CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

NEW HAVEN, CONN.

BULLETIN 131, NOVEMBER, 1900.

The Protection of Shade Trees in Towns and Cities.

Notice as to Bulletins.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Station Staff.

All Bulletins earlier than No. 71 and Nos. 72, 83, 86, 93, 98, 100, 101, 102, 105, 106, 112, 118, 120 and 123 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1887, 1891, 1893 (Pt. II.), 1894 (Pt. I.), and 1895 (Pts. I. and II.).

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 7,000 copies.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

Former Reports Wanted.

There is frequent call for our earlier Annual Reports on the part of public libraries, students, chemists, naturalists, and Station workers.

Persons who can supply copies of Reports of this Station for any of the years above named, will be likely to find purchasers by communicating with the Director.

THE PROTECTION OF SHADE TREES.

In September of the present year, Mayor Cornelius T. Driscoll of the City of New Haven called a meeting of citizens who were interested in the preservation of the city shade trees and who had special knowledge of the subject, to confer regarding the unsatisfactory condition of the trees.

This meeting resulted in the appointment of a committee consisting of the following members: His Honor Mayor C. T. Driscoll, *Chairman;* Henry T. Blake, President of the New Haven Park Commission; Philip Hugo, Director of the Department of Public Works; John J. Brennan, Superintendent of Streets; Ex-Mayor J. B. Sargent; Ex-Alderman Felix Chillingworth; Prof. W. H. Brewer of Yale University; Prof. Henry S. Graves, Director of the Yale Forest School; Dr. E. H. Jenkins, Director of the Connecticut Agricultural Experiment Station, and W. E. Britton, Horticulturist of the Station.

A sub-committee, consisting of Dr. Jenkins, *Chairman;* Prof. Graves, Mr. Britton and Mr. Blake, was appointed and requested to further study the matter and prepare a full report of their findings.

The main body of this Bulletin consists of the Report of the sub-committee, which was adopted by the general committee, and presented to Mayor Driscoll.

This report in its main features is, however, applicable to most of the cities, towns and villages of this State.

In every one of them may be found the same mutilations by vandals, the same evidence of lack of care and skill in planting, pruning and trimming and the same insect enemies.

In many of them too, may be found an increasing respect for shade trees, a desire for their better protection and more active interest in tree-planting.

In view of these facts and of the fact that much of the work on this Report was done by members of the Station staff, it is altogether proper that the Station should bring the results of this work to the attention of those individuals and communities which are reached by its bulletins.

In the smallest village, as well as in the largest city, trees can only be protected by the creation of an intelligent public sentiment on the subject. Small villages can more easily produce and maintain exceptionally fine shade trees than can cities, where "modern improvements" do so much to damage them, and few material things add more to the attractiveness of small country places and their value to those who are seeking temporary or permanent homes, than well-shaded and well-kept streets.

In regard to the illustrations herein presented, Figs. 7, 8 and 9 of Plate IV, and Plates VII and VIII, are from electrotypes kindly supplied by Dr. E. P. Felt, State Entomologist of New York. Fig. 17, Plate IX, was used in Bulletin 121 of this Station, 1895, by permission of the U. S. Department of Agriculture. Figure 16, Plate IX, was published in the Report of this Station for 1896, from an original photograph.

All others are from original photographs taken in the streets of New Haven and are fair examples of certain present conditions mentioned in the following report.

REPORT ON THE SHADE TREES OF NEW HAVEN.

Synopsis.

To his Honor C. T. Driscoll, Mayor of New Haven:

The undersigned, who were asked by you to consider the present condition of the shade trees of New Haven and to recommend measures necessary for their better protection and for replacing the trees that are from time to time destroyed, respectfully present the following report:

Present Condition of the Shade Trees in New Haven.

In some parts of the city, trees are dying and are being killed by various causes at a rapid rate. As they are not being systematically replaced, there has ensued very great damage to the appearance of the streets and the beauty of the city, and the result must be disastrous in these respects unless prompt and intelligent action can check the destruction.

For a single illustration, we note the condition of Temple Street from Chapel to Grove Street. This was formerly one of the most beautiful city streets in the country, lined with magnificent elms, whose interlacing branches formed a veritable cathedral nave. Half of these noble trees are now entirely gone, and others are in a state of dilapidation and decay which renders them a sad disfigurement of the thoroughfare.

At present the city is doing absolutely nothing in the way of planting trees on the streets or public squares. Such planting is done by owners of adjoining property if so inclined, and they are not restricted in the number or kind of trees or the manner or place of setting them.

Once set, however, they become the property of the city. No one but the superintendent of streets is allowed to prune them or to remove them when they die, and he is unable to do what is necessary through lack of funds and pressure of other claims on the appropriations for streets.

The pruning has often been so unskillfully done as to be a damage rather than an improvement to the trees.

Such in brief outline is the present situation. Further details regarding it will appear in what follows:

We desire first to speak of the causes of the present condition of the city shade trees, next of what can be done to improve their condition and to replace those which die, and lastly to suggest the general method by which this work should be accomplished.

Causes of the Present Condition of the Shade Trees of New Haven.

The unsatisfactory condition of many of the shade trees in the squares and streets of New Haven is due to a number of causes acting together; no single one of them being chiefly responsible for the damage. A brief statement of these causes follows:

1. *Old Age.*

Many of the trees in New Haven are of very great age. For example, the sycamore near the corner of College and Elm Streets, the last of a row which once bordered the Green, was set in 1759 and many of the elms on the Green were planted in the year 1787.

While under favorable conditions some of these trees may last for many years longer, their age must necessarily tell against them in their struggle for life under any circumstances.

2. *Lack of Water and Air about the Roots.*

All trees need to stand in ground which is sufficiently open to the air and suitably watered. The exclusion of either air or water from the soil is surely and quickly fatal. It is a matter of common observation that a filling of earth two or more feet deep about thrifty, mature trees will damage or kill them. The covering of earth works this injury simply by excluding air from the active rootlets.

The conditions of city life seem to require that streets and sidewalks should be made hard and as nearly impervious to water—and incidentally to air,—as may be. As a result, the trees standing on or close by the streets are greatly limited in their supply of both water and air by the water-tight and air-tight covering above their roots.

3. *Lack of Plant Food.*

The soil in a large part of the city is a light leachy sand, naturally unfertile and for more than a hundred years the tree roots have been constantly taking the available plant food out of it. A part of this matter assimilated by the trees remains permanently in the wood and by far the larger part goes into

the leaves. These leaves, as well as much of the grass growing under the trees, are crops which have been gathered annually for more than a century from our streets and parks; a crop which is rich in mineral matter and hence impoverishes the soil on which it grows, as our field and garden crops exhaust the fertility of land. Just as no market gardener thinks of success in farming without a yearly dressing of the land with fertilizers of some sort, so in our city parks the best success with trees cannot be expected on a soil which has supported their life for more than a hundred years, unless the supply of plant food in the soil is supplemented by the use of fertilizers.

The soil is further exhausted by the removal of a part of the grass whenever it is cut in our parks.

It is true that trees have the power to gather food enough to support life and make some growth even from soils which are, agriculturally speaking, almost barren. It is also true that the wastes of the community which pass into the soil help to feed the trees standing upon it. Moreover, from time to time, some fertilizing material has been put on our public squares with the object of improving the grass. But these various things do not fully meet the requirements of the trees. The yearly application of some suitable fertilizer to the soil about shade trees, is of the highest importance to increase their growth and—what is more vital—their thrift and their power of resisting unfavorable conditions.

4. *Mutilations of Trees.*

A very large number of the trees on the streets of New Haven, not only such as are newly planted, but also those of the larger sizes, have been and are now being injured and even ruined by the gnawing of horses, which contrary to city ordinances are hitched to them or left unhitched to bite and tear the tree trunks.

The damage done in this way is well shown in figures 1 and 2 of Plate I.

To show the extent of damage by horses, the following statement, based on personal observation, gives the total number of trees on the streets named, the number of such trees damaged by the gnawing of horses and collisions of vehicles, and the percentage of mutilated trees.

MUTILATION OF TREES BY HORSES AND VEHICLES.

	Whole number of trees.	Number mutilated.	Percentage injured.
Orange St., Canner to Court.....	260	82	31
Wall St., State to York.....	44	24	55
Ashmun St., York to Munson.....	107	59	55
Orchard St., Munson to Davenport Ave.	244	86	35
Chapel St., Day to College.....	86	38	44
Charles St., Orchard to Dixwell Ave...	18	8	44
Howe St., Whalley Ave. to Oak.....	130	41	31
George St., Temple to Winthrop Ave...	254	70	28
	1143	408	36

Another very destructive mutilation is the necessary cutting of large roots in digging for water and gas mains or sewers, and worse than this the cutting of main roots close to the tree or the cutting of the trunk itself in order to lay a curb-stone to line or make a cobble gutter. An illustration of such mutilation is given in figure 3, Plate II.

While this Report was in preparation, one of the finest elms in the city was blown down by a sudden squall, carrying to the ground a number of electric trolley wires, maiming a horse so that it had to be killed and doing injury to the building opposite. Had it fallen a few minutes earlier or later it would certainly have demolished street cars and destroyed human life. The tree was perfectly sound five feet above the ground, but at the surface it was a mere shell, the heart wood being entirely destroyed. The primary cause of this decay was quite certainly a mutilation of the root which had not healed and in which decay had started, spreading till the whole was gone. Figure 4, Plate II, shows the decayed trunk seen from the bottom and is a striking example of the damage which may result from a mutilation.

Another mutilation which has destroyed many trees or greatly marred them is unskillful trimming and neglect of the scars left by it. In many cases large limbs have been sawed off, leaving bare wounds almost horizontally exposed, to catch and hold the rain and entirely unprotected by anything like paint to keep the water out. Naturally decay soon begins here, and spreads into the body of the tree.

Figure 5 of Plate III gives an illustration of this kind of damage.

A further mutilation, less extensive than those just named, but very evident in some places, is the chafing of the bark by electric light or trolley feed wires. In some cases the bark has been wholly destroyed on one side and the limb killed. And lastly, each year some trees or parts of trees are broken off by severe gales, the injury usually occurring to trees which are not in a very thrifty condition.

5. *Poisoning by Illuminating Gas.*

Illuminating gas is extremely poisonous as well to the roots as to the leaves of trees. A considerable leak from a gas main, under repair, during a single night has killed trees standing near, and a very slight leak for a longer time will also infallibly kill them.

Many trees have been killed by this cause, the damage often being done before the leak was discovered.

6. *Insect Injuries.*

The insects which commonly injure street trees in New Haven may be grouped as (a) leaf-eating insects, (b) sucking insects, and (c) borers.

(a) *Leaf-eating Insects.*

Elm Leaf-Beetle.—*Galerucella luteola,* Müll. The adults appear in the first half of May, when the leaves are unfolding and perforate them with small round holes. The females lay their yellow eggs on the under sides of the leaves in irregular clusters. Each female is said to deposit about six hundred eggs, and the egg-laying period extends over several weeks. The eggs hatch in about a week and the young larvae or grubs feed upon the under surface of the leaves, eating off the green portion and leaving only the skeleton covered with the upper epidermis. Such leaves soon turn brown and fall.

The English elm suffers greater injury than our American species.

The larvae or grubs do much more damage than the adults, and in from fifteen to twenty days, when full grown, descend the body of the tree or drop from the branches in search of a place to pupate. Large numbers transform at the base of the tree, where partially covered with fallen leaves or rubbish they

may often be gathered by the quart. Many, however, crawl into crevices of the rough bark of the trunk and larger branches and there undergo this change. In from six to ten days the adult beetle comes forth, feeds for a time upon the leaves and then retires to winter quarters in some building or almost any sheltered place. In New Haven some of the beetles lay eggs for a second brood, but usually there is but one complete generation in a season.

The full grown larva or grub is about one-half inch long, with a broad black band along each side of the body and is covered with short tubercles bearing hairs. The pupa is about one-quarter inch long, naked and light yellow. The adult beetle is about one-quarter inch long, with head, chest and margins of the wing-covers, brownish yellow. Each wing-cover is also marked lengthwise with a more or less obscure black stripe. Plate IX, fig. 17, shows this insect in its various forms.

Canker Worms.—Fall Canker Worm, *Anisopteryx pometaria,* Harr. Spring Canker Worm, *Paleacrita vernata,* Peck.

Both these species injure elms in New Haven by eating the leaves during May and June. The eggs are laid on the bark of the trunk or branches by the wingless females; those of the fall species during warm days in November and December, those of the spring species in March and April.

The adult males are grey moths, having a wing expanse of about an inch, while the females are wingless and must creep up the trunks of the tree to lay their eggs in them. See Plate IX, fig. 16.

The larva or caterpillar becomes full grown in about four weeks after hatching, and is then about an inch long, of a dark brown color, with lighter stripes running lengthwise of the body. The color, however, varies considerably. The caterpillars "loop" in crawling, and when disturbed "spin down" from the branches on a fine thread by means of which they afterwards ascend.

They pupate in the ground. Much of the damage done by canker worms in the city has been wrongly attributed to the elm leaf-beetle; but the work of the two insects may be readily distinguished. The adult elm leaf-beetle makes "shot-holes" through the leaf and its larva or grub eats away the under

surface; while the canker worm eats any portion of the leaf except the principal veins, but does not puncture the leaf. The White-Marked Tussock Moth, *Notolophus leucostigma,* Sm. and Abb.; the Forest Tent Caterpillar, *Clisiocampa disstria,* Hübn.; the Fall Web Worm, *Hyphantria cunea,* Drury, and the Bag Worm, *Thyridopteryx ephemeraeformis,* Steph., all of them pests in other places, are also found in New Haven, but up to the present have not been so abundant as to be troublesome.

(b) *Sucking Insects.*

Elm Scale.—*Gossyparia ulmi,* Geoff.

This insect, shown in figure 6, Plate III, was introduced from Europe and is now distributed over the United States. It collects in clusters at the forking of the twigs and in the crevices of the bark, mostly on the under side of the branches, from which it sucks the sap for its food. The females, dark brown in color, with margins of a white woolly substance, are oval in outline, about an eighth of an inch long and bring forth their young alive instead of laying eggs. They exude a sweet sticky substance, known as "honey-dew," in great abundance and this often drips upon the ground and walks, under badly infested trees. The young appear about the middle of June. The branches which they attack generally die and the whole tree is weakened.

The Cottony Maple Scale.—*Pulvinaria innumerabilis,* Rathv.

This insect may be found on nearly every street in this city where there are maples. One of the worst infested trees stands on the corner of Wall and Orange Streets. White masses of a waxy material, resembling cotton, are seen in the crevices of the bark and on the under sides of the leaves and branches. The impregnated females live over winter on the under sides of the twigs and produce eggs under the cottony substance. They then shrivel and die. The eggs hatch in early summer, the young lice crawl about for a few hours, then settle along the mid-ribs of the leaves, where they continue to suck the sap, until mature, when they migrate to the twigs and there pass the winter.

Much damage has been done in various places by this insect, but it is easily controlled by remedial treatment.

(c) *Borers.*

Maple Borer.—*Plagionotus speciosus,* Say.

Maple trees in New Haven are more seriously injured by the maple borer than by any other species of insect.

The adult is a beautiful black beetle about an inch long, ornamented with cross-bands of bright yellow. The eggs are laid on the trunks of the maples in July and August and the young borers, as soon as hatched, tunnel in the bark or wood, where they remain through the winter. The appearance of these beetles is shown in figure 7, Plate IV. Usually the main tunnel is between the wood and bark, and sometimes passes nearly around the trunk in a spiral and upward course, girdling it. Examples of the injuries are shown in Plate IV, figure 10 and Plate V, figure 11. The "sawdust" or castings are thrown outside the burrow and serve as a guide to trees which have been attacked. The burrows often run deep into the solid wood and the larva doubtless passes the winter in these more protected chambers.

The life-history of this borer is not fully known, but it is supposed that two years are required for its full development.

Elm Borer.—*Saperda tridentata,* Oliv.

This enemy of the elm often causes great injury before its presence is suspected, and makes numerous galleries in the inner bark, so that the bark will sometimes separate from the wood in large sheets. The beetle is about half an inch in length, slate-colored, with orange markings. Its appearance is shown in figure 8, and the characteristic injuries caused by it in figure 9 of Plate IV.

The Pigeon Tremex.—*Tremex columba,* L.

Injured and dying elms are often attacked by this and many other species, which seldom attack healthy trees.

The Leopard Moth.—*Zeuzera pyrina,* Fabr., is exceedingly injurious to elms and maples about New York City. The adult is a large white moth, spotted with black, and the larva makes deep burrows into the wood.

7. *Lack of Knowledge and Care in Planting.*

The statements in the preceding pages have mainly to do with the life and health of the trees. A further consideration, which is of great importance and which is often overlooked, is

the failure to produce trees of symmetrical proportions. The purpose of planting trees in our streets and parks is not only to furnish shade but also to beautify the city. When trees are planted, the question should always be considered, whether the right varieties have been chosen, whether the individuals are perfect, and whether the location of each tree is such that it can develop symmetrically.

It requires only a short walk in the New Haven streets and parks to see trees which are misshapen because they have been crowded by one or more of their neighbors, and to see young trees which will never develop into beautiful individuals because they were not properly treated in the nursery.

The failure to produce symmetrical trees in city streets and parks can usually be attributed to the following causes:

(a) *Poor nursery stock.* It is as true of trees, as of our field and garden crops, that, to secure good results, the seed must be selected with care and from the right sources. Trees run into varieties as readily as other plants and these varieties differ greatly in beauty. Therefore, the seed for producing ornamental trees should be gathered from trees of known stock as to symmetry and hardiness. Often this is not done, however, and those who gather seed to supply the trade do not take into consideration the quality of the trees which produce it. Commercial stock is, therefore, liable to be (in part at least) from trees belonging to the less desirable varieties. It is safer that the seed used be from trees of known excellence. As a rule those who select young stock for street planting are not qualified to judge what individuals are likely to develop into well-shaped trees. With the system now in use, it is inevitable that a certain number of trees are planted which ought never to have left the nursery. Members of the Committee have noticed, in numerous instances in New Haven streets, young trees which can never be beautiful specimens because they were not properly handled in the nursery.

(b) *Poor judgment in selecting the species.* Hitherto the selection of the varieties of trees to be planted has been left entirely to the private citizens who purchase them. The result is that there is no uniformity among the trees on many streets, and frequently varieties have been set out which are not suitable for street purposes. A case in point is on lower Prospect

Street where, in about two blocks, Norway maple, sugar maple, red maple, basswood, white ash, elm, tulip tree, locust and cherry can be found jumbled together entirely without system. Without a systematic plan for the arrangement of street trees, the result can never be satisfactory.

(c) *Unwise location of trees.* In order to produce the best results, each tree should be given enough space for the development of its normal form. As a rule the trees in New Haven are planted too closely together, with the result that many individuals become one-sided or otherwise misshapen.

There is also a tendency to set young trees under old specimens which may die in a few years. This has been done in several places on the Green. The old trees have, however, not died and the young specimens have been crowded for room and light and have become distorted.

(d). *Improper planting.* This cause for failure in city planting is less common than the causes discussed in the preceding pages. Nevertheless, the members of the Committee have noted in the newly-planted streets a number of small trees, dead or dying, which should have lived if they had been properly planted.

(e) *Lack of care after planting.* Hitherto no attention seems to have been given to the young trees after they have been planted, except, in some instances, to trim off the dead limbs. Often young specimens require a certain amount of trimming in order to develop well-shaped crowns, but, so far as the Committee is informed, this is seldom done. Furthermore it frequently happens that young trees are injured so severely that there is no hope of their complete recovery. Even if they live, they cannot become perfect specimens, whereas if they are removed and replaced at once, the new trees will have the benefit of growth during the time the old ones would linger along before death.

8. *Electric Currents from Feed Wires.*

Whether or not the electric currents—which sometimes leak into trees from electric light, or trolley wire—damage the trees has not been certainly determined;—there can be no doubt, however, that they are of no benefit and prudence will dictate that such exposures should be carefully avoided.

What Can be Done to Protect and Improve the Shade Trees?

We have thus set forth the main causes of the present unsatisfactory condition of the city shade trees. To abate or remove these causes we make the following notes and recommendations:

1. *Age of the trees.* For old age there is no remedy! Nevertheless the recommendations given below will certainly lengthen the life of the trees by abating those attacks which weaken the vital forces and thus hasten decay and death.

2. *Lack of Water and Air about the Roots.* This lack is not very severely felt by trees standing in the squares with some green sward about them. In times of extreme and protracted drought these trees suffer in common with all vegetation and would of course be helped by watering once a month while the drought lasts, with a large volume of water equal to at least one-half the normal average rainfall.

On narrow paved streets in the center of the city little can be done, and it is a question how long the trees in such situations can survive. On residential streets conditions are better.

Lawns next the street, which are well watered, give access of air and water to the tree roots under them and thus greatly help to support the trees on the street adjoining.

The conditions for growth would be still better if the trees were on the lawn side of the walk instead of near the curb. With such an arrangement the trees would have more space for the growth of their roots, and there would be less damage if it were necessary to cut the roots in lowering the foundation of the road. Furthermore they would be out of the reach of horses and would thus escape one of the most serious sources of damage. Such a plan would improve the general appearance of the street by giving it a broader effect. There would be an advantage also in having the walks drain directly into the street and thus the possibility of standing water on or beside the walk would be avoided. Such a plan would be practical only where no trees have already been planted, and where the building lots are deep enough to leave some air space between trees and buildings. Figure 12, Plate VI, gives an idea of the general effect of this system of planting.

3. *Lack of Plant Food.* This may be supplied by a regular annual dressing with a moderate amount of fertilizer put on the surface. It is not practicable or necessary to dig it in. If the surface is enriched, the feeding rootlets of the trees will quickly find it out and develop most where they find most nourishment.

It is desirable, however, that experiments should be made in the use for shade trees of liquid fertilizers poured into holes, an inch in diameter, made for the purpose about the trees.

To avoid complaints, not always quite reasonable, a fertilizer for use in city squares should be nearly or quite odorless and not offensive to the sight.

We recommend for present use a mixture of

	Cost.
50 pounds nitrate of soda @ $45 per ton	$1.13
300 pounds cotton seed meal @ $27 per ton	4.05
100 pounds acid phosphate @ $15 per ton	.75
100 pounds muriate of potash @ $42.50 per ton	2.13
550 pounds costing	$8.06

The mixture is to be made by shoveling the ingredients together *just before use* and should be sown broadcast on each acre of land which is directly under the tree branches, as soon as the leaves begin to open in the spring.

In addition to such fertilization, we recommend an application of slaked lime to be made yearly, for some years, between December 1st and April 1st.

Five hundred pounds of stone lime, *which is moderately free from magnesia,* should be sown broadcast per acre, after being slaked with water. This quantity of lime will cost about $2.50.

For stone lime may be substituted 700 pounds of slaked oyster-shell lime. This can be bought here, ready for use, for 12½ cents per bushel of about 48 pounds in bulk, making the cost per acre $1.80.

The cost of mixing the fertilizer and slaking the lime—if stone lime is used—should not exceed $1.50 per ton, so that the total cost of fertilizing all the squares annually in the way recommended would be between $11.30 and $12.00 per acre annually, exclusive of the teaming and labor of applying the fertilizer to the land.

It may be added that the fertilizer and lime above recommended are an excellent dressing for grass and lawns, and that a well fertilized and well watered lawn greatly helps the trees which stand on the street bordering it.

4. *Mutilation of trees by horses, by street work and by electric wires.* Our present city ordinances forbid "any person to cut, bruise, injure or destroy any tree or shrub for shade, ornament, or use in any street or public square," also "to fasten any horse or other animal to any shade tree in any street or who shall place or leave any horse or other animal in such a manner that it may injure any shade tree," also "to mischievously injure or remove any fixture placed around any tree for its protection," or "to attach any guy rope, show bill, advertisement or other thing upon any tree without the permission of the Board of Public Works."

These regulations are suitable and sufficient for the protection of our trees if they were thoroughly enforced, which they manifestly are not and perhaps practically cannot be. Nevertheless more might be done in this direction and we would suggest that the police be instructed to take notice of all infractions which come to their knowledge and that the offenders be vigorously prosecuted.

The regulation of stringing electric wires is a delicate and difficult matter and it might be advisable to require that this should always be done under the supervision of an inspector furnished by the Board of Public Works at the expense of the Company doing the work.

As to the cutting of roots in the laying of curb stones, gutters, sidewalks and street mains, we know of no way to prevent it. The liability of our trees to damage from these causes seems inseparable from the necessity of properly constructed streets, and from the existence of heat, light and water systems which are indispensable municipal requirements. The Board of Public Works, however, rather than a contractor, should in all cases decide when and where mutilation of the trunk or roots of a tree is necessary.

All trees near the curb and within reach of horses should be so protected that they cannot be bitten or gnawed. Young trees should be surrounded by a frame or by wire netting so adjusted that it will not bind or cut the bark as the tree grows. For

large trees netting fastened on the street side will usually be sufficient.

Mutilation by unskillful trimming. When the limbs of a tree are amputated, extreme care should be taken to make the cuts close to, and perfectly even with, the trunk. If the pruning is done in this manner, the wounds heal more quickly than if stubs of the branches remain, and after healing there are no unsightly bulges at the point of cutting. Care should further be taken that no bark is torn from the trunk, as often occurs when a heavy branch is removed. In order to avoid this evil, a cut should first be made on the under side of the branch at a distance of a foot or more from the trunk, and then the branch should be cut off just above the notch. The stub can then be safely removed and a perfectly smooth cut made.

After the removal of a branch the wound should be painted with a coat of coal tar. The painting of wounds of living branches may be done best after the activity of the sap has ceased, for at this season the coal tar will adhere most perfectly to the wood.

The trimming of dead limbs may be carried on at any season of the year, but extensive pruning of living branches should preferably be done when the trees are not in sap, for it has been shown by experiments that wounds made in the fall and winter tend to resist decay better than those made during the period of growth.

No recommendations can be made regarding the trimming of trees to improve the shape of their crowns, for this operation can only be carried out by a skilled forester or landscape gardener, who must treat each tree according to its individual requirements.

Mutilation by Wind Storms. Nothing can be done to protect our trees against the wind other than to keep them in as strong and thrifty condition as may be, thus giving them greater power of resistance.

5. *Poisoning by Illuminating Gas.* We have nothing at present to recommend other than that the police should report at once any suspected leakage of gas in the streets, both to the Board of Public Works and to the Gas Company, and that the latter should be required by the Board of Public Works *at once* to examine and repair if necessary.

All citizens should coöperate in giving timely notice of suspected leaks, which, if not stopped, may soon kill valuable trees. In some cities, when a tree has been killed by gas leaks, the Company is required to pay the expense of removing it and planting a new one under the direction of the City authorities. Such a regulation seems eminently just, and its adoption in New Haven is well worth considering.

6. *Insect Pests. Means of destroying Leaf-eating Insects.* Trees can be protected against all leaf-eating insects if the foliage is kept well covered with poison during the early part of the summer. A thorough spraying should be given the trees as soon as the leaves have unfolded, for if the elm leaf-beetles can be poisoned before laying eggs the battle is won. Another application should be made about two weeks later or as soon as the young larvae begin to hatch out from the eggs. The second spray should be directed against the under surface of the leaves. In a dry season like the past, probably no other spraying would be necessary, but if rains were frequent four applications might be required to keep the foliage well poisoned up to the first of July.

Arsenate of lead is perhaps the best poison to use for this purpose. It has been employed during the last five or six years, has given entire satisfaction and is considered superior to Paris green by several competent and experienced men in charge of street trees.

It may be prepared as follows:

Arsenate of Soda	4 oz.
Acetate of Lead	11 oz.
Water	100 gallons.

The arsenate of soda and the acetate of lead should each be dissolved in four quarts of water and then poured into the spraying tank containing the required amount of water. This mixture will not injure the foliage even if a much larger proportion of poison is used. It should be stirred constantly to insure uniformity in the mixture applied, though most spraying outfits are provided with an agitator for this purpose.

If trees cannot be sprayed, however, some good may be accomplished by destroying the pupae of the Elm Leaf-Beetle as they congregate at the base of trees. They may be gathered and burned, or drenched with a mixture of 1 lb. of whale-oil

soap dissolved in 5 gallons of water, or with kerosene (10 per cent.) and water mixed and applied with a pump made especially for the purpose.

In the winter the belfries and towers of all public buildings should be searched and the beetles found in them carefully gathered up and burned. Vast numbers of them are often found in such places.

As the females of the canker worm and of the white-marked tussock moth are wingless, trees may be protected against them by putting sticky bands around the trunks of the trees. A strip of tarred paper five inches wide, tacked around the tree and covered with a quarter-inch layer of printers' ink makes a serviceable band. Cotton batting should be placed under the paper to prevent insects from crawling beneath it. The ink will harden after a few weeks, but may be kept soft and sticky by brushing it over occasionally with black Virginia oil such as is used for lubricating the axles of freight cars. The ink and oil should not be spread on the bark of the trees.

Several forms of metal protectors are on the market, but all need frequent attention to keep them in good condition. All forms of bands and protectors are unsightly and are not needed where spraying is practiced.

Remedies for Sucking Insects. All the sucking insects that have been named above or that are liable to injure shade trees must be destroyed by something that will kill by contact, as they do not take the arsenical poisons into their system. The cheapest and most efficient of these insecticides is kerosene oil and water, but a pump of special pattern is necessary to apply it. A mixture containing fifteen per cent. of kerosene will kill most sucking insects without injury to the foliage of the trees. One pound of whale-oil soap in five gallons of water is also an efficient remedy.

Remedies for Borers. Borers are more liable to attack trees which have been weakened or injured than healthy and vigorous specimens and often attack that portion of a tree where large branches have been cut off in a careless way and decay has begun. This form of attack is shown in Plate VI, figure 13. The maple borer, however, sometimes attacks strong trees. Constant watchfulness will detect the borers when they begin their work and they may then be destroyed by injecting carbon-

bisulphide into the tunnel which they make and plugging it tight with putty. Sometimes they can be killed by running a wire into the burrow, but it is often necessary to dig them out and properly dress the wound with paint. The very best preventive is to keep all trees in a perfectly healthy and vigorous condition.

We advise that the elm trees on the "Green" and on other centrally located public squares of New Haven be sprayed for a few years to reduce as much as possible the injury sure to be caused by the elm leaf-beetle, canker-worm and other leaf-eating insects. It does not seem practicable to attempt to spray all street trees, but suitable equipment should be procured so that at a day's notice any tree in any street of the city can be sprayed when it is found that any insect pest is threatening serious damage.

Such equipment should contain at least one power spraying outfit for large trees, and three hand barrel pumps, of which two are of the special form for mixing kerosene and water, together with plenty of ½ inch hose, couplers, extensions, nozzles, etc.,* constructed especially for spraying purposes. The cost of such an outfit would be not far from $500.00.

Though the members of this committee have not had opportunity to test the various power sprayers on the market, we believe that an outfit such as devised for use in the parks of New York City by Dr. E. B. Southwick, Entomologist of the Park Commission, is the best and most economical equipment for New Haven. This outfit consists of a "Daimler" gasoline motor operating a Gould's force pump. Motor and pump together weigh but 300 lbs. and may be placed on a spring wagon with the tank containing the insecticide. This motor requires very little attention and is economical, as a gallon of gasolene per day, it is stated, is all that is required for fuel.

Hand barrel pumps with the kerosene attachment are made by the Deming Co., Salem, Ohio, and The Gould's Mfg. Co. of Seneca Falls, N. Y. The kerosene attachment may be removed and the pumps can then be used to apply any mixture.

Such pumps (without the kerosene attachment) made by Morrill & Morley of Benton Harbor, Mich. and The Gould's

*The city of Springfield is equipped with two power sprayers and twelve barrel pumps. See Report of City Forester for 1899, p. 4.

Mfg. Co. of Seneca Falls, N. Y., have been in use for several years at the Experiment Station and have given satisfaction.

One of the best nozzles for spraying trees is the "McGowen," made by J. J. McGowen, Ithaca, N. Y. For small trees or shrubs, the "Vermorel" is excellent and may be obtained from any pump manufacturer.

The general appearance of the spraying apparatus mentioned above is well shown in Plates VII and VIII, figures 14 and 15, which were kindly supplied by Dr. E. P. Felt, Entomologist of the State of New York.

In reference to the cost of spraying trees, we cite the following from page 21, Bulletin No. 20, Vol. 5, of the New York State Museum, "On the Elm Leaf-Beetle in New York State," prepared by Dr. Felt, the State Entomologist:

"*Cost of Spraying Elms.* I have taken some pains to ascertain the precise cost of spraying per tree in the hope of encouraging those to whom this would be a serious item. It is pleasant to record that the expense is much lower than I had supposed. Dr. Smith, of the New Jersey Agricultural Experiment Station, has kindly supplied the following data. The elms on the college campus at New Brunswick are 50 to 75 feet high and were sprayed at odd times by the janitors, it requiring about an hour or two with force pump, tank and ladders to treat one tree. The poison necessary for each spraying was worth about six cents. It will thus be seen that the cost per tree would be between 36 and 56 cents, varying with the price of labor. In the city of New Brunswick the trees were sprayed at a contract price of one dollar for the season, the understanding being that they were to receive three treatments if necessary. The contractor prepared the outfit, furnished the material, did the spraying at the price mentioned and had a neat margin remaining.

Mr. Kirkland, Assistant State Entomologist of Massachusetts, has kindly supplied me with the following figures. A grove of over 200 red and white oaks ranging in height from 40 to 70 feet were sprayed once at an expense of 49 cents per tree. In this instance arsenate of lead was used at the rate of 20 lbs. to 150 gallons of water, a considerably stronger mixture than would be necessary for the larvae of the elm-beetle. In addition, he estimated the expense of spraying smaller trees, 20 to 40 feet high, at 15 to 20 cents per tree.

The cost of spraying the elms in Albany this season, aside from wear and tear of the apparatus, is considerably less than the figures above given. The trees present a wide range in size, although the majority are from 50 to about 70 feet in

height. Taking them as they come, Mr. Lewis has succeeded in spraying them once at the low cost of about 15 cents per tree. This is largely due to the excellent apparatus, to be described later, and is a most encouraging feature of the work.

"It is hoped that these figures will induce private individuals to provide protection for their trees, either by doing the spraying themselves or else by hiring some capable party."

We are informed by Mr. Wirth, Park Superintendent of Hartford, that the cost of spraying in Bushnell Park last summer, averaged $1.00 per tree and that the benefit to the trees was well worth the outlay.

7. *The remedies for defects in the Methods of Selecting, Planting and Caring for Trees,* may be applied by a city forester, as will be explained in what follows:

How Shall the Work of Protecting and Improving the Trees be Done?

In the foregoing, we have named the principal troubles which beset the city shade trees and have indicated how they may be greatly lessened if not wholly removed. There remains to consider the question as to how and under what management and supervision this work can be most efficiently and economically carried out.

A City Forester.

It has been shown that the present unsatisfactory condition of our street trees is largely due to the lack of intelligent care. In this report certain remedies have been suggested for the existing evils, but it is the opinion of the Committee that they can not be properly applied unless supervised by a competent expert. In order to establish and manage a city nursery, to select specimens for the streets and parks and to superintend the work of planting them, to trim the young trees, to select such as should be removed, to protect the trees from injurious insects and from mutilation, to properly fertilize them, etc., etc., there is required a special knowledge which can be found only in a trained expert.

The Committee therefore recommends the appointment of a City Forester.

Duties of the City Forester.

The City Forester should be charged with the entire care of the trees in the streets and interior parks of the city. It should be his duty to make regular and thorough inspections of all the trees within the city, and, in case of damage from insects, disease, gas, lack of water and air for the roots, or from any other cause, he should institute and superintend the application of such remedial measures as may be necessary. If any trees are dead or have become unsightly through disease or mutilation, the City Forester should superintend their removal. If trees stand too closely together and they can be safely thinned out, he should superintend this operation.

The City Forester should, further, establish and manage a city nursery to raise trees for the newly planted streets and to fill the gaps in the older streets and parks. He should personally select the trees from the nursery and superintend the planting in the streets and parks; and he should see to it that the young trees are protected, where necessary, by wire screens or similar appliances. Finally it should be his duty to trim the trees whenever necessary.

Method of Appointment.

With regard to the mode of appointing a City Forester, it is evident that his selection and the tenure of his office should be kept as free as possible from all political considerations and influences.

To secure this desirable result it seems to us that the most effectual as well as the most simple and appropriate way would be to make him an official and appointee of the Department of Parks. It would of course be necessary in such case to enlarge the jurisdiction of that department so as to embrace the care of all the trees in the streets and public squares of the city, and in order to ensure systematic, continuous and scientific work, a fixed annual appropriation should be provided for by charter amendment of sufficient amount to cover the necessary expenditures of the department in its enlarged province.

What the amount of such annual appropriation should be we do not undertake to suggest, regarding that matter as one

which is not proper for us to consider, and which in any case we are not at present in possession of sufficient information to determine.

A City Nursery.

In event of the appointment of a City Forester, the Committee would recommend the establishment of a nursery to raise trees for future planting. There would be a considerable saving of expense, and the quality of the stock would be much better than that which could be purchased from a commercial nursery. When a lot of 100 or more trees is purchased from a nurseryman, it is practically impossible to obtain perfect individuals in every case. If there were a city nursery under the charge of a City Forester, it would be possible to transplant the young trees in the nursery more often than is usually done, and to give each individual a personal care which is impracticable where trees are raised in very large numbers.

Under efficient management the cost of the trees raised in a city nursery should not exceed one-half to one-quarter of the cost of those purchased from commercial houses, the quality of the stock would be very much better, and the percentage of loss from death in transplanting would be considerably reduced.

The Committee would recommend the use of a part of the Springside Farm for the nursery. Probably from three to five acres would be sufficient for the production of five hundred trees annually.

During the first year it would be necessary to start a seed bed, and it would be desirable to purchase and set out young plants in order that there may be as little delay as possible in producing trees of a size suitable for street planting.

A liberal estimate of the first year's expense, necessary for a nursery large enough to produce 500 trees annually, is as follows:

750 small trees	$ 75.00
Seed	10.00
Labor, tools, frames, etc.	100.00
Fencing	100.00
Total	$285.00

Under economical management the total annual cost of maintaining such a nursery in succeeding years should not exceed $100.

The cost of purchasing five hundred trees from nurserymen for immediate planting would be not less than $300, but might be $500 for the quality of stock required. If large trees were set out the cost would be enormously increased, but, if trees are properly cared for after setting, better results can be obtained from comparatively small stock.

The cost of planting would probably not exceed 60 cents for each tree or $300 for 500 trees. It would be desirable, however, to make an appropriation of at least $500 for this purpose to cover all emergencies. For the first year there should, therefore, be an appropriation of $1,000 for planting 500 purchased trees and $285 for the establishment of a nursery.

Varieties of Trees Suitable for Street Planting.

In conclusion, we desire to say a few words regarding the kinds of trees which it is desirable to plant on city streets.

New Haven, the "Elm City," has for many years been noted for the beauty of its elms, and it seems eminently proper that this character should be preserved. It is, therefore, recommended that when the old elms die, they be replaced by the same species. If the newly set trees are properly cared for, there should be no difficulty in producing specimens of as fine proportions as those now standing.

Next to the elm, the most popular tree for street planting in New Haven has been the sugar maple. In youth it forms a compact, oval, or egg-shaped crown of remarkable symmetry. With advancing age the top becomes broad and often nearly flat, giving the tree an expression of dignity, which it altogether lacks when young. It is transplanted with ease and thrives well in the unfavorable conditions of large cities. It grows rapidly, being surpassed in this respect among the maples, only by the silver variety.

The red maple seems to thrive admirably in New Haven. Although it is surpassed by the other maples in grace of form, it will always be a favorite street tree on account of its scarlet flowers, which appear early in spring and its brilliant autumn foliage. It is recommended for planting in New Haven.

The silver maple has been planted in the New Haven streets only to a limited extent. In its natural habitat it is one of the

most beautiful of all the American trees. Unfortunately, however, it is fastidious as to soil and situation, and the specimens planted in cities do not usually do justice to the capabilities of the tree. It grows with great rapidity and in early life develops a spreading crown with long drooping branches. The wood is soft and brittle, especially when the tree does not find congenial soil, and often the slender trunks are unable to support the long branches, which are broken by their own weight. Wind and ice storms do considerable damage to the silver maple, and the soft wood, when exposed, is quickly attacked by fungus diseases which eventually kill the tree. In the judgment of the Committee it should take a subordinate place among the trees recommended for planting in streets.

The Norway maple is an admirable tree for street planting. It forms a large, compact, round head and casts a very heavy shade. It grows more slowly than the trees already mentioned, but it has the advantage of requiring but little care after planting. It is perfectly hardy in New Haven.

Of the trees which have been but little planted in New Haven, the Committee would specially recommend the pin oak, tulip tree and sycamore.

The pin oak is rapidly coming into popularity in a number of cities. It is distinguished by a graceful pyramidal form with drooping lower branches which often sweep the ground. It is easily transplanted and thrives peculiarly well as a street tree. Its growth is apt to be slow directly after transplanting, but in a few years it is able to keep pace with most other trees. It is recommended for trial in New Haven.

There are a number of other oaks which might well be tried in our streets, as the red, white and scarlet varieties. If frequently transplanted in the nursery and severely pruned before removal, they may be successfully planted in cities.

The tulip tree grows naturally in the woods near New Haven, and will doubtless thrive as a street tree. It grows rapidly and during the period of its principal height growth forms a conical crown, which in old age becomes more or less irregular. It is a tree of great dignity and should be given a trial in New Haven.

For broad streets the sycamore is a beautiful and appropriate tree. Both the American and Oriental varieties are used, and

both develop large spreading crowns and grow with great rapidity. The American sycamore is, as a rule, more subject to disease than the Oriental variety, and in consequence the latter is usually given the preference.

There are a number of American lindens (basswood) planted in the streets and parks of New Haven. This species grows rapidly and develops a large, round crown which casts a deep shade. With proper care the American linden makes an excellent avenue tree, but it is liable to be injured by storms and, if it is neglected, disease is apt to attack the wounds, eventually killing the tree.

The European varieties of linden are to be recommended on account of the perfect symmetry of their compact crowns. They thrive admirably in this climate.

Ash is often planted as a street tree, but its tendency to fork and to become straggling makes it less desirable than those already mentioned.

To summarize what has been discussed above, we make the following

RECOMMENDATIONS.

1. The rigid enforcement of those city ordinances which forbid the bruising, injuring, or destruction of trees, and the fastening of animals to trees in such a way as to injure them.

2. That all trees standing within reach of horses in the street be protected by frames or wire netting, so that they cannot be mutilated.

3. That when limbs are removed from trees, greater care be exercised to cut them smoothly, close to, and even with, the trunk and without tearing the trunk bark. The exposed wood should be painted with coal tar.

4. That the stringing of electric wires be done only under the supervision of the Board of Public Works, and that this supervision be paid for by the company doing the work.

5. That when trees are killed by gas leakage from the mains, the owners of the mains be required to pay to the city the cost of the removal of the trees killed and of planting new trees in their places.

6. That the land under trees in the city parks be annually dressed with lime and with odorless fertilizer of the composition named, at a cost of from $11.00 to $12.00 per acre.

7. That on new streets, when the building line is far enough from the street line, it is desirable to plant just in front of the property line, rather than just back of the curb.

8. That the elm trees on the Green and other interior parks of the city be sprayed regularly for a few years, and thereafter as seems necessary, in the way prescribed.

For this purpose the city should buy a spraying outfit of approved construction, such as has been described, costing about $500.00.

9. That in winter systematic search be made in all belfries and towers of public buildings, and that the elm leaf-beetles, which winter in great numbers in such places, be gathered up and destroyed.

10. We also recommend the permanent employment of a City Forester, who should have charge of the trees in all respects.

11. That, in case such an officer be employed, the city have a nursery of from three to five acres at Springside Farm, where trees suitable for planting on the streets and interior parks can be grown.

All of which is respectfully submitted,

E. H. Jenkins, *Chairman,*
W. E. Britton,
Henry S. Graves, *Secretary,*
Henry T. Blake.

Fig. 1.—Tree ruined by gnawing of horses. Decay started from the injury and only a shell of living wood remains on one side of the tree. This tree is liable to be broken over by a strong wind and probably will fall upon the adjacent building.

Fig. 2.—Tree injured by use as a hitching post.

Fig. 3.—Trees mutilated in laying curb and gutter.

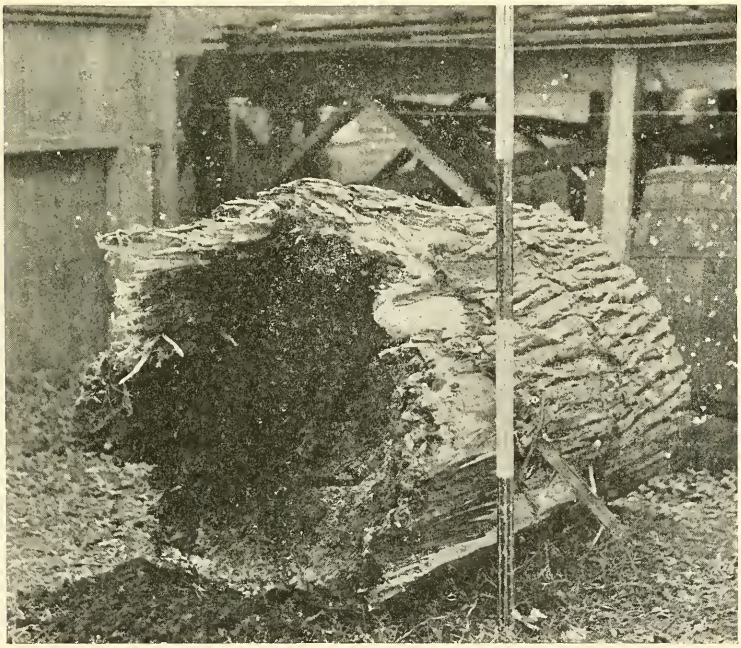

Fig. 4.—Trunk of an Elm which was thrown over in a squall, Oct. 15, 1900.

Fig. 5.—Decay following unskillful pruning.

Fig. 6.—The Elm Scale on Twigs.

Fig. 7.—Adult Maple Borers.
(After Felt.)

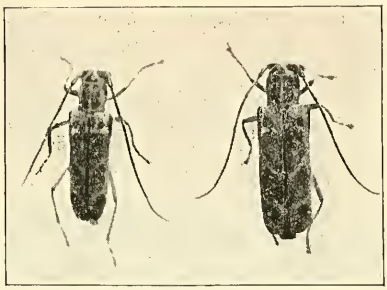

Fig. 8.—Adult Elm Borers.
(After Felt.)

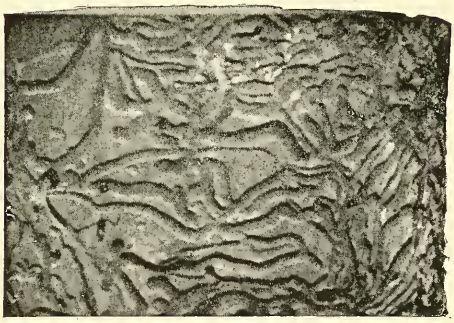

Fig. 9.—Work of Elm Borer.
(After Felt.)

Fig. 10.—Work of Maple Borer nearly girdling the tree.

PLATE V

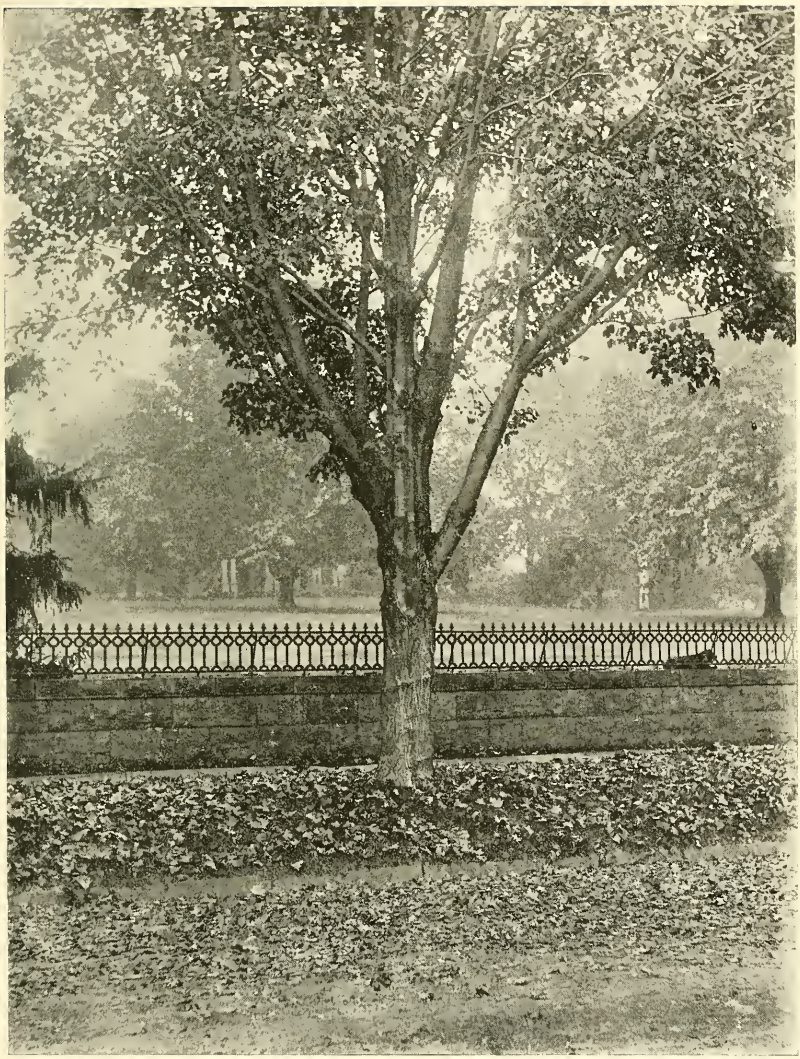

Fig. 11.—Damage by Maple Borers showing tunnels cut spirally around the trunk.

Fig. 12.—Trees set near the property line away from the curb.

Fig. 13.—Damage by Borers, following unskillful pruning.

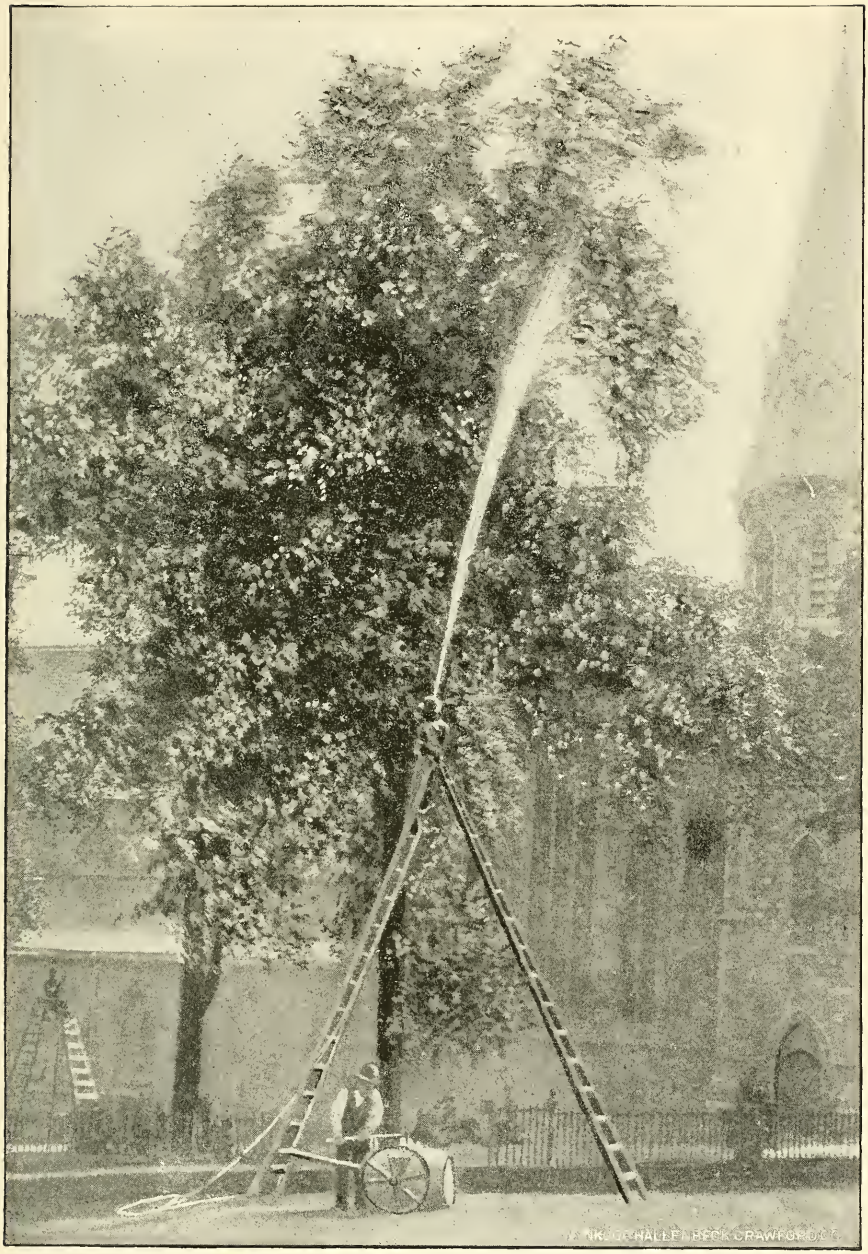

Fig. 14.—Hand Spraying-Pump in Operation.
(After Felt.)

PLATE VIII

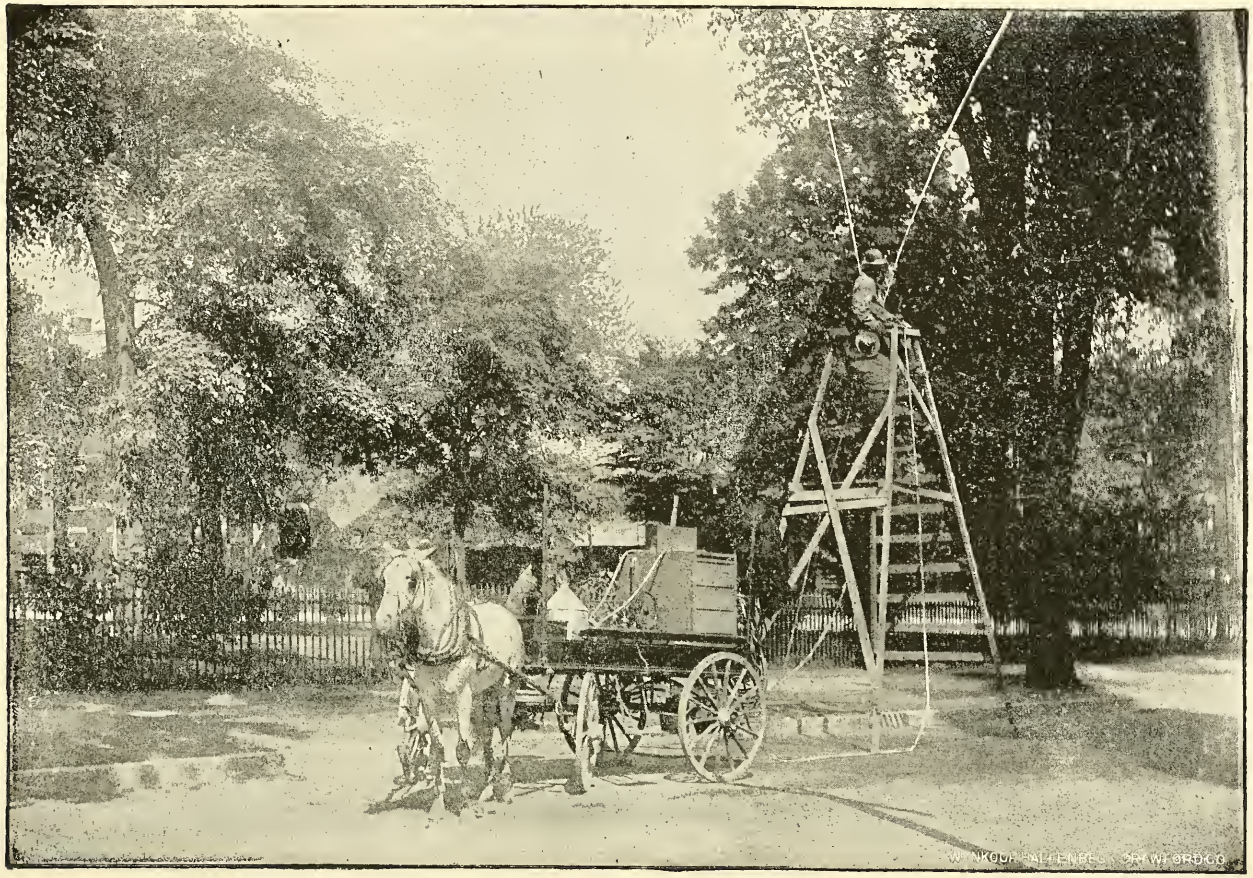

Fig. 15.—Power Sprayer in Operation.
(After Felt.)

Fig. 16.—Fall Canker Worm Moths. Male and Female.

Fig. 17.—Elm Leaf-Beetle.—*a*, eggs; *b*, larvæ; *c*, adult; *e*, eggs, enlarged; *f*, sculpture of eggs; *g*, larva, enlarged; *h*, side view of greatly enlarged segment of larva; *i*, dorsal view of same; *j*, pupa, enlarged; *k*, beetle, enlarged; *l*, portion of elytron of beetle, greatly enlarged. *(After Riley.)*