount of root breakage and stripping of root bark.

The problems ahead are bound to be numerous and complex. There will be the need for replacing thousands of shade trees with young specimens. The choice of the better species and the employment of the best planting methods must prevail. The partially uprooted trees and the down trees that have been straightened present particular problems because they and many others not so drastically damaged will be in a weakened condition for lack of roots, adequate stability and injuries that expose them to disease.

Experience in the culture of shade trees has shown the effectiveness of fertilizing or feeding weak, non-thrifty trees as a means for bringing them into a state of vigorous growth and to a greater degree of resistance to unfavorable climatic conditions and in overcoming the effects of disease. This practice will unquestionably be emphasized more in the coming growing season in the hurricane area than ever before. It is well to review some of the fundamental features which underlie this practice and which have contributed to its increasing use.

The well-grown deciduous shade tree is a relatively heavy feeder of nitrogen and mineral nutrients each year in the elaboration and maintenance of its extensive foliage system. The formation of wood and the growth and renewal of feeding roots are also nutrient-demanding growth processes. The shade tree on a lawn or along a street does not have the benefit of a cyclic return of nutrients and organic matter cast off by spent leaves and dead twigs. The shade tree is largely dependent on the nutrient-supplying power of its original soil which is too frequently infertile, of poor texture and often limited in volume. With age the lateral and vertical roots explore greater volumes of new soil when not limited by street paving and impervious layers of rock, hardpan or dense clay. Root extension when possible has its limitations and competition with neighboring trees, shrubs and grass is often a factor preventing further extension. The competition with grass is worth noting as grass roots are very dense and occupy the surface layers of the soil where the conditions for root growth are generally most favorable. Trees also have a great concentration of feeding roots in the upper layers of the soil particularly near the stem and in the area covered by the branches. The extensive areas of surface soil upturned by American elms blown down in the hurricane gave ample evidence of the great concentration of the roots of this species in the upper two feet of soil.

One of the most beneficial effects of fertilization is the stimulus to more abundant root formation particularly of the small, much branched feeding roots. This occurs with crop plants and trees. A striking demonstration of the pronounced effect of sodium nitrate upon root branching of various crop plants was secured by Weaver and his co-workers [1] (1922). Plants were grown in soil fertilized in bands at various depths, the fertilized layers being eparated by soft wax seals from the-adjoining soil to prevent diffusions of the nitrate salt. The roots pene trated the wax seals readily and no matter how near the surface nor how deep the fertilized layer the greatest branching of roots occurred in the fertilized layer. In some forest nursery investigations Wahlenberg[2] (1929) modified the root systems of pine transplants to a deeply rooting type by placing fertilizer well below the soil surface. It is also possible to encourage deeper rooting of established trees by the proper placement of the fertilizer and to extend the lateral development of feeding roots by placing fertilizer beyond the most concentrated area of roots which usually occurs within several feet of the trunk.

To secure placement of fertilizers below the surface layers of the soil for established shade trees various methods are available. The most widely used method in New England has been the making of holes 18 inches to 2 feet deep with a crowbar. These holes are made in circles about 30 inches apart beginning near the trunk and extending out beyond the spread of the branches. A charge of solid fertilizer is then placed in each hole and the holes left open or closed. This type of placement of mixed fertilizers containing phosphorus is of particular value in getting the phosphorus in the vicinity of the tree roots since this nutrient diffuses to a very limited extent laterally or vertically. The crowbar method permits the use of organic materials such as pulverized manure, bone meal, blood or tankage which extend the period over which the nutrients become soluble and aid in the retention of moisture and probably has a beneficial effect upon the micro flora of the soil.

In recent years there has been an increase in the use of methods for injecting dilute solutions of soluble fertilizers into the soil under pressure. These methods have much to recommend them for placing quickly

[1]Weaver, J. E., F. C. Jean and J. W. Crist—Carnegie Inst. Washington Pub. 316. 1922.

[2]Wahlenberg, W. G., U. S. Dept. Agr. Cir. No. 125. 1929.

available nutrients in the lower soil levels together with large quantities of water. A combination of the injection method with crowbar feeding may be advisable in cases of greatly weakened trees.

I wish to conclude with a few remarks on the composition of tree fertilizers and the rates of feeding. It is apparent that a great divergence of opinion exists upon what constitutes a really satisfactory fertilizer for shade trees. This is not strange and has not been settled for crop plants or fruit trees. The materials best suited for one section with heavy soils may not be the best adapted for regions with light sandy soils. We are all aware of the beneficial effects to be secured from nitrogenous fertilizers. The requirement for phosphates and potash is less firmly established on many soils. When trees growing on a variety of soil types and degrees of fertility are to be fertilized it appears that a mixed fertilizer is to be preferred. Many complete fertilizers with 15 to 20 units of plant food should prove satisfactory. The nitrogen content should be from 5 to 10 per cent.

The amount of fertilizer to be used depends on the condition of the tree, the nature of the soil and seasonal factors. Some of the recommendations made in the Middle West where heavy soils prevail and where the summer drought is more common and severe than in the East have been found to be excessive in Connecticut. A 10–8–6 fertilizer when used at rates based on a pound for each foot in height, branch spread and inches of trunk circumference has severely injured and killed sapling sugar maples, silver maples and catalpas at the Bartlett Tree Research Laboratories. Our findings were that a pound of fertilizer per inch of trunk circumference or slightly more was an effective rate. The object of shade tree feeding is not to force excessive vegetative growth but rather to maintain trees in a good state of growth with healthy green foliage so that the trees are able to resist the normal unfavorable climatic conditions that prevail in summer and winter and to satisfactorily cope with injury and disease.

TREES ON CITY AND VILLAGE STREETS

By C. E. Van Fleet, *Superintendent of Fire Alarm, Mt. Vernon, N. Y.*

Officers, Members and Guests of The Eastern Shade Tree Conference:

On behalf of the International Municipal Signal Association originally known as the International Association of Municipal Electricians, organized in 1895 with the object of co-operating in the formulation of standards for the safe installation and most efficient operation of municipal electrical systems, and to co-operate with other organizations with the view of improving the efficiency, particularly of municipal signal services, I wish to present for your consideration and study the following resolution which was presented by Mr. Robert E. Neal, City Electrician of Waltham, Mass., to the members of our New England Section, and which was adopted by this group at a meeting held in Fitchburg, Massachusetts on October 19th, 1938.

WHEREAS; The hurricane of September 21st, 1938 caused serious interruption to the services and irreparable loss to Fire and Police Signal systems, Current supply, Street Lighting circuits and wire communications systems, and

WHEREAS; This loss was greatly augmented by uprooted trees and diseased limbs which fell on these aerial wire systems, thereby rendering them unserviceable, and

WHEREAS; Many of the uprooted trees resulted from poor root systems, in a number of cases caused by man-made injuries inflicted so that improved highway and sidewalk pavements might obtain, and

WHEREAS; It has long been recognized that shade and ornamental trees can not live long if their root systems are confined to the soil directly beneath modern pavements, and

WHEREAS; The movement to plant trees in an effort to Partially rehabilitate the affected storm area has already started,

BE IT RESOLVED: That this organization through each of its members focus the attention of the Public and other Municipal Officers to; General Acts of 1915 Commonwealth of Massachusetts Chapter 145, Section 7, which reads as follows:

> "Section 7, Towns and Cities may appropriate money to be expended by the Tree Warden in planting shade trees in the public ways, or, if he deems it expedient upon adjoining land, at a distance not exceeding twenty feet from said public ways for the purpose of improving, protecting, shading or ornamenting the same, provided however, that the written consent of the owner of such adjoining land shall first be obtained."

Also that attention be focused to Municipal Ordinances or Town By-Laws already enacted or which can be adopted to cover planting of shade trees on private property in accordance with this or similar statutes.

BE IT FURTHER RESOLVED: That each member of this New England Section give publicity to this message through all available channels, to the end that future planting of shade trees may be confined to private property as far as possible.

BE IT FURTHER RESOLVED: That these facts be presented to, and the active co-operation sought of all Tree Wardens; The Massachusetts

Tree Wardens Association; The 15th National Shade Tree Conference; The Massachusetts Forest and Park Ass'n; Department of Public Works of the Commonwealth of Massachusetts; The Field and Forest Club of Boston; The New England Regional Planning Commission; all New England State Planning Commissions; The Massachusetts State College; all New England Womens Clubs; all New England Garden Clubs; all New England Tree Expert and Surgery Companies; The Mayors Club of New England; The Boston Real Estate Exchange; all power, light and communications companies operating within New England, and to the President and Board of Directors of the International Municipal Signal Ass'n.

BE IT FURTHER RESOLVED: That this resolution be spread upon the minutes of this meeting and printed copies be made available for member distribution.

The hurricane of September 21st, 1938 caused serious damage to aerial line construction, which resulted in hazardous interruption of Fire Alarm, Police Communication, Traffic Lights, Street Lighting, Electrical Supply and Public Communication circuits throughout the New England States including the eastern sections of New York and New Jersey.

This tremendous damage and serious interruption to municipal signal services together with other electrical transmission lines was caused in the majority of cases by the uprooting of trees and the breaking off of diseased limbs which fell on and demolished these aerial lines, and led the members of our association to consider the possibilities of securing the co-operation of the Public, of Governmental Authorities, and associations interested in the preservation of our shade trees, toward a better planned method of placing and planting of shade trees in the future, particularly in new real estate development, and the planting of new trees in an effort to rehabilitate the affected storm area, which has already been started.

Recognizing that public shade trees are priceless assets and worthy of every protection that the Law can afford, the Association passed the above resolutions pointing out that in the recent hurricane many of the uprooted trees resulted from poor root systems, and man-made injuries inflicted so that improved highway and sidewalk pavements might be obtained, and that shade or ornamental trees can not live long with root systems confined to the soil directly below modern pavements.

The resolution also calls attention to a Massachusetts Law, which authorizes the planting of shade trees, using public funds along highways, and with certain restrictions on private property. Municipal Ordinances in other sections of the country authorize the planting of shade trees with public funds along public highways between the curb and sidewalk, or, between the sidewalk and the private property line.

From a number of personal observations made where trees have been planted between the sidewalk and the property line, it is in my opinion, the most feasible and practical method, where the set back of building will permit. While I do not profess to be a Horticulturist, never-the-less I have gained some experience as an amateur gardener, and I can see by this method of planting that a tree will have more opportunity to develop a stronger radial and feeding root system, than if it were planted in the narrow strip between the sidewalk and curb, where the root systems would be greatly restricted due to the present day pavement, and the resultant, dead, gas filled earth under same.

There was a value in trees planted along the curb line thirty or forty years ago, for at that time gravel or water bound macadam surfaces were used which required a certain amount of moisture to maintain them properly, but today with the installation of water mains, gas mains, sewers, surface water catch basins and drains, electric power and communication conduits in our highways, together with the very extensive use of concrete for highway paving, curb foundations and sidewalks, the curb side shade trees are greatly handicapped by man, in covering their root systems with an impenetrable top which prevents them from receiving proper food and nourishment through the lack of water.

Concrete or asphaltic pavement with concrete base, are the commonly accepted pavements now in use and are gradually but effectively sounding the death knell of all trees planted along the curb lines.

Furthermore planting along or in back of the property line would result in better shaped trees, as the trunks and limbs would not be cramped under a canopy of overhead wires, which, in a great many instances cause more serious damage to the trees through chafing and burning than it does to the wires.

It is of vital importance and modern civilization demands that municipal signaling systems, adequate and efficient street lighting, public communications and other electrical transmission services be installed, yet it is a well known fact among Expert Tree companies, Municipal Tree departments, and those whose duty it is to maintain these services, that we are unjustly and severely criticised when even under the best known practices, we are compelled to prune trees planted under aerial transmission lines in order to maintain the service demanded by the public.

The Street Light Committee, of the Illuminating Engineering Society, have for a number of years recommended the planting of trees at the property line which would greatly increase the efficiency of highway lighting, which is a very important factor in our modern traveling methods, and for the protection of pedestrians.

It may be of interest to note that notwithstanding the efforts of our members in the New England Section to discourage the practice of planting trees under electrical transmission lines, reports have been received that in a number of instances some states have planted new trees along State Highways directly beneath these transmission lines.

It is my personal opinion, and I believe that your reaction as well as the majority of our membership will be, that the perfect answer to the problem of trees and wires, is to place all electrical communication, signal and supply wires underground in congested areas.

The initial cost of this type of construction is more expensive than pole line construction, on the other hand the additional cost is materially offset by the reduced cost of maintenance, and the continuity of service in a major catastrophe such as the recent hurricane, and when it comes to municipal signal services, which are of an emergency character, particularly the Fire Alarm Systems, the additional cost over the reduced cost of maintenance is very small as compared with the value of the lives and property of our citizens, which these systems are installed to protect.

Realizing that the cost of this type of construction in rural territories would be prohibitive, also realizing that a great majority of our municipalities will always be faced with the unnecessary evils of pole line construction, and now that so many of our ancient trees have been blown down, it is hoped that this movement will result in a widespread improvement in shade tree locating, and in the provision of more continuous electrical transmission service with increased safety of operation and maintenance for the benefit of the general public and all concerned.

STREET TREES IN NEW YORK CITY

By Nelson Miller Wells, *Landscape Architect, Hastings-on-Hudson, N. Y.*

The question of street trees in New York City is no mean subject. Twenty odd years ago Laurie Cox of the Department of Forestry at Syracuse University conducted a survey and made certain superficial recommendations on the planning, planting and maintenance of street trees in New York City. But before that time and since that time there has been no serious thought on the problem except in specific situations.

During the years between 1935 and 1938 when I was Chief Planting Designer for the New York Park Department, I had an opportunity to delve into this subject and in the few minutes assigned to me I shall tell you of the New York City street tree problems I encountered in studying a master street tree plan. These studies were made with reference to soil maps, air pollution maps, real property inventories, property zoning maps, maps of existing trees, and maps showing existing and proposed arterial thoroughfares and parks.

The legal aspects have been particularly confusing. Between 1868 and 1934 there were nine chapters of law with revisions which required eighteen interpretative opinions by the Law Department of the Corportion Council's Office between 1914 and 1934. Then there is the Code of Ordinances for the City of New York and the Greater New York Charter and its amendment of 1934. Lastly there is the new city charter which went into effect the first of this year. To all intents and purposes the entire responsibility of street trees lies with the Commissioner of Parks. I fear that the last Charter, as well as all other ordinances, is frought with so many "except" clauses that the authority is pretty hard to define or enforce.

A physical survey of existing street trees is a large undertaking in itself. There are probably between one and two million trees on the streets of this city. The closest estimate of all trees in the parks and on the streets is based on an actual count of all trees in Manhattan and Brooklyn and totalled two million, two hundred thousand trees. Compare this figure of over 1,000,000 street trees with other cities. Three or four years ago Minneapolis reported about 300,000, Philadelphia about 150,000, Baltimore about 140,000, Washington, D. C. about 120,000 and Newark, N. J. about 75,000.

During the three years I was in the Department we planted between fourteen and fifteen thousand trees on streets bordering parks and playgrounds and on a few major thoroughfares. The natural losses are heavy. Two hundred or 300 trees are lost each year due to vandalism, gas poisoning, and auto accidents. In a single year there are sometimes as many as 2000 trees lost or removed in the line of street widening and subsurface constructions.

The trees which exist on our streets today have been planted over a period of many years by individual property owners, by the Department of Parks, and by the Borough Presidents. In a large measure these plantings, particularly that large volume planted by individuals, have been made without due regard for soil preparation, the suitability of the tree for the situation or the part they would play in a city-wide street tree system. The resulting effect is a lack of uniformity, an injurious crowding, and a generally poor, weak growth which requires an immense burden of maintenance. Approximately one-third of the trees are in a poor condition. Inadequate forestry practice in the past has left a heritage of badly pruned and undernourished trees. Practically no street tree in the city reaches maturity and the average life span is under twenty years. Most of our streets are not designed to receive trees. Many trees have been planted at ten foot intervals especially where the lots are only twenty feet wide. Poplars and Silver Maples, both fast growing and weak wooded types which are undesirable, have been freely planted and in sections of Brooklyn and Queens they predominate. In many districts, especially in Manhattan, the ground under the streets is either rock or sub-structures. Buildings and pavements seal the surface of the ground from air and rainfall. The atmosphere is seriously polluted and with a weakened growth plus vandalism and escaping gas, the trees are likely subjects for diseases and insect depredations.

The difficulty of maintaining trees in New York City is probably greater than in any other city. To simulate the tree lined Boulevards of Paris or Washington would require a constant replacement program of great proportions. In recognition of the unnatural growing conditions created by poisoned atmosphere; terrific reflected heat; soils low in humus content, frequently high in the acidity range, and with nutriment values spent, it is a wonder that trees live at all. The least provision that can be made is a generous supply of fertile soil and plant foods. A volume of soil not less than 2¼ cubic yards, to a depth of at least 3½ feet, should always be provided. The surface opening should not be less than 15 square feet. A program of laying Belgian blocks instead of an iron grating has been adopted in the city with good success. It serves to prevent the compacting of the soil over the roots, their sand filled joints permit the entrance of surface water and the stones act as a beneficial agent in conserving moisture and protecting the roots from rapid changes in temperature.

The so-called Oriental Plane tree, really the London Plane, *Platanus acerifolia*, is definitely the best street tree for this city although it is on the border line of hardiness in this latitude. Positive injuries were sustained by this species during our recent severe winters. The Maidenhair tree, *Ginkgo biloba*, is also good although in its juvenile stages it is apt to be awkward. In the next zone of tolerance the Pin Oak, *Quercus palustris*, and the Norway Maple, *Acer platanoides*, appear to be the most successful.

In districts where the growing conditions are less severe a few other kinds of trees are doing well: The Red Oak, *Quercus rubra*, (I have a very strong impression that if this tree were tested in deep city conditions it would be found to be as successful or perhaps more successful than the Pin Oak), various small leaved European Lindens; the Honeylocust, *Gleditsia triacanthos*, and the Sweet Gum, *Liquidamber styraciflua*.

Based on my observations there are seven points which I should like to stress about city street trees.

1. That *legal complexities* should be cleared away so that unrestricted authority and responsibility rests with the Commissioner of Parks or some other responsible agency.

2. That adequate funds be provided to properly and intelligently *plan a street tree program*.

3. That the *locations of trees* be carefully considered. The trunk of the tree should be at least three feet from the face of the curb. Locations near the property lines are obviously preferable to curb-side locations. Close spacings mean interlocking crowns, heavy shade, and increased maintenance. Wide spacings of 40 feet or more are generally preferable. Four trees to the block, two on each side of the street, will produce the effect of a tree lined avenue.

4. That the *trees* selected shall be of types which are adaptable to the prevailing soils and exposures and the aesthetic effects to be attained; and that the quality of the trees shall be the finest of their respective kinds.

5. That *provisions* be made in the matter of ample soils and fertilizers, drainage, guying and guarding of young trees, and paving blocks or iron gratings to prevent the compacting of surface soils.

6. That a *maintenance equipment* be provided which is capable of practicing the best known principles of forestry service.

7. That *smoke abatement* ordinances be enforced, to control the proper combustion of fuel and rid our city atmosphere of the poisonous gases and soot which now pollutes it.

HURRICANE DAMAGE IN HARTFORD AND BETTER TREES FOR STREET AND ORNAMENTAL PLANTING

By George H. Hollister, *Superintendent of Parks, Hartford, Conn.*

On my return to Hartford two days after the hurricane and viewing the damage, I was convinced that no one tree species proved to be better than another in standing up against the tremendous force of the wind during the storm.

It is true that in some places particular varieties seemed to fall while others did not and yet a short distance away all species were blown over. This convinces me, that the wind was very gusty at times, so that where it hit with greatest force, all species of trees fell and where there was a lesser force only certain varieties went down.

I am also convinced that had there been a normal, instead of an over-abundance of rainfall during the summer, and also had there not been an almost unprecedented amount during the four days preceding the blow, a great many (possibly 50%) of the uprooted shade trees would not have fallen.

The fact that the ground was saturated with water to the extent of being soggy made it possible for the trees in falling to literally pull their roots many feet through the soil and for this reason the shade trees fell very slowly.

The storm coming from the east, many trees on the west side of north and south streets were blown over while those on the opposite side stood up. This was caused by the cutting of roots in laying curbs or to lack of root development next to the street—the side on which the wind struck. This same destruction took place on highway embankments where the weakest root development was on the side from which the storm came.

As for Better Trees for Street and Ornamental Planting we already have as fine a group of different species of trees as is to be found anywhere except where the flora of the north and south meet.

Despite all of the enemies of the American elm, it still stands at the head of my list of street trees and also as an ornamental tree.

Among other desirable street trees are:

Norway Maple	*Acer platanoides*
Red Maple	*Acer rubrum*
Sugar Maple	*Acer saccharum*
White Ash?	*Fraxinus americana*
Maidenhair Tree	*Ginkgo biloba*
Tulip Tree?	*Liriodendron tulipifera*

Sweet Gum?	*Liquidamber styraciflua*
European Planetree	*Platanus orientalis*
Scarlet Oak	*Quercus coccinea*
Bur Oak?	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Red Oak	*Quercus rubra*
Little leaf European Linden	*Tilia cordata*
European Linden	*Tilia vulgaris*
American Elm	*Ulmus americana*
Moline Elm	*Ulmus americana var. Moline*
English Elm	*Ulmus campestris*

Many ornamental plantings have been destroyed or badly damaged and we are obliged to do a great deal of replanting. So far as my department is concerned we shall replace, mostly, with the same kind of trees that were destroyed. White pine and hemlock of which we had a great many were most damaged by uprooting. In many places pines were broken off. In a planting of specimen evergreens of some twenty varieties and species ranging from eight to forty feet in height, about the only trees not damaged were two tall *Cryptomeria lobbi* and some of the smaller *Chamaecyparis*. The rarest and best specimen of blue spruces, *Picea pungens* var. *violaceae*, about fifty feet high, was broken off about twenty feet from the ground. This is the only kind of which we lost the only specimen.

Fortunately, a nurseryman friend had propagated cuttings from this tree and has given us two small ones.

There are about 150 native and exotic species and varieties of trees in our parks and most of these are desirable for ornamental planting.

Following is a list of trees desirable for ornamental planting or specimens:

There are at least ten different oaks that we can grow well in this section; among the best for ornamental planting are:

OAKS:

White Oak	*Quercus alba*
Bur Oak	*Quercus macrocarpa*
Red Oak	*Quercus ruba*
Pin Oak	*Quercus palustris*
Turkey Oak	*Quercus cerris*

MAPLES:

Sugar Maple	*Acer saccharum*
Norway Maple	*Acer platanoides*
Red Maple	*Acer rubra*
Sycamore Maple	*Acer pseudo-platanus*
Silver or White Maple	*Acer dasycarpum*

beside horticultural varieties and Japanese maples.

ELMS:

American Elm	*Ulmus americana*
English Elm	*Ulmus campestris*
Winged Elm	*Ulmus alata*

OTHER TREES:

Sweet Gum	*Liquidamber styraciflua*
Tupelo or Sour Gum	*Nyssa sylvatica*
Sycamore	*Platanus orientalis*
Hackberry	*Celtus occidentalis*
Horse Chestnut	*Aesculus hippocastanum*
Horse Chestnut (red-flowered)	*Aesculus rubicunda*
Linden (American)	*Tilia americana*
Linden (European)	*Tilia vulgaris*
Linden Little leaf	*Tilia cordata*
Tulip tree	*Liriodendron tulipifera*
Red Bud	*Cercis canadensis*
Flowering Dogwood	*Cornus florida*
Shadbush	*Amelanchier canadensis*
White Ash	*Fraxinus americana*
Biltmore Ash	*Fraxinus Biltmoreana*
Weeping Willow	*Salix babylonica*
White Willow	*Salix alba*
Beech	*Fagus americana*
Beech (European)	*Fagus sylvatica*
Beech Purple	*Fagus sylvatica var. purpurea*
Beech Fernleaf	*Fagus sylvatica var. heterophylla*
Maidenhair tree	*Ginkgo biloba*
Black Walnut	*Juglans nigra*

Among the larger desirable evergreen trees are the following:

White Pine	*Pinus strobus*
Red Pine	*Pinus resinosa*
Swiss Stone Pine	*Pinus cembra*
Austrian Pine	*Pinus sylvestris*
Hemlock	*Tsuga canadensis*
Carolina Hemlock	*Tsuga caroliniana*
White Spruce	*Picea canadensis*
Englemann Spruce	*Picea engelmanni*
Norway Spruce	*Picea excelsa*
Colorado Blue Spruce	*Picea pungens glauca*
Koster Blue Spruce	*Picea pungens kosteri*
Fraser Fir	*Abies fraseri*
Nikko Fir	*Abies homolepis*
Veitch's Fir	*Abies veitchii*
Douglas Fir	*Abies pseudotsuga taxifolia*

THE SHADE TREE PROBLEMS OF MASSACHUSETTS HIGHWAYS

By John V. McManmon, *Director of Roadside Development, Massachusetts Department of Public Works, Boston, Mass.*

Roadside Development. Improved roads have become a necessity to practically every community. In the past, road construction has been directed chiefly toward improving the travelled way only which, of course, is of first importance. The increased use of roads, however, has brought about the necessity for greater widths and more intensive maintenance as the safety, comfort and convenience of the motorist involves a more or less complete development of the entire right-of-way.

Roads are now built over and under railroads to eliminate the danger of grade crossings, and lights, warning signals and direction signs are being installed on open crossings. Trees are being planted and unsightly places landscaped. Since proper roadside development is directly beneficial to motorists, abutting property owners and communities at large, it should be included in every road program.

Upon the completion of every road, provision is made for the safety, comfort and convenience of the motorist. While the primary object in constructing a road is to accommodate traffic, the ultimate service to the public depends upon the attention given these features.

After the necessary plans are made, trees and shrubs are planted, shoulders and banks seeded and sodded, grass and weeds kept mowed and the entire right-of-way maintained. This work has come to be known as Roadside Development and the Department of Public Works has taken an active interest in this in order that the roads and highways of our Commonwealth might be made beautiful and delightful for the enjoyment of the motorist.

Massachusetts has a shade tree problem that is a little different from other states, in that a great deal of our road construction is on old right-of-way which means that we have the problem of dealing with old established trees that have been planted in rows rather close to the roadway. This condition was created by the construction of highways that at the time seemed to meet the traffic demands. As the increase in traffic took place, these roads did not meet the demands of the traffic flow and therefore they had to be reconstructed, curves eliminated and sight distances increased to allow safer use of the roadway.

Therefore, to meet this problem, the Department of Public Works, through the Bureau of Public Roads, received approval to transplant the best of these large trees rather than destroy them. Proper locations were selected and the trees were transplanted rather than destroy many well developed specimens that could be placed back far enough to allow reconstruction to take place. These trees in their original planting were planted too closely together to allow for their proper development and existence. This work is being done by properly experienced tree movers to insure the best results. In many cases in the future development program of our roadsides, this practice will be applied where it seems advisable to do so.

In all cases where reconstruction is contemplated, the trees are given consideration as to their preservation and proper location. In some places the right of way has been altered to avoid the destruction of trees. The Highway Department feels that the money is properly spent in this type of project because of the increasing value of trees to the landscape value of our highway system.

Where new construction is being considered and the proper right-of-way is laid out to fit the topography and the landscape, the proper cross section must be designed to make certain that consideration is given to the conservation and the preservation of existing growth in order that it might be made a part of the future landscape plan. The rounding of slopes to blend into the existing hillside will prevent soil erosion. The location of utilities underground or overhead at the side line so that landscape treatment may be used to screen them from the travelled way will assure a more satisfactory place for trees to exist. A survey of the existing native or volunteer growth is made to determine the varieties of trees to use in the landscape design. These trees may be considered as plant indicators as to soil conditions and as to what varieties might be best suited in the project. The existing growth is important in dealing with soil erosion, wind erosion and other problems along our roadsides. It is from the existing volunteer growth that we can determine the use of plant material and put it in its proper place in the landscape design. It also is used to determine the moisture content of the soil and the natural condition that we are trying to duplicate. The landscape man must study the natural causes of plant life that he might assist nature with its work rather than conflict with it. Soils play the role of the dictator in this case because they cannot be fooled when it comes to the selection of plant material. Many failures in landscape problems can be traced back to the use of improper soil.

When we have completed the above, we can proceed with the planting and feel we have come within some degree of properly landscaping the highway from an aesthetic as well as economical standpoint. When these principles are applied we find that we have a simple treatment and one most desired where landscaping is done on a mileage basis.

The use of trees around structures and in the screening of unsightly areas is important to the highway. Placing them around structures reduces the artificial glare of new construction and makes it merge with the surrounding landscape. Their use in traffic circles to guide traffic and reduce the glare of oncoming headlights is an important factor in safer highways.

Trees are placed along the side of the highway today in groups to bring out foliage effects and to duplicate the work of nature. The tree in highway planting can be used as an accented point in the design or to create a vista. In the use of native trees, the resistance against attacks from insect and disease is created because we are using a variety of trees that will not all be subject to the same attack.

The divided highway is the safest road on which to travel today. Here the trees can be placed well back of the hardened surface to give a much safer feeling and confidence to the motorist because his vision is not hampered by overhanging branches and low growing tree tops.

We might state here that "the tree is the unconscious guide to the motorist for safer driving by its proper location in the landscape design."

The discussion of trees and their place in roadside development cannot be considered complete unless we touch upon the subject of the care of trees. After the trees are properly placed we must provide for their existence and protection against insects and diseases. This is being given consideration by the establishment of a permanent force of men experienced in the care and treatment of shade trees.

The program of work to be done by this force is as follows: to prune and remove dead limbs from the trees in order that the safety of the motorist might be assured; to keep the foliage from shielding traffic markers and direction signs. The feeding of the tree is considered and each year several hundred trees are provided with the proper plant food.

The problem of controlling insects and diseases was too great for our own forces to handle effectively due to the large number of miles involved. This work was surveyed and the forces of one of the leading arborists of the State were sent into the field to spray 500 miles of shade trees along the highways.

The recent hurricane of last September caused the greatest damage to shade trees along our highways in the history of the State. Many valuable trees were blown over, branches were left dangling over our highways and a constant danger to the travelled way. Approximately 40,000 trees have been damaged or weakened and had to be inspected, treated and made safe. Many trees were tipped and to save them, the work of straightening them and the placing of the proper tree guys had to be started at once.

The arborists of the State played an important part in this work. The efforts of their skilled men working in the field have saved thousands of trees. These forces working on damaged shade trees will save a large number of trees which would otherwise be neglected. The knowledge of insects and diseases is important in order that the prevention of the spreading of these pests might be handled properly. The Department is supplying its men in the field with all the information that can be secured in order that some of these attacks on the life of the shade tree may be retarded or isolated in the area where they are first discovered. It is with the proper knowledge and experience of the field men in observing such conditions that we can best meet the attack.

The Joint Committee on Roadside Development is interested in your knowledge of species best used for planting along the highways, their location in regard to structures and the factors affecting the loss or saving of roadside trees. Your research work on these factors may be used to great advantage by highway departments of New England as to the varieties of trees suited for roadside work and will help in the proper care of trees after they have been planted. The Joint Committee on Roadside Development recognizes your experience in this field of research and is only too willing to cooperate in this specialized field.

THE SHADE TREE PROGRAM OF CONNECTICUT

By John L. Wright, *Director of Roadside Development, Connecticut State Highway Department*

"The show must go on, come what may," is a tradition of the theatre. With us, in highway work, keeping the roads open to traffic at all times falls within the same category. Through floods, blizzards, and hurricanes, one will always find the highway crews battling the elements with but one thought in mind—to keep the highways open and safe.

The wind storm of September 21, following the weeks of torrential rains, caused far more widespread damage to the roadside trees of Connecticut than any storm on record. A conservative estimate places the number of destroyed trees on the Connecticut highway system at 50,000. A questionnaire sent out by the sub-committee on forest fire hazards, down timber, and roadside planting, of the Governor's Committee on Rehabilitation, from as yet incomplete returns, shows a total of approximately 70,000 trees destroyed on city streets and town roads exclusive of state highways. These figures give concrete evidence of the magnitude of this disaster.

Before the storm had abated, highway crews throughout the stricken area, augmented by whatever additional forces could be mustered, were busily at work cutting through the tangled masses of tree trunks and public utility pole lines, endeavoring to open the roads. It was a gigantic task. Yet, in a surprisingly short time one road after another was opened to traffic, the faithful crews working unceasingly until all fallen trees and other debris had been entirely removed from the traveled path of the highways. A great deal of credit is due to these crews, and to the many volunteers who aided them, for the efficient manner in which this task was accomplished.

Once the roads were opened to traffic, the Department was faced with the complex problems of rehabilitation, calling for immediate attention. There were innumerable trees which had fallen on houses, across sidewalks, and driveways. There were countless badly damaged trees still standing, together with quantities of broken branches hanging hazardously over the highways. Furthermore, there were numerous partially uprooted trees scattered throughout the storm area, which were deemed worthy of salvaging.

It is safe to say that at the present time at least 90% of this emergency work has been accomplished. All trees have been removed from houses—sidewalks and driveways have been cleared, nearly all dangerous standing trees and hangers have been eliminated, and a good share of the salvagable trees have been straightened, guyed, and fertilized.

In addition just following the storm, the roadsides were lined with brush, logs, stumps, and other debris. This constituted a very unsightly and hazardous condition. Large quantities of brush piled against buildings and along miles of woodland sections of the highways created a definite fire hazard. In various locations, on curves and at intersections, this debris seriously impeded the sightline of the motoring public.

In order to conserve State funds, a W.P.A. project to the amount of $539,000 was immediately applied for and duly obtained. This project

This Department intends to continue with its shade tree planting program as rapidly as funds permit. It will be guided by the lessons learned from the results of the storm. Even greater attention than formerly will be centered on the selection of species, and all due consideration will be given to the planting sites, so that every opportunity may be allowed the trees to grow into strong, healthy, mature specimens, capable of withstanding the ravages of wind and drought.

Tree planting *must* be continued, even on a larger scale than formerly, if this generation is to pass on to future generations their just heritage of tree lined roads.

BREEDING TREES FOR DISEASE RESISTANCE

By Arthur Harmount Graves, *Curator of Public Instruction, Brooklyn Botanic Garden, New York*

Several months ago I was speaking on "Shade Trees" to a New York audience—a garden club—and tried to make clear the fact that the very popular plane tree now and for many years past planted commonly along the streets in all the boroughs of New York City as well as throughout the country in general, is a *hybrid*—the London plane—and *not* the oriental plane, as it seems to be usually called. I tried to explain carefully that this form of plane tree has probably resulted from a cross pollination of the common native buttonball, *Platanus occidentalis*, or sycamore, as the U. S. Forest Service would have us call it, and the oriental sycamore, *Platanus orientalis*. Then I was astonished to hear the gentlemen who followed me on the program continue to call the tree (which of course everyone knows, since it is one of the best shade trees for large cities) the oriental plane. This must have been either because they had not heard me, or because they were not convinced. Apparently, the wrong name (oriental plane) is so firmly rooted that it would take nothing less than a hurricane to overthrow it.

In my outdoor tree classes, for more than 20 years past, I have tried carefully to show that the tree is a hybrid, and to make this plain have pointed out its resemblances now to one and now to the other parent. Not being, by training, a taxonomist, I would not dare to do, or rather to say all this on my own initiative. Mr. Alfred Rehder, of the Arnold Arboretum, and Dr. Leon Croizat of the same institution, stand back of me.

What are the facts? In Gardener's Chronicle for July 26, 1919, in an article entitled "The London Plane," (p. 47) we read the following:

was for the state-wide clean up from the highways of brush, logs, stumps, and debris, resulting from the storm of September 21st. This work has been going forward steadily for over two months. Although far from completed at the present time, excellent progress has been made in many sections. It is believed that the entire work can be consummated well within the allotted amount.

No definite estimate of the number of trees still standing that warrant attention of tree crews has been attempted. In one small section comprising Norwich and several adjacent towns, the foreman stated that in hastily covering the trees in his section he was unable to find a single tree that would not have to be climbed. This, doubtless, is an extreme condition; however, at every hand there is a tremendous amount of tree work that must be done.

The tree crews of the Highway Department are at the present time concentrating all their efforts on repairing the damage done to those trees still standing which are deemed worth of conserving. In this work the W. P. A. Elm Tree Sanitation crews in many locations are rendering invaluable aid. Systematic pruning, bracing, bolting, guying, and fertilizing are being carried on as rapidly as possible, and it is planned to continue with this work—funds permitting—until existing conditions have been remedied.

For the past four years the Connecticut State Highway Department, as its contribution toward the fight on the Dutch Elm disease, has carried on an elm tree spraying program in those portions of the State where the elms have been seriously infested with canker worms, and elm leaf beetles. It is hoped that this valuable service may be available this year as usual, although many of the stately elms, which were previously sprayed, are gone.

The Connecticut Legislature passed laws in the 1927 Session placing the responsibility for the care of all state highway shade trees on the State Highway Commissioner, and authorizing him to plant trees and shrubs within highway bounds, as might be deemed feasible. Since that time the Department has carried on a carefully planned program of shade tree planting. Infinite care has been given to the selection of species and of planting locations. To date, thousands of trees have been planted along the roadsides, the majority of which, happily, were not seriously injured by the storm. Plans for the continuation of the shade tree planting program for this fall were completed when the storm broke. It seemed advisable to cancel these plans. It is believed that this was a very wise decision.

"The studies that Prof. A. Henry has made in recent years of hybrid trees led him also to the study of the London plane. His conclusion is that this tree is 'undoubtedly a hybrid and must have originated as a chance seedling in some botanic garden where an occidental plane and an oriental plane happened to be growing together.'. . . One of the first proofs of hybridity is in the variability of the seedlings of the London plane (slide), a well established characteristic of the seedlings of a first cross (F 2'5). This variability is to be noted in the size and depth of lobing of the leaves, in the number of fruit balls on a stem and in the characteristics of the individual fruits (achenes) that make up these balls, all more or less intermediate between those of oriental plane and American plane.

Prof. Henry makes a very interesting attempt to show that the London plane possibly originated at the Botanic Garden of Oxford about 1670. The younger Bobart, who became curator of the garden in 1680, compiled a manuscript list of the trees and shrubs there, which was printed by Messrs. Vines and Druce in 1914. In this list three planes are included, viz., *Platanus orientalis*, *P. occidentalis*, and one which Bobart distinguished as *P. inter orientalem et occidentalem media*. And in the Sherard Herbarium at Oxford there is a dried specimen (No. 476) corresponding to this diagnosis, and labelled "*Platanus media*," which Prof. Henry says is undoubtedly the London plane. Additional evidence is also found in the British Museum, where is preserved the type specimen of Plukenet, used by him in his (the first) published description of *P. acerifolia* in 1700, also two fine leaves of this tree, collected by Petiver, and labelled "*Platanus media* n.d. Bobart, Ox." There seems to be no doubt then that the London plane was growing at Oxford late in the seventeenth century, and as Plukenet described it as bearing large fruit balls in 1700, it was at that time probably some thirty years old. Moreover, this is the earliest extant evidence of the existence of the London plane."

Another evidence of the hybrid nature of the tree which we call the London plane is its remarkable adaptability. Like the mule, the well-known animal hybrid of horse and jackass, it endures harsh treatment all its life without flinching, and yet makes a better showing under adverse conditions than either of its parents. On the block where I live in Brooklyn are pin oaks, Norway maples and one London plane. The much vaunted pin oaks and Norway maples look pretty tired by August, with frayed, discolored leaves and slight yearly growth, while the London plane, with the same environment, is as green and vigorous as if it were early spring. This, to me, is additional evidence of its hybrid nature. What I mean to say is that hybrids are often—not necessarily *always*—of a hardier nature and may also show greater vegetative vigor.

There are therefore four indications of the hybrid nature of the London plane, *Platanus acerifolia.*

1. The varied character of the seedlings and the fact that some of them resemble the oriental, others the occidental parent, and others the hybrid itself.

2. The remarkable adaptability of the tree.

3. The fact that it has never been found in the wild state.

4. The fact that in the tree itself some characters are like those of one parent and others like the other parent.

This evidence is, of course, only circumstantial. We have no direct proof of the crossing of the oriental and the occidental species. Personally, I am inclined to the belief, on the basis of the evidence, that it *is* a hybrid. The only other possible explanation is that it is a variant of one of the above-named species. However, the fact remains that it is a different tree from the oriental plane and the sycamore.

Unfortunately for my thesis a disease of the London plane was reported in 1935 by Jackson (11th Nat. Shade Tree Conf. 77–79) as being prevalent in the Philadelphia area. The causative agent is a species of *Ceratostomella.* According to the report, there may be predisposing causes to the disease, such as injury from sidewalk and curb improvements. We in New York City, where thousands of these London planes are planted, have not noticed any such disease, or at least if such has been reported I am not aware of it. However, until this cloud disappears (if it does) it would be wiser to "go slow" in planting London planes.

As far as I can find out, no work has been done—that is, in a systematic way—in breeding shade trees. At any rate, no published results of such work are available, although I believe that Dr. E. J. Schreiner of the Northeastern Forest Experiment Station is including this objective in some of his crossing work.

That such work should be practicable is shown by our own experience at the Brooklyn Botanic Garden in crossing various species and hybrids of chestnut trees. This we are doing primarily to develop resistance to the blight. We have found that this crossing work is easily done if one knows how and if the various operations are carried on at the right time.

We have every possible proof that our hybrid chestnuts are true hybrids and we find in many cases that they demonstrate hybrid vigor not only in vigorous vegetative growth but also in sexual precocity. Our particular object here is of course to develop a chestnut which shall replace our practically extinct American timber species and at the same time be blight resistant. In our first crosses of the Japanese and American, the former being disease-resistant but a comparatively low-growing tree, the hybrids show remarkable vigor, but even the best individuals are not as resistant to the dread chestnut blight fungus as is the Japanese parent. (slides) We are therefore now crossing these Japanese-American parents (which have bloomed at an early age) with Chinese chestnuts, which we have proved by testing with inoculation of the fungus to be entirely resistant. This is only one of the lines we are following in the effort to eventually develop a timber type of chestnut which shall be disease-resistant. In our plantations at Hamden, Conn., we have from the beginning tried to assemble all the species of chestnut in the world, and we now have all except three Chinese chinquapin species growing. Having them growing in close proximity makes the work of crossing easier. To date we have produced by hybridization nearly 50 different new types of chestnut trees (slide).

Possibly the selection of particularly promising individuals of a species and their vegetative propagation by cuttings, or in some other way, may be said to come under the head of breeding, if we use the term in a very broad sense. It does not involve the mingling of the protoplasm of two parents. It consists merely of establishing a race of individuals, all essentially alike since they are derived from an individual and constitute therefore what is known as a *clon*.

A few days ago I received a letter from Dr. R. Kent Beattie, Principal Pathologist of the Division of Forest Pathology of the U. S. D. A., telling of the work done along this line by the Dutch. He says: "I may say that in my visit I made to the Netherlands where I spent a number of days going over their work, I was convinced that the Dutch are doing very excellent work along the line of attempting to produce a European elm resistant to the Dutch elm disease. The method they are using is to search the European elm population for resistant individuals and then to multiply the resistant ones by propagation until they have determined their resistance. Of the 500 or 600 elms, which they brought from Madrid, Spain, in the year 1929, only one individual turned out to be resistant to the disease. It has been very greatly multiplied and many of its progeny have been tested. This particular clon was No. 24 in their series of elms. It has now been named Elm Christine Buisman. If they have succeeded in getting any other resistant elms of the European type, I am not aware of it. As far as I know they have not undertaken any crossing of species of elms. Nothing in the literature that they have published would indicate it and I cannot remember seeing anything when I was in the Netherlands that would lead me to believe that they had."

I quote also from an article by Dr. Beattie in *American Forests* for April, 1937, p. 160, which gives some additional facts.

"Dutch investigators are making an energetic and thorough search for resistant individuals of European species and for resistant elm species from other parts of the world which have characteristics that will make them useful as substitutes.

A splendid collection of species, varieties and strains of elms has been assembled by the Willie Commelin Scholten Laboratory and the Park System of The Hague. These are propagated and grown in plantations in four different localities and are being systematically inoculated in large numbers with the elm disease fungus. Among European elms, the best results have been obtained with a strain of *Ulmus campestris* produced by vegetative propagation from a tree which came originally from Madrid, Spain. Among introduced species, the greatest resistance is found in the Siberian elm, *Ulmus pumila*, as it was in American investigations. With these resistant trees and others later developed, the Dutch hope to replace their native elms.

Unfortunately for the United States, the Dutch found that the various American species of elms are all susceptible to the disease and that the treasured American elm, *Ulmus americana*, with its unique vase form, is perhaps the most susceptible of them all. This is also confirmed by our work in America. However, it is possible that with the huge population of American elms in the United States, resistant individuals may be found."

It should be possible to cross pollinate these elm species and the sooner we start the work the better. A disease-resistant species like *Ulmus pumila*, the Siberian elm, should be crossed with the American elm. The object in view should be, in my opinion, to produce an elm of large size and beautiful vase-like outline, like our cherished American species, and at the same time resistant to the Dutch elm disease.

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