

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

Bulletin No. 397

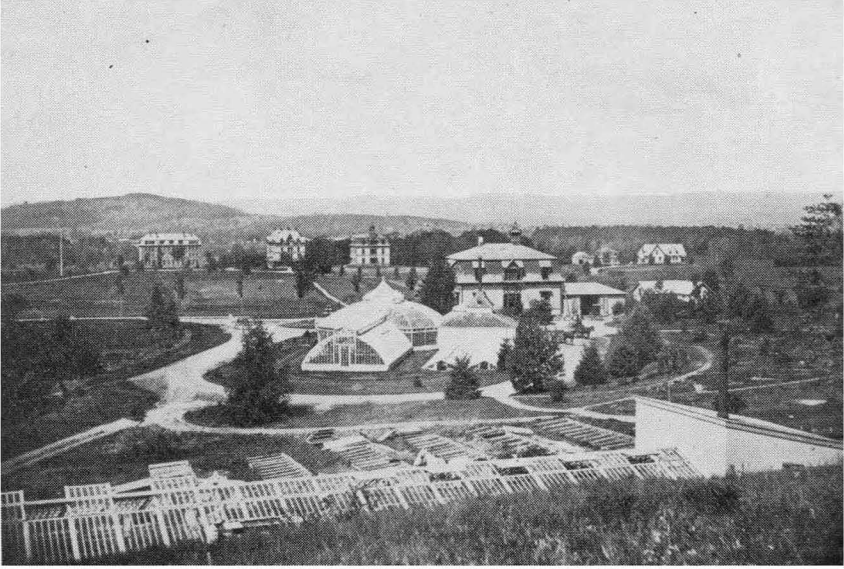
December 1942

**A Civilian Program for
Tree Protection**

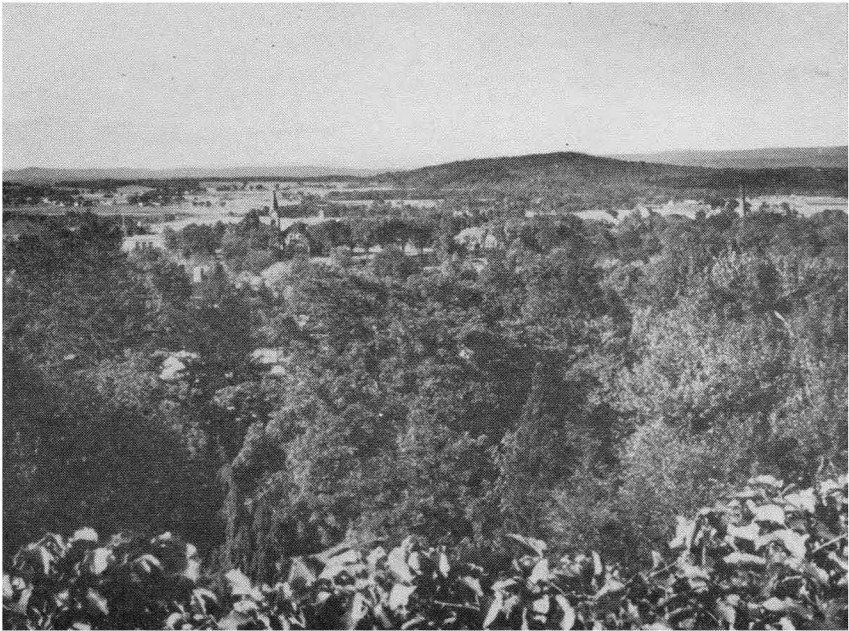
By Malcolm A. McKenzie

Public appreciation of shade trees in Massachusetts is evidenced by the extensive and varied planting throughout the State. This bulletin, prepared primarily to promote municipal tree management, also suggests methods of tree care in general.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.



View of Massachusetts State College campus taken about 1880, illustrating how starkly buildings stand out when tree cover is absent.



View of Massachusetts State College campus 1942, taken from approximately the same spot as the earlier photograph and showing how tree cover obscures outlines of buildings and renders target indistinct.

A CIVILIAN PROGRAM FOR TREE PROTECTION

By Malcolm A. McKenzie, Research Professor of Botany

34276

INTRODUCTION

The appreciation of shade trees, widespread in the life of the American people, is of paramount importance in Massachusetts, and in the spring of 1942 there was a marked increase in the number of requests for the investigation of tree casualties. Trees were reported to be afflicted with diseases and other defects, and the urgency of the demand for the completion of field and laboratory studies was promptly recognized.

Healthy trees should be highly prized by all communities, but seriously weakened trees may be dangerous liabilities. A tree or limb which falls on a highway (Fig. 1) may injure a pedestrian, delay the transportation of troops and war materials, damage an automobile, or destroy electric light, telephone, fire alarm and telegraph services. During normal times the temporary incapacity of the injured person may not be a serious loss, damage to an automobile may be covered by insurance, and the public utilities' supply of replacements may be ample for all demands. During wartime, however, delay in movement of men and material and the loss of man hours is tragic, a destroyed automobile is irreplaceable, and the loss of electric light, telephone, fire alarm and telegraph service may mean failure in transmission of air-raid and fire alarms and in mobilization of aid. Air bases, air fields, defense centers, and military or naval defense areas may be isolated and unable to function. Therefore, these investigations were undertaken with the twofold purpose of learning what significant defects were present in trees and what treatment might be given to prevent damage to persons and property. From one point of view the objectives are closely related. A tree which is or can be made reasonably sound can be a reasonably safe tree. The cruxes of the problem are the recognition of various tree defects and the timing of their discovery and treatment.

The Massachusetts law (G. L. chap. 87) provides that each municipality be officered by a person responsible for "all trees within a public way or on the boundaries thereof"; in towns, a tree warden; in cities, a forester or corresponding official. In section 1 of chapter 41 of the General Laws, the term of office for tree wardens in towns was limited to one year. If, however, a town adopts the amendment passed by the General Court in 1939, the tree warden may have a term of three years, thereby providing for a measure of continuity for municipal tree programs. Very serious consideration should be given to the matter of providing adequate appropriations for tree work, and as an emergency measure, a supplementary program for tree protection under the direction of the tree warden or other responsible officer appears necessary and is recommended.

¹ The writer is indebted to Professor A. Vincent Osun, Head, Department of Botany, for valuable assistance, suggestions and criticisms during the preparation of this bulletin. Acknowledgment is also made to Dr. S. J. Ewer, Technical Assistant in Botany, for criticism of the manuscript and the preparation of certain of the illustrations. The helpful interest of the Massachusetts Tree Wardens' and Foresters' Association, the Massachusetts Horticultural Society, the Massachusetts Forest and Park Association, the New England Telephone and Telegraph Company, the Western Massachusetts Companies, the Boston Edison Company, the Municipal Lighting Association of Massachusetts, the New England Power Association, the New England Gas and Electric Association and the New England Section of the International Municipal Signal Association has played an important part in completing this work; particular credit should be given to Mr. A. Warren Stewart, President of the Massachusetts Tree Wardens' and Foresters' Association.

TREES IN WAR

In time of peace the annual value of the tree crop in the United States, principally in manufactured forest products, approaches \$800,000,000 and in wartime this figure may be more than doubled. Therefore, the importance of wood and other tree products is widely recognized. The essential value of shade tree programs during wartime, however, has not been universally appreciated. The use of trees and other plants has always been important for the concealment of unsightly areas and for securing privacy about dwellings. Since the battleground of modern war is limitless, including the homes in cities and towns throughout the world, any increased obscurity associated with native tree plantings is of significance as supplementary protection against aerial attack.

The decentralizing of municipalities or the expansion of communities into subdivisions has been a matter of research involving many considerations, especially in recent years. When the decentralizing of cities began in the United States it was not with any thought of making the communities less vulnerable as targets, but rather for the constructive benefits of peaceful pursuits including convenience, health, safety, and general welfare. Fortunately, civic planning, perhaps unwittingly but nevertheless genuinely, anticipated the future and materially contributed to the present-day war effort. Recently, R. P. Breckenridge,² Major, Corps of Engineers, Fort Belvoir, Virginia, published this heartening description under a photograph: "Aerial view of a well-planted city. Trees screen this area and render it practically immune to aerial attack." A second photograph bore this gloomy prediction: "A city where tree planting has not been considered important. Note the vulnerability and visibility to aerial attack." Major Breckenridge pointed out in particular that trees and natural foliage are obviously of prime importance in any camouflage scheme.

The development of war housing projects has added heavy duties to some municipal tree programs, and there is not time for all municipalities to provide additional tree canopies, but all towns and cities can make judicious use of the trees already planted on streets and roadsides. Spraying for the prevention of attacks by destructive pests will aid materially in enabling trees to render important service and every community should provide for tree protection. The dangers of the policy of "too little and too late" were never more clearly apparent than in the war on plant pests. Let no one be lulled into complacency concerning the imminence of attack by disease fungi and insects. Too often, ground lost to these invaders can never be recaptured. The economic loss sustained by unwarranted curtailment of pest control programs finally reaches every individual in the nation. The danger of winning the war only to lose the peace was never more real than in relation to the control of plant diseases and insect pests, and the importance of unbroken continuity in a pest control program cannot be emphasized too strongly. The ample scientific basis for this statement, although somewhat involved, may be visualized as the pattern from which "blitzkrieg" tactics were copied.

Trees protected from pests are in turn a safeguard to life and property. Moreover, the sprayers, trucks, hose lines, and storage tanks employed in shade tree protection may serve other use in an emergency. The tree wardens were among the first public officers to make specific study and provisions for a revision of local programs in cooperation with public service agencies. In fact, on November

² The Use of Trees in Camouflage. Trees, Sept.—Oct., 1941. pp. 7 and 15.

15, 1941, they published recommendations³ which should materially facilitate the operation of the war emergency work of tree programs.

In brief, then, in view of the camouflage value of shade trees (Frontispiece), municipal tree planting and protection programs previously developed for the promotion of peaceful pursuits may now enable communities which were interested in living better, also to live longer.

INVESTIGATIONS

The present studies included forest and shade trees in all sections of the State, with special attention to street plantings. The principal types of troubles found are analyzed briefly.

Fungus Diseases and Insect Pests. Insects⁴ contributing to tree injuries have been found to include insects causing initial injury to healthy tissues, insects associated with secondary injury to tissues previously weakened, and insects which serve as vectors or carriers of other pests. Fungi and bacteria related to tree injury include organisms which may kill trees promptly, induce chronic disease, or cause disintegration of portions of weakened trees.

Dutch Elm Disease. The Dutch elm disease has been found in only seven trees in Massachusetts, but mention of it is included here to call attention to the importance of keeping this disease in check in any program concerned with the elimination of hazardous trees. Extensive spread of the disease would doubtless result in greatly increasing the number of dangerous street trees. (For additional information see tailpiece.)

Wood-destroying Fungi. It often happens that a limb broken from a tree during a wind storm had been previously weakened as a result of decay following invasion by wood-destroying fungi (Fig. 2). Sometimes evidence of this weakness prior to the break may be completely lacking, but in many instances it might have been detected had the tree been inspected. If a tree shows extensive signs of decay, limbs which may be broken by the wind should be removed, as in the case of the tree shown in figure 3.

Physiological Disorders. Trees, like all other green plants, require water, nutrients, sunlight, and air in order to function as living organisms. The lack or excess of some of these essentials may result in injury or death. Thus, trees sometimes suffer from drought, flood, alteration of water table, winter conditions, shade, evaporation, non-availability of nutrients, and other inherent or induced soil conditions.

Chemical Injury. Calcium chloride and other chemicals stored or applied in locations which permit contact with the soil about trees may cause injury to roots. In the atmosphere, some of these materials may cause the burning of foliage.

Smoke Injury. Smoke and fumes frequently contain sulphur compounds or other toxic substances which may injure trees with which they come in contact.

³ Recommended Principles and Practices of Massachusetts Tree Wardens' and Foresters' Association and Public Service Agencies.

⁴ Inquiries concerning specific insect pests or their control should be addressed to the Department of Entomology, Massachusetts State College, Amherst, Massachusetts.

Similar injury⁵ was observed on foliage exposed to sulphur dioxide fumes from a defective electric refrigerator.

Fire. The huge losses resulting annually from forest fires are already known to most persons, but the knowledge of how a fire injures individual trees is apparently not so well understood. Extensive injury to the trunk and branches of shade and ornamental trees often results from the burning of rubbish nearby, and scorching of the bark is sometimes the prelude to invasion by fungi.

Injury from Illuminating Gas. Many trees have been killed from the effects of illuminating gas in the soil. Usually by the time the gas injury shows in a tree, no remedial treatment is practical. In recent years considerable progress has been made in detecting gas leaks by means of surveys conducted by gas companies, and tree casualties have been reduced and human lives saved by the prompt repair of leaks.

Site. Tree troubles may originate at the site in which the tree is growing. The basic nature of a possible site may be such as to make the planting of a particular type or individual tree unwarranted. After the selection of a suitable species or specimen, planting should be done in such a way as to avoid air pockets in the soil, which often prove a source of trouble later. Careful planting in a well-chosen site is the best insurance for the future growth of the tree. Sometimes after an area has been planted, new buildings or other factors may necessitate the removal or transplanting of the trees. Turf grading operations which fail to provide a needed brick- or rock-lined wall around trees are a common source of trouble. The installation of curbing, hard-surfaced roads, and sidewalks may result in root injury. Erosion of soil during these operations and under a variety of other conditions may dangerously undermine trees. Weakening of anchorage should be guarded against in all locations.

Narrow Tree Belts. In most communities, public shade trees are ordinarily planted in the space between the hard surface road and the sidewalk. In some instances this area is extremely narrow, but widening is often precluded by existing conditions. Trees restricted in this way are under a severe handicap and in most cases have been observed to do better than one would reasonably expect. Extended periods of drought or other tests of vigor, however, sometimes take a heavy toll of weak trees in narrow planting belts.

Storm Damage. Ice storms, lightning, high winds, hail, heavy rain, and snow result annually in severe damage, and storm injuries accumulated over any extended period of time may result in trees becoming serious hazards in the community. Injury initiated by the hurricane of 1938 has served as a basis for subsequent extensive damage and, in some cases, ultimate death of trees.

Girdling Roots. In planting a tree, if care is not taken to provide a hole of adequate size in which to spread the roots, there is danger that they may become wrapped around the trunk in such a manner as to choke the normal growth (Fig. 4). The ill-advised application of a fertilizer close to the base of trees may cause excessive root development and girdling about the trunks. Girdling roots are not necessarily harmful, particularly if root grafting results. When a girdling root above or below ground is detected as the cause for tree weakening, it may be severed and the constriction of the trunk somewhat relieved.

⁵ McKenzie, M. A. and L. H. Jones. Injury to trees from sulphur dioxide fumes of electric refrigerators. Science 91:239-240. 1940.

Other Girdling. Wire guards, fences, and supports in contact with trees may girdle the trunks and cause permanent scars, injury, or death.

Injury by Animals. In former days the gnawing of the bark of street trees by horses was often cited as a source of injury and possibly wounds caused in this way may again become common. At present, however, damage by horses is not a serious problem although limited injury to trees may be caused directly or indirectly by some other animals.

Frost Cracks. A sudden drop in temperature may result in the withdrawal of water from the cells of the wood in a tree trunk and its fixation as ice crystals. The resulting cell shrinkage lacks uniformity and creates a tension within the woody tissue. With the development of sufficient stress, rending occurs along the grain of the wood. An accompanying loud report may be the first warning of this type of injury. The sharp lengthwise clefts commonly seen on the south and southwest exposures of trees are the ultimate wounds of this sequence. Frost ridges in which splitting of the wood results without rupturing the bark differ only in the degree to which the shrinkage of woody tissue takes place or sufficient tension develops. Many frost cracks close and heal readily (Fig. 5, A) when the shrunken tissues thaw and absorb a sufficient amount of water. Sometimes, however, a frost crack may become a permanent weak spot (Fig. 6) which will reopen each winter and may be effectively closed only by mechanical aid, such as screw rods inserted through the tree trunk at right angles to the fissure.

Slime-flux. Wet yellowish streaks extending down the limbs and trunks of trees are frequently observed to originate at an injured crotch (Fig. 6), the cut at which a branch has been severed, or in some other wound. A slimy ooze in which fermentation organisms become active may continue to flow down the surface of the bark for a considerable period of time and in persistent cases where the bark and growing tissue are continually wet, extensive injury may result.

Lost Protection. Some trees require protection from drying winds or excessive heat or cold. Since the hurricane of 1938 in which such protection was sometimes lost, resultant injury has been particularly conspicuous. Tree owners reasoned that sheltered trees survived the hurricane, but failed to evaluate critically the post hurricane exposure of these trees resulting from lost protection.

Branch Wounds. Friction resulting from the rubbing of branches or the contact of public utility wires with branches often causes wounds which may later directly or indirectly result in the death of certain parts of trees. Utility companies have long since learned that where wires are in direct contact with trees there is not only the immediate prospect of interrupted service from burning as a result of contact of the energized wire and grounded tree, but also the later penalty of the killed branch crashing through the wires.

Trunk Wounds. It is not uncommon to find the trunks of trees debarked by automobiles, snowplows, or lawnmowers. Such injuries may be the beginning of serious trouble, serving as points of entrance for decay organisms and the ultimate weakening and collapse of trees.

Unusual instances of trunk wounding, as those associated with the Connecticut Valley flood of 1936, are sometimes difficult to explain after the conditions causing them no longer prevail. For example, trees situated in locations which now appear to be at a safe distance from flooding waters show bark injury known to have been caused by ice floes.

Root Injuries. The most conspicuous root injuries are those resulting from excessive root pruning; especially the type shown in figure 7, upper. The almost certain sequel to such pruning is shown in figure 7, lower.

Neglected Pruning. Most trees require a minimum of pruning for health, appearance, disease control, safety, utility line clearance, or other considerations. Delay in pruning or failure to prune correctly may prove to be a costly mistake, especially in municipal shade tree management. Severe damage to neglected trees, injury to citizens or their property, as well as the interruption of the service of wire-using agencies, may result.

Branch Stubs. Careless pruning or storm injuries sometimes leave jagged branch stubs as an invitation to wood-destroying fungi. Probably tree deterioration starts in this way more often than in any other.

Exposed Wounds and Cuts. Many tree casualties are found to result from untreated wounds and cuts. Prompt treatment of wounds and immediate attention to cut surfaces following the removal of branches are constructive preventives useful in checking early deterioration.

Cavities. Extensive cavities in trees represent the advanced stages of progressive decay following injuries. The best treatment for them is to prevent their occurrence, or check their progress.

Dangerous Trees. Trees seriously weakened by disease or decay at a large crotch (Fig. 2), and skeleton trees which have ceased to serve communities for purposes of shade not only are frequently a blot on the landscape but may actually constitute a serious menace. Sometimes failure to appreciate the need for the prompt removal of such trees or the lack of responsibility for this work may cause serious delay in the removal of a dangerous tree. The result of this delay may prove injurious, fatal, or costly to someone.

Evergreen Failures. Coniferous evergreens may be injured by the weight of snow on branches or tree tops. When parts of trees are broken, the same treatment accorded wounds of deciduous trees may be given or may be altered as necessary. In all cases, branch stubs or rough jagged edges of wounds should be cut back smoothly. The resin coating which usually covers cut surfaces of evergreens suffices as a dressing. When trees are broken during a wind or wind-and-rain storm, the entire tree or most of it commonly falls (Fig. 1). The guying of evergreens in certain locations will sometimes prevent accidents of this type.

Trees and Utility Wires. Trees and wires both serve society in war as in peace. Adequate tree maintenance and maximum service from wire-using agencies do not represent fundamentally divergent policies. Certain conflicts between trees and wires are inevitable, however, and the results of some of these conflicts and the mechanical devices adapted to overcome or minimize them are shown in figure 8. Shade tree maintenance has benefited materially from the joint use of poles by utilities, as well as in other progressive utility programs. The almost forgotten overhead wire mazes (Fig. 9) which have been compacted (Fig. 10) and in many cases placed underground, foretell even better conditions for shade trees in the future. Placing utility wires underground, however, should not be considered a panacea. In certain instances this practice is desirable and practical, but at other times the cost to consumers would be prohibitive. Nor should it be

supposed that wires underground may be forgotten, since tree roots and wires may sometimes conflict. For the present, however, the equipment of wire-using agencies is not likely to be changed materially, and there should be opportunity for additional study of problems concerned with overhead wires and trees. During wartime, extra vigilance is necessary to insure the fullest measure of uninterrupted service from both trees and wires, and accidents resulting from the falling of weakened trees should be prevented.

The following data prepared independently by L. B. Shepherd, Division Toll Service Supervisor, New England Telephone and Telegraph Company, indicate the nature of tree troubles encountered by wire-using agencies. A total of 35 percent of toll open wire troubles is associated with trees, principally sugar maple, poplar, elm, birch, spruce, beech, and oak.

Sugar Maple—Failure occurs at the crotch, and at the time the limb is in leaf. To all appearances, the tree may be a healthy one. It is suggested that crotches of old maples be checked for decay, and that ends of limbs be examined for indications of dying branches.

Poplar—Failure occurs by trunk breaking off either at base or near top of tree, after tree has reached 8 to 10 inches in diameter.

Elm—Failure occurs in large elms at the crotch or midway in limb, probably on account of the resistance to the wind when the tree is in full leaf. Crotches should be checked as suggested under "Sugar Maple", and crotch reinforcements should be provided for those limbs considered hazardous. Experience has shown that limbs of elms are brittle, and snap easily under pressure.

Birch (White or Yellow)—Failure occurs during period of heavy wet snow. Trees become laden with snow and ice and lie over into wires.

Spruce or Pine—Failure occurs during violent wind, and trunk snaps off about 15 or 20 feet from ground line. It is suggested that attention be given to trees that are leaning (probably result of hurricane), shallow rooted, and have dying foliage.

Beech and Oak—Failure occurs when trees are leaning into wires, particularly on sidehills.

Cutting Wood for Home Use. The fuel shortage has brought an increase in the number of inexperienced persons chopping wood for home consumption. In order to accomplish the most for their efforts, persons will do well to consult their county agricultural agents and inform themselves on time-saving methods in the cutting and use of fuelwood. Careless chopping has in some instances resulted in serious damage to utility service. Fuel conservation of this type is indeed attained at a high cost in other critical materials and service. The felling of trees on wires should always be avoided, and in doubtful cases, chopping in the vicinity of wires should not be attempted. Extended fuelwood programs organized to save other types of fuel serve a valuable need if dangers of spreading the Dutch elm disease and damaging service of wire-using agencies are carefully guarded against. With certain limitations on the disposition of elm wood, as indicated elsewhere in this publication, the consumption of wood from hazardous trees may be an important supplement to the fuel conservation program, especially in cities where woodlots are not often immediately available. However, attention should be called to the fact that trees in the public way or on the boundaries thereof are the responsibility of the tree warden, and promiscuous cutting by individuals is unlawful. Disposition of the wood after a tree is cut may be arranged by the municipal officer in charge of trees.

Harmful Practices. Willful maltreatment, panacea claims, and tree magic are for the most part of historical interest only in connection with modern tree care. An informed public, the sincere efforts of the members of the arboricultural profession, and in some states the licensing of tree workers, have done much to establish the scientific treatment of tree troubles. Damage sometimes results from carelessness, inadequate diagnosis of tree defects, or the employment of inexperienced operators, and every effort should be made to shun these pitfalls.

PRECAUTIONS

Essential Considerations. Many of the operations essential to the satisfactory maintenance of shade trees can be completed by persons without specialized training. Nevertheless, certain important considerations concerning trees and apparatus and materials employed should always be borne in mind.

A person contemplating tree work would do well to inform himself concerning the nature of the tree, details of the operations involved in his plans, and the equipment and materials necessary for the work. By so doing he will more fully appreciate the significance of the completed job whether he does the work himself or employs others to do it. An excellent procedure before beginning actual operations on a tree is to make a diagram to scale showing the operations contemplated. In this way an individual will give himself the opportunity of experiencing practical problems involved and develop an intelligent plan of action. Whenever possible, attention should be directed toward corrective treatment of minor defects and the prevention of major injuries by early treatment.

Poisonous Materials. Many of the materials used for the protection of tree wounds and as sprays on foliage are poisonous, inflammable, or caustic. Utmost care in handling all materials should be exercised constantly, therefore, and all materials should be used only in accordance with directions furnished by the manufacturer. One should always be mindful of protecting other persons, animals, and property from damage resulting from operations or the use of materials. Unused materials likewise require attention and should not be stored in places, or under conditions, in which they are or may become hazardous.

Poisonous Plants. Two important woody plants associated with injury to humans are poison ivy (*Rhus toxicodendron* L.) and poison sumac (*Rhus vernix* L.) (Fig. 11), and all persons working with trees would do well to be able to recognize both of these plants in the field. Detailed descriptions and discussions of poisonous properties are available elsewhere for those interested; attention here is directed to the need for avoiding direct contact with roots, stems, leaves, flowers, or fruits — as well as the smoke arising from the burning of any of these plant parts. Injury to humans is an irritating dermatitis, the extent of which varies greatly according to the individual. Specific directions are required for any effective program dealing with ivy and sumac eradication.

Electric Current. For reasons of personal safety, as well as the protection of utility service, work on trees or parts of trees in close proximity to wires should be undertaken only by authorized persons, skilled in this particular practice. Individuals observing the need for tree work of this type should make prompt report to, or obtain information from, the tree warden or other duly designated municipal officer.



Figure 1. A fallen evergreen tree with decayed trunk. Failure in this tree blocked the highway and disrupted service by wire-using agencies. Inspection could probably have detected the trunk weakness in the decayed tree. Note undisturbed sound evergreen in foreground which was subjected to the same meteorological conditions. Photograph furnished by Boston Edison Co



Figure 2. Advanced decay in this elm and a sleet storm combined to interrupt wire service in this community. Damage by this fallen tree could have been even more serious; note proximity of dwelling house and police and fire equipment. Photograph furnished by Boston Edison Co.



Figure 3. The fungus, *Polyporus versicolor* Linnaeus ex Fries., fruiting on the trunk of a maple. Abundant fruiting of this fungus, which grows on dead sapwood, is an indication of extensive weakness in a tree.

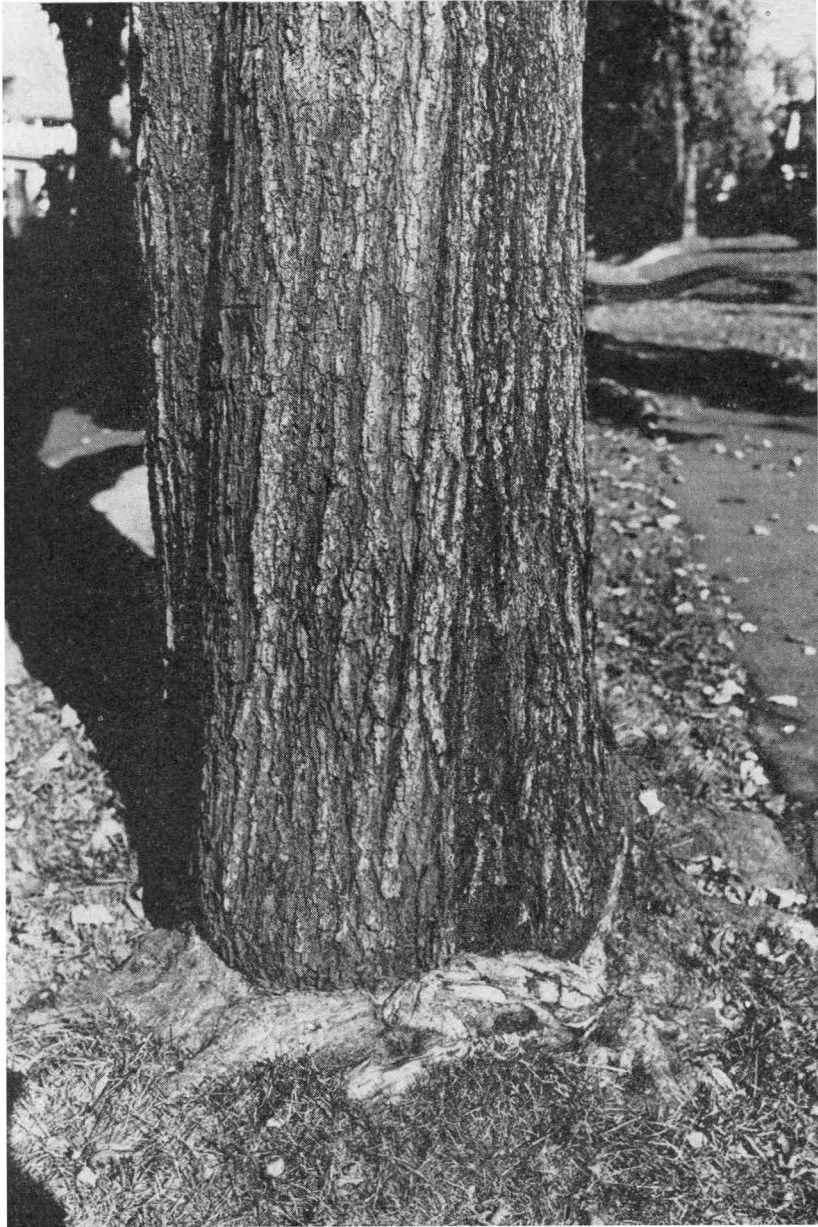


Figure 4. A red maple almost completely girdled at the base by a root. Note bulging of trunk slightly above ground line, which is characteristic of this trouble. Root causing the girdling is often slightly under the surface of the ground.

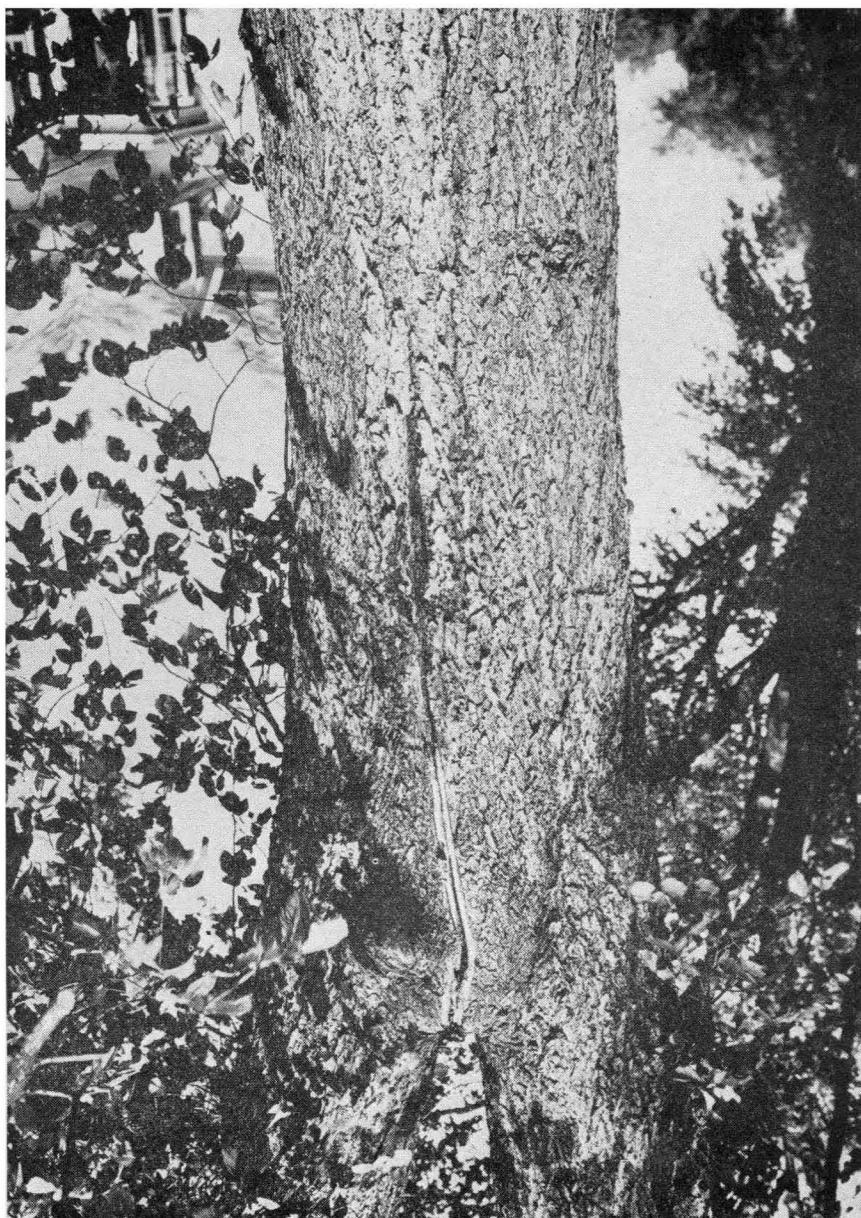


Figure 6. An elm in which a frost crack extended from a crotch down the trunk. Note repeated reopening and resultant slime-flux.

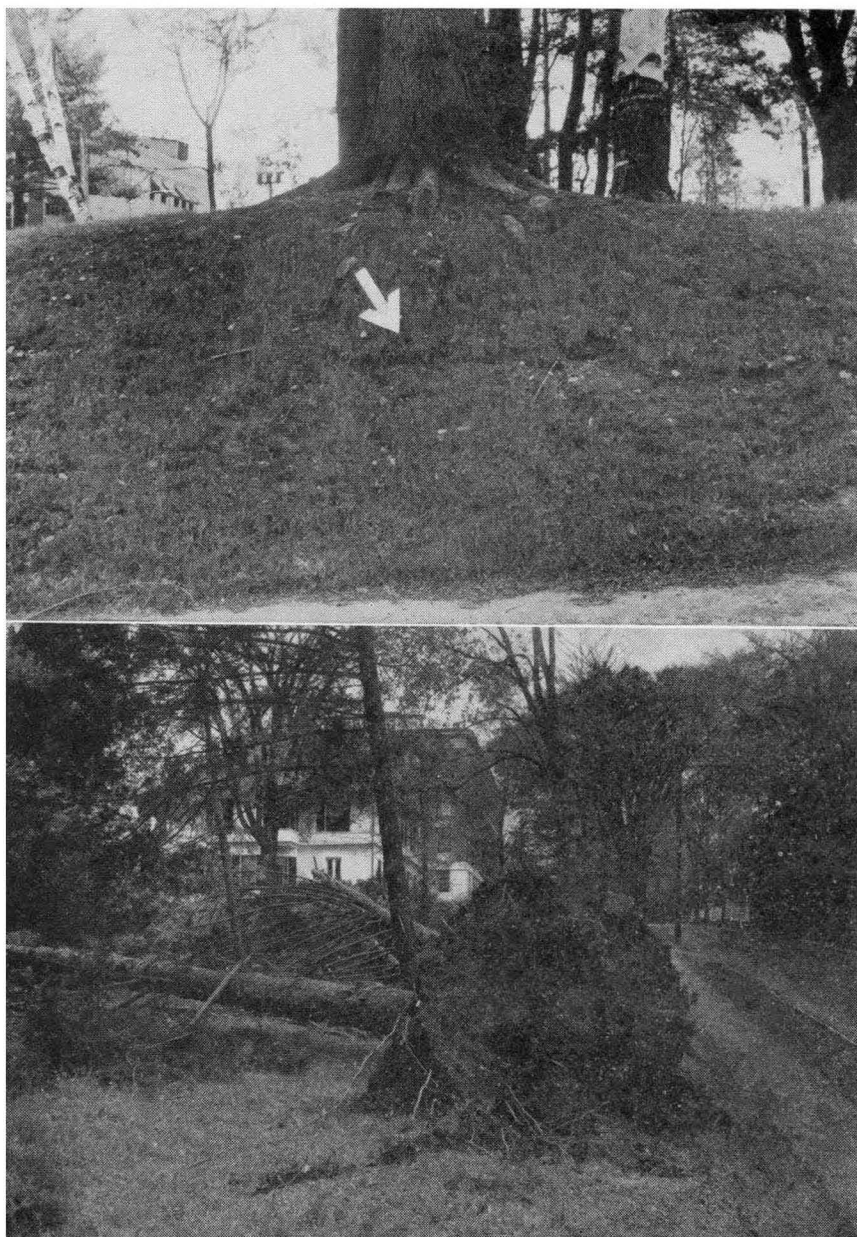


Figure 7. Tree anchorage weakened by excessive root pruning. Note cracking of soil shown in upper photograph taken well in advance of casualty shown in lower photograph.

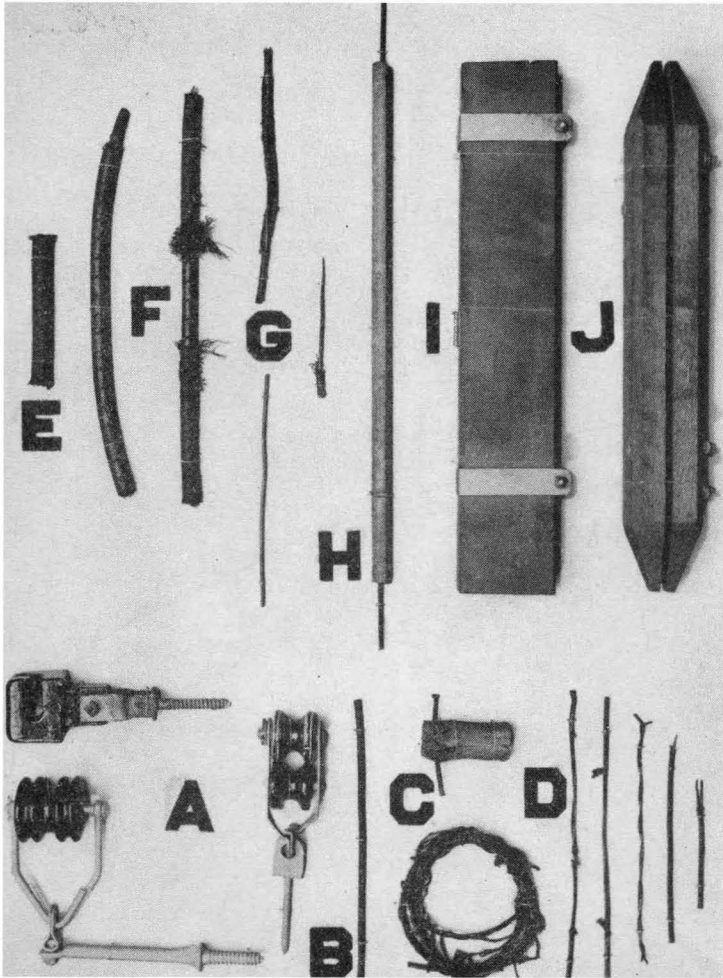


Figure 8. Tree trouble board prepared by wire-using agencies. Approximately x 1/9.

- A. Electric light insulators used by light companies to protect wire from trees.
- B. Telephone tree wire used for drop wire through trees.
- C. Telephone wires showing abrasion from trees.
- D. Effect of contact with light wire after insulation was worn off in tree.
- E. Electric light tree wire before use.
- F. Electric light tree wire showing abrasion from trees.
- G. Electric light wire showing wear from hanging in electric light insulators.
- H. Tree guard for telephone wire.
- I. Tree guard for telephone cable covering cable and strand.
- J. Tree guard for telephone cable covering strand only.

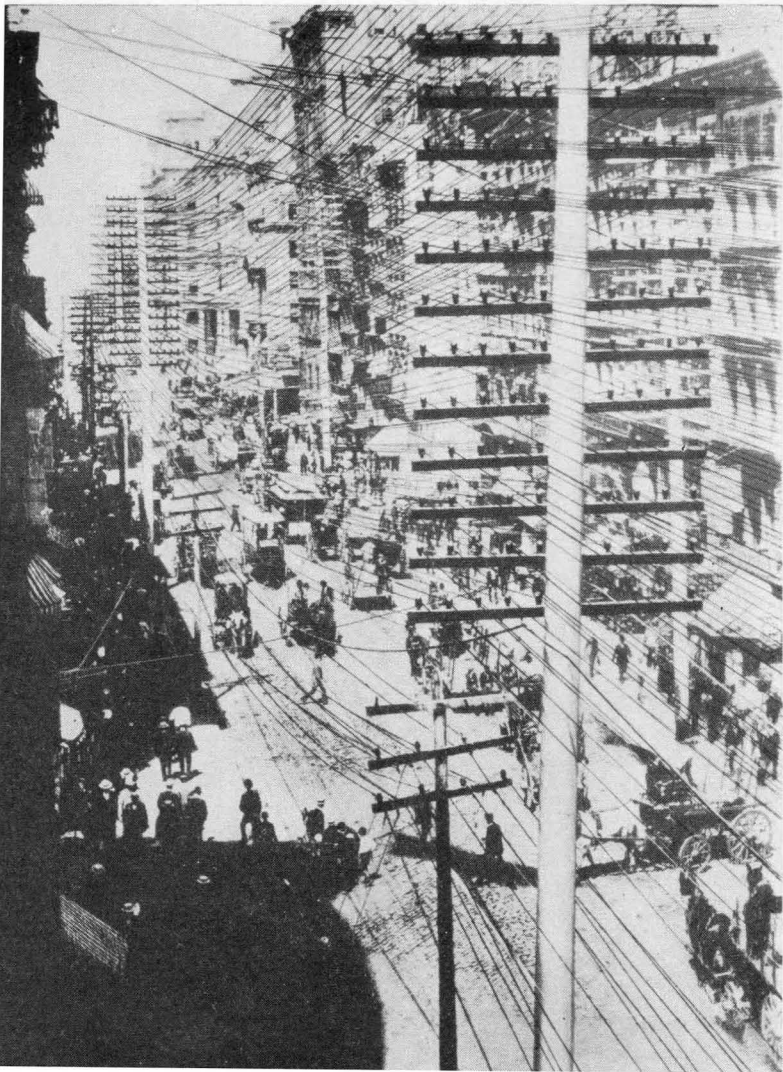


Figure 9. Add all the new telephone wires to this maze of 1887, then picture lower Broadway today! Some poles were 90 feet high, with 50 crossarms. This pole line near the corner of Broadway and Maiden Lane, New York, carried 150 wires. Today, under this same section of Broadway, there are about 30,000 telephone wires in 17 cables! Farther uptown, under the intersection of Seventh Avenue and West Thirty-sixth Street, 282 cables, containing about 560,000 wires, enter manholes from four directions. Pole lines today are fast disappearing in cities but still are used in rural districts. Reprinted from National Geographic Magazine Vol. LXXII, No. 4, October, 1937 p. 399. Photograph copyright American Telephone and Telegraph Co.



Figure 10. Today you talk over a wire; Tomorrow you'll see over one. On left is a section of cable, containing 600 wires, such as now is used for long-distance calls and network radio programs. At right is a section of the new "coaxial" cable, over which you can "see" by television as well as talk. It is only one-ninth as large as the other and contains two flexible copper tubes, with a thick wire inside of each. Waves like those of radio will carry 240 conversations at once through this cable, each at a different frequency. Other waves will carry television pictures over the same channel. Copyright National Geographic Society.



Figure 11. A. Poison ivy (*Rhus toxicodendron* L.), woody stem, flowers, fruit (berries), compound leaf, consisting of three leaflets.

B. Poison sumac (*R. vernix* L.), woody stem, flower and 9-leaflet leaf.

C. Poison sumac woody stem, fruit (berries), and 7-leaflet leaf.

Drawn by S. J. Ewer. Approximately $\times 1/3$.



Figure 11. D. Winter condition of poison sumac. Note fruits which may persist during the winter. Photograph courtesy of R. L. Coffin.

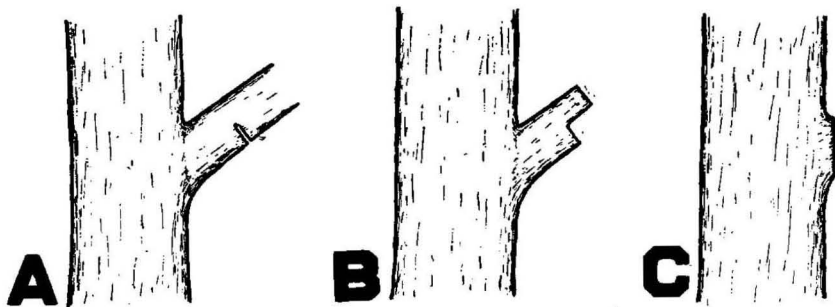


Figure 12. Safe procedure for removal of limb.
 A. First cut on lower side of limb.
 B. Second cut on upper side of limb.
 C. Removal of stub by final cut.
 Drawn by S. J. Ewer.

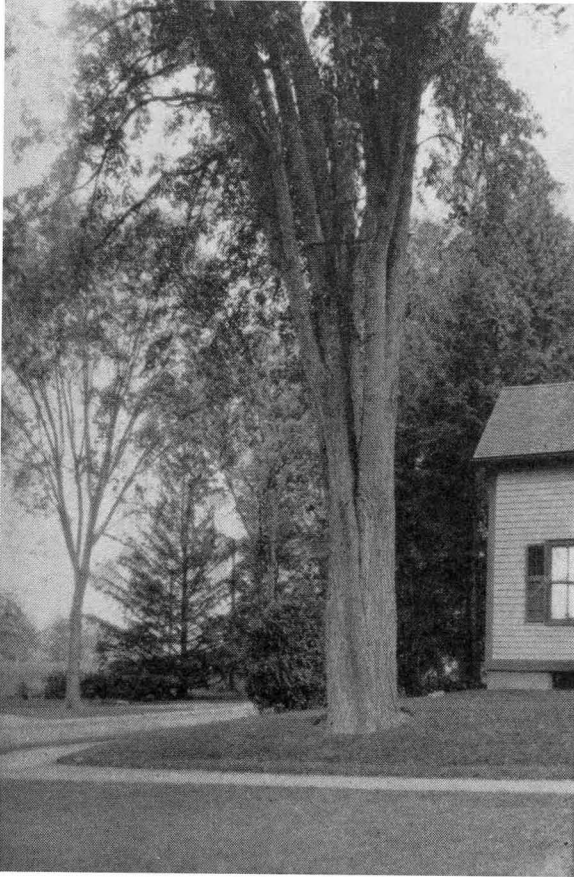


Figure 13. The earliest successful crotch bracing in the United States on the campus of Massachusetts State College, showing the now discarded practice of wrapping braced limbs with chains as well as the method of sinking end of brace in branch. In modern tree work the use of rigid bars in higher parts of the tree for direct strengthening of crotches is an improvement over the earlier method, but the principle of multiple bracing and the sinking of braces in the wood to avoid girdling are the same. The work in the tree pictured survived all tests perhaps too well, for the full crown of the tree remained intact permanently, but the tree was uprooted in the hurricane of 1938. Photograph furnished by the late Dr. George E. Stone, under whose direction the tree operations were completed

Methods, Equipment, and Materials. In pruning work, attention should be given not only to the details of removing a troublesome branch but also to the effect the necessary operations will have on the future vigor and development of the tree. Carelessly chopping a heavy branch may result in an ugly wound and permanent injury to a tree, whereas the desired removal of the branch could have been accomplished satisfactorily with a pruning saw. Special tools and supplies are sometimes necessary for operations on trees, and in recent years supply houses have listed considerable tree surgery equipment and material. However, during the war emergency, it is futile to indicate detailed operations for special tools, since in most cases individuals will have to rely on their ingenuity to make use of any tools and equipment at their immediate disposal. The sterilization of the implements used in tree operations with alcohol is an added precaution against spreading decay organisms and infectious disease fungi. Also, freshly made cuts in which fungi are present may be sterilized with a water or alcoholic solution of mercuric bichloride, especially if the wound dressing or paint to be applied later does not possess antiseptic properties. These operations may prevent primary wounds from developing into extensive injuries such as cavities which require special study before satisfactory treatment can be attempted.

For similar reasons, when bolts, braces, and guys are installed in trees as mechanical aids for support, the parts contacting the wood may be dipped in asphalt or some other suitable material to check the development of fungi. When a brace is to be installed in tree branches, a hole somewhat deeper and slightly under the size of the brace may be bored, to provide for the accumulation of sawdust and enable the brace to fit snugly within a decay-resistant groove. If the completed job is not waterproof, the operations may have done more harm than good. A leak which develops around a bolt may ultimately weaken the entire support.

Foresight vs. Hindsight in Tree Management. Practices and remedies based on rumors and legends should be avoided in favor of approved methods. Almost daily, correspondents belatedly seek advice on the repair of injurious cures they inflicted upon trees from intuition without preliminary consideration of the work they wished to undertake or the nature of the living trees at their mercy.

A record of completed and proposed tree work, including lessons learned by experience, will be a valuable aid in checking results and serve as a reminder of uncompleted jobs. The record will also call attention to the need for repainting certain wounds and giving other supplementary treatment from time to time. No list of suggestions could provide for all of the problems which will be encountered in individual tree operations, but by intelligent planning many costly disappointments may be avoided.

TREE PROTECTION AND IMPROVEMENT PRACTICES

Although the variety and sometimes the extent of defects found in trees during these studies might appear to be cause for alarm, any exaggerated fears of a treeless future should be allayed by the predominance of relatively sound and vigorous trees. Moreover, many of the defects can be treated with appropriate remedial measures.

Municipal Trees Planted on Private Property. In the General Laws of Massachusetts, provision is made for the use of public funds for planting trees on private property under prescribed conditions. Chapter 87, section 7 reads:

"Towns may appropriate money to be expended by the tree warden in planting shade trees in 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, that the written consent of the owner of such adjoining land shall first be obtained."

Some tree wardens who have availed themselves of this provision of the law report satisfactory results. No definite recommendations on the desirability of planting trees on private property can be furnished, however, since conditions vary widely in different communities. It sometimes happens that in areas where narrow tree belts obtain, dwelling houses have little, if any free space as frontage. Nevertheless, it would be well for tree wardens to explore all possibilities for planting on private property in order to improve local tree conditions as far as practicable.

Disease and Insect Control. It is not feasible to give control practices in detail for the individual fungus diseases and insect pests observed. Diagnoses made from specimens submitted to the Experiment Station will be reported whenever the cause for the trouble can be definitely ascertained from laboratory examination. Standard spray programs for the protection of foliage constitute the minimum pest control measures that should be accorded trees.

Physiological Troubles. Physiological troubles of trees may be revealed by the presence of small leaves or early yellowing and loss of foliage. Progressive weakening, following disease, repeated insect infestation, and faulty transplanting often result in certain physiological disorders. Inadequate food and water relations are also common sources of trouble.

Compensation for lack of water during extended periods of drought may be made by adequate watering of the soil about tree roots. If necessary, holes may be drilled as in the application of fertilizer discussed below. Plant foods may likewise be made available by addition of fertilizer to the soil about the feeding roots, the amount required being dependent upon individual cases.

A satisfactory technique for introducing fertilizer into the soil includes the drilling of holes about 18 inches deep and 2 feet apart, in the ground approximately under the limits of branch spread, or closer in the case of small, round-headed trees lacking extensive feeding roots. The fertilizer is then inserted in the holes, leaving the upper two inches for the replacement of soil. In determining the location of feeding roots of spiry trees, holes should be drilled beginning at a distance about half the height of the tree away from the trunk and extending in concentric circles to the limits of the roots.

The value of decaying organic matter, such as well-rotted manure worked into the soil at the rate of 15 to 20 cubic feet to 100 square feet of soil, should not be overlooked in choosing a satisfactory general utility fertilizer. Unfortunately local conditions may often make its use impracticable. However, when manure is used it should be mixed thoroughly with the soil or a manure and soil mixture should be introduced into holes in the same way as prepared fertilizers. At times, roots under turf or in hard-packed soil may not be satisfactorily reached by the soil in a cultivation program may be advisable. ordinary methods around about a tree permits many advantages when Plowing the surface fertilizers such as nitrate of soda, at the rate of 2 to 5 this practice is feasible, and sometimes small quantities of lime may be pounds for a medium-sized tree surface of plowed ground. Trees, such as oaks or applied in the spring on the soil require an acid soil, are to be excepted. black and red spruce, which re

Raw bone meal is a good fertilizer for most trees and may be applied either on a plowed surface or in drilled holes. It becomes available slowly and appears to do no injury even when used in large quantity. In applying all nutrients care should be exercised not to overfertilize trees, else root burning may result and more harm than good be accomplished. From the fertilizers applied to the soil, only those substances which are water soluble and can be absorbed by the root hairs will have direct nutritional value. Hence, the presence of water is always necessary in any successful fertilizing program. The retention of water and other substances in the soil may be facilitated by the application of mulches. Such practice is of particular importance in the case of evergreens.

Treatment of Wounds. Wounds on limbs and trunks of trees occur in a variety of shapes and sizes. Those which result from the fracturing of a branch usually have irregular and jagged margins. All wounds which can be shaped so that the longer axes are parallel to the grain of the wood and which may be brought to points at the extremities, are likely to heal more satisfactorily and to appear less ugly than wounds not so treated. Final cuts of the wound margin should be made so as to provide opportunity for callus growth (Fig. 5, B) and for drainage of water.

When the outline of the surface to be treated has been definitely determined, all rough and loose edges of bark should be removed with a sharp chisel, and shellac applied with a small brush. The shellac will prevent drying out of the narrow exposed moist layer of the inner bark. When this step has been carefully completed, the wood surface of the wound should be made smooth and treated with creosote, creosote oil, or other sterilizing agent; and with coal tar, asphalt or other materials for protection. Creosote is inflammable and should not be permitted to come into contact with an open flame. The creosote should be applied only to the cut wood surface, with particular care to avoid the living inner bark previously covered with shellac.

Good wound dressings or paints are possible substitutes which may be used in a single application provided the precautions previously outlined are observed. Asphalt without creosote is an excellent protective covering for wounds. The necessity of applying it hot doubtless explains why it is not more widely used. An emulsion of asphalt and water is obtainable commercially and the use of this preparation eliminates the necessity for heating. This material may be applied in the same way as wound paint. The water soon dries, leaving an asphalt covering.

The application of tar mixtures and creosote may cause severe injury to certain trees including magnolias, tulip-trees, and ornamental *Prunus* species. For these, other treatment is advisable, even though less permanent in character, and the following sterilizing and protective materials are sometimes used: liquid wax, shellac, corrosive sublimate (bichloride of mercury), copper sulphate, spar varnish, grafting wax, good commercial Bordeaux paste, Bordeaux powder mixed with raw linseed oil, and water glass (sodium silicate).

In applying all protective coatings, care must be taken not to cover the uninjured bark about the wounds. Frequently, recoating of treated surfaces may be necessary after a year's time, and blistering, cracking, or checking should be corrected as soon as detected. Careful attention to these details may preclude additional serious injury. In all cases, individuals contemplating the use of materials on trees should inform themselves thoroughly concerning the nature of these materials and their proper handling, including the need for precautions against possible injury to persons and property.

Small wounds on slender branches do not ordinarily require protection, but may be treated on valuable trees as a precautionary measure. When pruning operations include so many small branches that treatment of all cut surfaces is impossible, a safeguard for prompt healing is the careful use of a sharp hand or pole pruner. In using an ordinary hand pruner with a curved blade, especially on surfaces which are not to be treated with a protective covering, care should be taken to hold the pruner so that the supporting base may bruise only the discarded twig. Pruning hooks should be used only with considerable caution.

In making secure one's position while treating wounds in remote parts of trees, it is often necessary to resort to the use of ropes. Experienced workers use ropes extensively both while pruning and while treating tree wounds. The amateur may frequently find that he is able to remove branches without the aid of ropes, but they may be necessary to establish a safe position before engaging in extensive wound treatment activities. The wearing of spurs, however, is never advisable in operations where the tree being treated is to be retained.

Pruning. Pruning is an important part of any tree improvement program and may be accomplished at almost any season of the year when practicable. In spring, when tree growth is most active, wounds inflicted during pruning tend to heal more rapidly than at other seasons. However, bleeding is most copious at this time, and loss of sap may somewhat weaken the trees as well as prove a nuisance along streets and highways. For these reasons, excessive bleeders, such as birch and maple, should always be pruned later in the season. Pruning when the tree is in full leaf also has advantages in that dead and weakened parts are then more obvious; and street and park trees are often pruned in winter when spraying and other tree work programs are less pressing.

Whether the pruning work to be accomplished is simple thinning, extensive trimming, topping, or pollarding, the technique of removing branches should receive careful attention. On large limbs the first operation should be a cut made with a saw on the under side of and somewhat less than half way through the limb at approximately one foot from the ultimate pruning point (Fig. 12, A).

This should be followed by a cut on the upper side of the limb about two inches farther out than the lower cut. Cutting with the saw should be continued until the limb falls (Fig. 12, B).

A third cut made at the ultimate pruning point will remove the stub and leave a clean cut surface of minimum size for sterilizing treatment and at the same time promote a rapid callus growth (Fig. 12, C).

An attempt to complete the cutting in one operation on the upper side of the branch will most frequently terminate unhappily in an ugly enlarged wound surface which will not callus over but will encourage slime flux and defy satisfactory later treatment.

Following storms, the prompt pruning of broken branches is essential in treating damaged trees. A saw which makes a wide cut is the best implement to use in removing large branches. A strong sharp knife, a mallet, and a chisel will complete the necessary instruments for removing accessible limbs. Bark or wood which is splintered or loosened should also be removed with a sharp cutting implement and the same protection against infection should be employed as in the case of wounds.

Doubtless there will be instances in which all efforts to restore symmetry to a storm-injured tree by pruning will fail. In such cases, severe pruning of the entire top of the tree, or pollarding, may be the best solution to the problem. Most trees respond to pollarding in some degree, and certain trees, like willows,

respond readily. In the course of time a nearly normal tree symmetry may be developed by gradually reshaping the outline of profuse dense growth, and later the tree's symmetry may be further improved by grafting if this practice proves necessary. The result will commonly be the production of a dense head growth. To a limited extent, this growth is often an effective contribution to the landscape.

Cavities. Certain general suggestions for the repair of cavities have already been indicated. In special cases, complete treatment involving excavation, sterilization, bracing and filling may be desirable, but it is most doubtful whether an inexperienced worker is ever justified in undertaking to complete the entire series of operations independently. In many cases, cavity enlargement can be checked by removing the obviously diseased wood and sterilizing and protecting the exposed surfaces. It is almost impossible to eliminate all infected wood, but debris and decayed tissue should be removed so as to expose a reasonably sound and smooth wood surface which can be treated with antiseptics and protected with wound dressing as already indicated. Careful consideration should be given to the matter of the ultimate shaping of cavities in order to prevent the accumulation of small reservoirs of water.

Mechanical Support. Any one of a variety of factors may indicate the need for supplying additional mechanical support in trees. Specifically, attention has been directed toward the following conditions of a tree and the environment which make bracing advisable: decay, split crotches, weakened sharp-pointed crotches, borer infestation, injured or pruned roots, poor or limited shallow root systems, profuse top growth, proximity of damageable property, exposure to strong wind, or loss of sheltering structures.

Considerable progress has been made recently by professional tree workers and students of mechanics in the matter of bracing trees. Experimentation and experience have pointed out certain errors in early work (Fig. 13).

The use of steel rods as rigid braces with or without washers and nuts is commonly termed bolting of trees. In cases where parts of a tree must be drawn together for bolting, the hole bored for a prescribed screw rod should be larger than the screw rod. Therefore, washers and nuts must be used on both ends of the rod. For other purposes it is evident that holes drilled for screw rods should be rod size or smaller. Holes smaller than rod size should be drilled when washers and nuts are not used on ends of screw rods. In this case dependence is placed upon the grip of the screw rod in the self-threaded channel. When the size of the hole drilled to receive the screw rod is identical with the size of the rod, washers and nuts should be used on both ends of the rod. Screw rods serve in crotch bolting, holding limbs together or apart, and cavity bracing. Also, as "lip bolts", these rods draw together a long split or frost crack in trunk, branch or cavity. Specific conditions will determine the number and location of screw rods needed to insure the relative safeness of trees.

Steel cable instead of rigid rods is often used for bracing trees. A simple method of cabling employs the fastening of a lag hook or eyebolt into each of the two limbs forming a crotch so that the hooks or eyes face each other. The hooks or eyebolts are then tied with steel cable. Where lag hooks are used, provision should be made so that a final quarter turn will make the cable secure.

When trees require additional structural support, guying may solve the problem. In such cases wires are appropriately affixed to the tree and connected with four strong posts set firmly in the ground on the north, east, south, and west sides. If the guying is temporary, broad bands of leather or other strong material are sometimes wrapped around the tree and supporting wires attached.

In the case of permanent guying, however, two eyebolts may be placed on opposite sides of the tree trunk, one about six inches above the other and two wires fastened to each.

Bridge Grafting. An injured part of a tree to be bridged by a graft should receive as preliminary treatment the same protection given any other wound. In the spring, at which time the grafting is to be performed, the wound should be inspected and the adjacent bark cut back evenly with a heavy pruning knife to provide the wound with edges of tightly fitting, healthy tissue.

The young shoots or scions to be used in bridging the wound should be in a healthy condition but completely dormant. To insure dormancy in scions, pruned from the tree being treated or a similar one, it is advisable to cut twigs about the diameter of a lead pencil to the desired length before the buds swell in the early spring and store them under conditions which will prevent drying out. A good method is to bury them on the north side of a building where warming of the soil in spring is delayed. A protective covering wrapped about them will prevent direct contact with the soil and a board over all will insure against water soaking of the scions in the event of seepage into the ground during heavy rains.

Immediately prior to their use, scions should be sharpened or beveled by long sloping cuts in order to form thin wedge-shaped ends which may be pushed well under the bark without noticeably separating it from the growing layer. The entrance points for scions are provided by extending cuts vertically for about two inches from the wound at each point where a scion is to be inserted. The cut bark at the upper end of the wound should then be raised slightly and one end of the prepared scion slipped into place. The other end of the scion is then inserted in similar fashion into the cut bark at the lower end of the wound. For most satisfactory results, the scions should be approximately in line with the grain of the wood and of sufficient length to arch somewhat over the bridged area. Small brads will hold the ends of scions in correct position, and liquid wax freely applied to the upper and lower wound edges and to the edges of the attached scions will prevent drying out. The number of scions required will depend upon the size of the area to be bridged.

Disposal of Stumps. Two general methods for the disposal of tree stumps may be employed. The stump may be removed entire from its site by aid of root pruning and the use of heavy apparatus, or the stump may be destroyed in place by burning or other means. If the former method is used, there may be certain advantages to retaining a portion of the butt for purposes of leverage. Details of this method are omitted here, however, since the use of heavy apparatus requires the services of experienced operators.

The destruction of a stump in its site, when it cannot be readily disposed of otherwise, may be accomplished in a reasonably simple manner after completing certain necessary preparations. The part of the stump above ground should be reduced as much as possible by cutting off the trunk as near to the ground line as convenient. Generally, in the case of a storm-uprooted tree, this operation will be most satisfactorily completed by working on the tree without attempting to free it from any position in which it may have become securely fixed. Upright stumps may present some difficulty, while in the case of uprooted trees the disposal is already partly accomplished. Having eliminated much of the stump above ground, the next step is to reduce the underground stump. Removal of the soil so as to form a circular trench, followed by progressive digging toward the ball of the root, may consume time, but careful attention to this detail is essential for later satisfactory progress.

Attention should next be given to the matter of severing any remaining roots holding the stump in place. At this point the stump without root attachments should be in such relationship with the ground that except for its weight it could be readily removed from the hole. The closely packed soil about the roots may be removed with a pickaxe or washed off with a strong stream of water when this facility is available. The use of water, even if dependence has to be placed upon a heavy rainstorm, has advantages, particularly if local conditions permit good drainage.

The root ball, free from soil, should then be allowed to dry thoroughly and any parts of it which can be chopped off should be eliminated. In this way the stump remaining for ultimate destruction can be still further reduced, and any axe blows which fail to sever parts of the root stump completely enough for removal will not be in vain since they will aid in the final destructive process.

The appearance and condition of the stump at this stage in the operations should determine whether additional openings in the form of holes bored with an auger are necessary before the application of kerosene. Intermittent applications of kerosene daily, allowing time for adequate penetration through entrances cut and bored near the top of and throughout the stump, should be as numerous as the varying conditions may require. When penetration with kerosene is reasonably complete, dry rubbish, placed over and about the stump, should be ignited. The stump will then be either partially or completely consumed, depending upon the thoroughness of preparation.

This method of destroying stumps may be curtailed or elaborated according to the results desired. Sometimes the only objective may be the reduction of size to permit burial of the stump in its original site. In other cases complete destruction or reduction of the stump to a size which will permit easy removal is necessary. It is obvious that this discussion is concerned principally with the destruction of individual stumps in small-scale operations by a reasonably safe method. Large-scale operations may employ temporary chimney construction, forced draft burners, or explosives. The method outlined is of use primarily to persons without expensive equipment or knowledge of machinery and construction. The chief penalties are the time consumed and the extra work necessary in preparation.

Detecting and Reporting Defects. During the summer season, dead, defoliated, and injured trees are often easily spotted by the absence, sparseness, or discoloration of leaves. At other seasons signs of injury are less conspicuous, but fractured limbs and some other injuries may be more clearly seen because of the absence of foliage. The weight of snow and ice on branches sometimes causes injury to trees, and prompt treatment or removal of injured parts should prevent tree injuries from becoming injuries to persons or property.

The extent of damage to utilities' wires and other property resulting from falling trees indicates the need for detecting badly weakened trees before they collapse. It may be pointed out that there is need for all utilities to keep their lines under inspection and arrange for the immediate removal of any hazards which threaten them. Intelligent cooperation by the public in reporting to their municipal tree departments all dangerous trees, will aid in preventing service failures and destruction of scarce materials.

CONCLUSION

Safe Trees the Minimum Requirement. In former years federal funds for public works supplemented local appropriations and permitted many communities to give needed care to municipally owned trees. More recently, war activities have absorbed the personnel previously employed in this work to such an extent that even when additional appropriations for tree work are available, it is not always possible to have the work completed. In spite of obstacles, however, safe trees must be the minimum requirement for municipal tree programs.

Responsibility and Organization. Unless some way can be found to distribute more adequately the responsibility for tree work, the number of trees neglected over one or two years may increase to a point where no amount of community organization can solve the problem. Already an increase in wire interference by trees has been reported by the public utilities. It is essential that civilian and military workers be protected while travelling in the public way; it is also essential that the communication and power lines be maintained with the least possible disruption. Public utilities are keenly aware of their responsibility in maintaining vital service lines and are prepared to do their part in eliminating tree hazards. Their supplies for replacements and new equipment are critically limited. Repairs are costly and preventable accidents are wasteful. Many tree injuries can be treated and many impending tree accidents can be prevented. Civilians have organized themselves into groups for protection against air raids and invasion and, in the light of mounting tree casualties and resultant property damage, it would be well to provide for tree protection as a supplement to the civilian defense program.

Know your Tree Warden. Massachusetts is especially fortunate in having a tree warden in every community as a key man about whom to rally in this important activity. Advance information concerning a weakened tree may save a life, a life line, and a tree. Tree wardens may further enhance their already distinguished service throughout Massachusetts by organizing corps of civilian inspectors, and supervising their activities. Such a corps might well consist of representatives from the following organizations: Massachusetts Horticultural Society, Garden Club, Women's Club, Rotary, Kiwanis, Massachusetts Forest and Park Association, Massachusetts Safety Council—in fact, all groups interested in civic affairs; in addition to representatives from the wire-using agencies, such as power, municipal light, telephone, police and fire alarm telegraph. Without doubt, these organizations will aid the tree warden by nominating or recommending qualified and interested civilians to serve with and assist the warden in processing such a protection program. The public can cooperate effectively by discovering and reporting defects in trees to the local tree department.

MY TREE WARDEN'S NAME

STREET ADDRESS

TELEPHONE NUMBER

THE DUTCH ELM DISEASE

Since 1930, when the Dutch elm disease caused by the fungus, *Ceratostomella ulmi* (Schwarz) Buisman, was first discovered in the United States, all persons interested in our shade trees have become increasingly alarmed as the number of elms known to be affected has steadily mounted. As the name implies, the Dutch elm disease was first observed in the Netherlands; and, since its discovery in 1919, thousands of elms in European countries have been killed. The disease exists throughout the extensive range of climatic and soil conditions included in the Netherlands, France, Italy, Austria, Belgium, Switzerland, Germany, Poland, Czechoslovakia, Balkan States, and Great Britain. The disease is widely distributed in England but has not as yet been found in Scotland.

In both Europe and North America, the only continents where the disease has been observed, elms and trees of the closely related genus *Zelkova* are apparently the only hosts upon which the disease occurs in nature. A few species of elms are reported to be resistant, but none is known to be immune; and the American elm (*Ulmus americana* L.) is very susceptible.

From 1930 to 1932 the known cases of the disease in America were limited to less than a dozen trees in Ohio. Later the disease was found in the mid-Atlantic States and southern New England. Elms in Massachusetts were first known to be affected in 1941 when one diseased tree was found in the town of Alford, in Berkshire County. In 1942, six diseased trees were found in the State; three in Egremont, one in Great Barrington, one in Westfield, and one in Sheffield. These trees were destroyed immediately, and in order to further protect disease-free elms, concerted effort has been directed toward the prompt disposal of all freshly cut elm wood. This is the most practical control that can be employed effectively in checking the increase in population of bark beetles which spread the causal fungus. Since the fungus is virtually a prisoner within an affected tree, it cannot spread significantly except as it is carried from a diseased to an uninfected tree by a vector. The best evidence indicates that the smaller European elm bark beetle (*Scolytus multistriatus* Marsh.) is the principal carrier insect. This insect invades the bark of weakened trees or freshly cut elm wood, where eggs are laid in galleries engraved between the bark and the wood. Upon emergence, beetles feed for a short period of time on healthy elm twigs and in this manner may spread the disease to previously healthy trees if the feeding beetles come from galleries in which the fungus is present. At this writing (December 1942), the beetle is known to occur in Springfield, West Springfield, and Westfield in Hampden County, and widely in Berkshire County, in addition to the originally known eastern Massachusetts infestation which now includes most of the area east of Worcester County. Possibly the native elm bark beetle (*Hylurgopinus rufipes* Eich.), which is generally distributed in Massachusetts, may also spread the disease. If so, the prompt disposal of cut elm wood is doubly necessary.

Therefore, all agencies and individuals whose work brings them into contact with freshly cut or drying elm wood, which is highly attractive to bark beetles, are urged to dispose of this wood promptly by burning, unless there is complete assurance that the bark will be removed immediately after the wood is cut. Tree wardens, foresters, arborists, fire wardens, highway departments, state departments, and public utilities have cooperated generously in aiding in this practical method of protecting disease-free elms. As in the case of all fungus diseases and insect pests of plants, however, unbroken continuity of the program is most essential. Experience has shown the interruption of investigational and control programs to be a costly mistake. The elms of Massachusetts are a priceless possession of all the people of the Commonwealth.

THE DUTCH ELM DISEASE

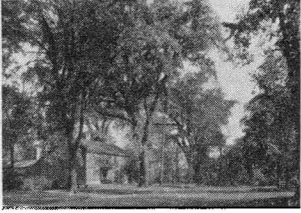


Fig. 1. Elms in a Massachusetts town.

The Dutch Elm Disease—caused by the fungus, *Ceratostomella ulmi*, and spread by bark beetles—menaces our Massachusetts elms.

Widespread in Europe since its discovery in 1919.

Known in the United States since 1930, following the importation of fungus and carrier-beetle infested elm logs from Europe—1929 to 1934.

Found in N. J., N. Y., Conn., Pa., Md., Va., W. Va., Ind., Ohio, MASSACHUSETTS — 1941.

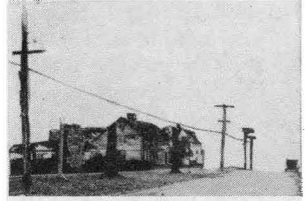


Fig. 2. The street in figure 1, as it would appear without elms.

64,468 known diseased elms have been destroyed in eradication programs to September 1942.



Fig. 3. Elm affected with the Dutch Elm Disease.

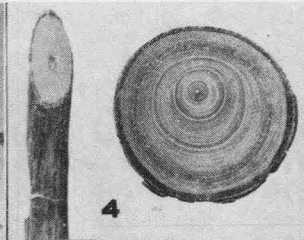


Fig. 4. Streaking of infected wood.

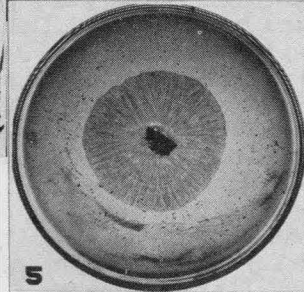


Fig. 5. The fungus in culture.

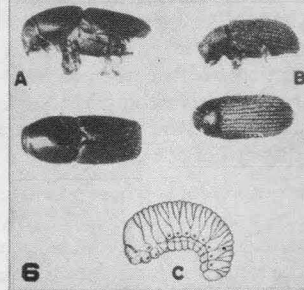


Fig. 6. A. Smaller European bark beetle.
B. Native bark beetle.
C. Larva or grub.
(All greatly enlarged.)

Fig. 7. Work of carrier beetles.
(Somewhat reduced.)

Fig. 8. Natural graft of elm roots.
(Photographs from Mass. Exp. Sta. Bul. 343. Figs. 3 and 8 furnished by Division of Forest Pathology, U.S.D.A. Fig. 6 from Cornell Ext. Bul. 290.)

Symptoms of the disease include: Wilting, curling, yellowing, and early falling of leaves; Brown streaking of infected wood.

Trees may die suddenly or gradually.

A wood-staining fungus living in the water-conducting channels causes the disease.

Death of trees results from a toxin produced by the fungus.

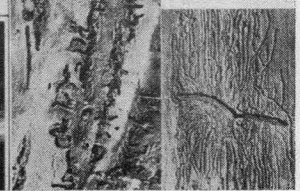
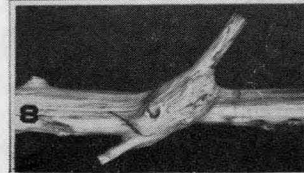
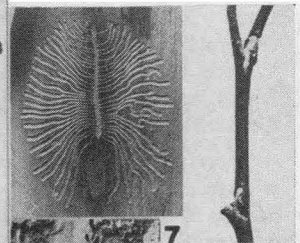
Trees affected with Dutch Elm Disease may appear similar to elms affected with other wilt diseases—

Therefore, laboratory study of wood showing streaking is necessary to prove which disease fungus is present.

The smaller European and native elm bark beetles serve as carriers of the fungus.

The beetles engrave breeding galleries in weakened trees and later the young emerge to feed on tender green twigs.

Other means of spread include direct contact between diseased and healthy trees — natural grafts of roots and branches.



All known diseased elms are being destroyed.

The final goal of the eradication program is the protection and preservation of disease-free elms.

The public is urged to cooperate by sending specimens from the wilted parts of trees to —

THE DUTCH ELM DISEASE LABORATORY
MASSACHUSETTS STATE COLLEGE, AMHERST, MASS.