A Program For Shade Trees In Oklahoma

A street planting of elms in Stillwater, Oklahoma. American elms are shown at the left, Dwarf Asiatic at the right.

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A PROGRAM FOR SHADE TREES IN OKLAHOMA

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THE PROBLEM

INTRODUCTION. Trees need no advocate in Oklahoma. Early plantings of elm and sycamore dating back to the first occupation of the state bear mute evidence that Oklahoma has always cherished her trees and considered them a valuable asset to her homes and communities.

Today this appreciation of trees is being felt more keenly than ever, partly because the growing prosperity of the state permits a greater attention to rural and municipal tree planning, and partly because the unfavorable weather conditions of the past few years have brought us face to face with the danger of losing some of our most valuable shade trees.

There is a good reason to believe that our trees will continue to be a growing asset and that shade tree conservation projects will be developed in many parts of the state within the next few years. Unless such projects are carefully and wisely planned and executed, they are bound to lead to haphazard and disappointing results.

This bulletin is an outgrowth of the awakened interest in tree conservation shown by the citizens of Oklahoma City, Guthrie, Woodward, and numerous other communities of the state. It is prepared to serve as a guide in preserving and caring for the present tree plantings and in planning shade tree programs for the future.

THE SHADE TREE STRUGGLES FOR ITS LIFE. A tree which is moved from its natural environment in field or forest and planted near a house or pavement or in a congested city district is faced with abnormal conditions for growth. Its very existence is often a severe struggle against these abnormal conditions. Such trees need much more care and attention than trees growing under a more favorable environment in the orchard or forest.

The artificial conditions of town and city planting are expressed in many ways. The most important of these is the struggle for water. Trees which are already operating on a minimum of water, due to the low annual rainfall in many parts of the state, are further handicapped by the presence of nearby pavements, sidewalks, and buildings which may greatly reduce the soil area exposed to rainfall. Unless some

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means are provided to furnish an artificial supply of water or to conserve the limited amount which is available, such trees will show signs of distress and may ultimately die.

Many other unfavorable factors also conspire to injure and weaken town and city trees. The smoke from factories and houses usually contains gases which are poisonous to trees. Chief of these poisonous gases in smoke is sulfurous acid, but chemical processes in factories may also release hydrofluoric acid, chlorine, hydrochloric acid, nitric acid, ammonia, bromine, and other gases in quantities deleterious or deadly to trees. The amount of poisonous gas in air may be very small and yet injurious. Of sulfurous acid, for example, any amount in the air greater than one part of gas in 200,000 parts air is injurious to vegetation. Some species of trees are much more resistant to poisonous gases than others. The evergreens and oaks, for example, have been considered much more tolerant of sulfurous acid than ash, maple, or beech.

An important feature of gas injury to trees is the fact that the owner of a factory which gives off such poisonous gases is financially responsible for damage to trees resulting from the gases. In a number of cases, damages have been awarded owners of trees which have been injured in this way. Diagnosis of poisonous gas injury is a phase of plant pathology which has been carefully worked out in recent years, and it is now possible, in many cases, to diagnose injuries of this sort with a high degree of certainty. Similarly, natural or artificial gas leaking from underground pipe lines or mains often injures or kills the roots of nearby trees. This type of injury is also readily identified.

Occasionally city trees may be injured by chemicals which are poured on the ground near the roots, such as oils, salt, chemicals used to lay dust, and waste water containing various injurious substances. Chemicals used in spraying trees if applied at the wrong season or in too great strength may cause serious spray injury or even complete defoliation or death of the sprayed trees. This is a frequent cause of tree trouble reported to the Experiment Station. Spraying, if not intelligently and carefully carried out, may cause much worse damage than the disease or pest for which the spray was applied.

Dust is often a limiting factor in tree development At times, the dust suffocates the trees by filling the tiny pores through which the leaves receive and discharge air; at other times, even more severe injury may result from dusts which contain poisonous chemicals, as, for example, the dust from recently oiled roads.

Mechanical injuries from various causes are much more frequent in trees in the city or near dwellings. Each abrasion of the bark and each branch which is cut off or torn off offers a route of entry to numerous disease-causing parasites and pests which would be unable to attack an uninjured tree.

Finally, the unfavorable conditions for shade tree growth include the limited space for development imposed by roadways, building construction, and other engineering operations. Sunlight which is an essential for the well-being of any plant, may be reduced sufficiently to cause injury when trees are planted among tall buildings, or trees may be injured by too much sunlight concentrated by reflection from nearby white walls so that trees are injured from excessive sunlight.

Any or all of these hindrances to the normal development of trees tend to make the shade trees' life a virtual struggle for existence. It is only a very resistant and thrifty tree or one which is given the best of care which can withstand these ill influences without showing obvious signs of suffering. If the species or variety which is selected for shade tree planting is not adapted to the local climate or is not relatively resistant to unfavorable environment, that tree will suffer still more from the handicaps which confront town trees. In all probability, it will languish and in the course of time it will die.

LOWERED VITALITY IS ACCOMPANIED BY INCREASED SUSCEPTIBILITY TO DISEASE AND INSECT ATTACKS. The unfavorable conditions facing street and shade trees have a double effect in threatening the tree. They injure the tree directly, and as a consequence the tree becomes much more subject to attacks of pests and diseases. A healthy, vigorously-growing tree is, in general, more resistant to insect pests and to leaf and wood diseases than a tree which has been weakened by drought, poisons, or other causes. This is true, for example, of the flatheaded apple tree borer, which will not attack a healthy tree, and the heart-rot and die-back diseases of trees, which can gain a foothold only when the tree has become weakened or injured. The wounds to which every tree is subjected from time to time, either through accident or through pruning, must rapidly heal over if the tree is to escape disease infection or infestation by insects. Such wounds heal very slowly in a weakened tree, and hence such a tree often becomes infected or infested before healing of the wounds is completed. The first line of attack in controlling tree pests and diseases is to build up and preserve the vigor and thriftiness of normal tree growth.

A THREE-POINT PLAN FOR IMPROVING SHADE TREES

I. SELECTION OF ADAPTED TREES

The question is often asked: "What is the best shade tree for Oklahoma conditions?" The best tree is one that will withstand drought conditions in summer, severe open winters, late spring freezes, insect invasions, and that will be resistant to disease. It must also satisfy personal opinions as to desirability. This is further complicated since different sections of Oklahoma have varying conditions of soil and climate.

The following lists (Tables I and II) represent those trees most likely to prove satisfactory when aided by proper planting and care. The trees are listed alphabetically and not with the intention of placing the "best" trees first.

TABLE I.—TREES FOR STREET TREE PLANTING.

Common Name	Botanical Name	Advantages	Disadvantages
Ash, Green	**Fraxinus pennsylvanica lanceolata**	Glossy, rich green foliage; desirable round-headed form; resistant to drought; leaves practically free from insect troubles; responds readily to proper conditions.	Slow growing (might be considered an advantage); wood somewhat brittle, borers are a menace.
Cottonwood	**Populus deltoides virginiana**	Rapid growing, large tree, furnishing mass and shade quickly; attractive fall color; drought resistant when established. Useful for temporary planting between slowly-growing types.	Coarse, irregular features; cotton-bearing qualities are objectionable, but trees that do not bear cotton can be secured; needs moisture when young; leaves drop during dry weather.
Elm, American **(Illustrated on the cover and in Figure 1.)**	**Ulmus americana**	Desirable, sturdy tree of long life; large glossy leaves that form dense foliage; relatively large tree.	Needs much care when transplanted and during first few years; tips of branches die in drought; weakened trees susceptible to borers, scale, red spider, and leaf hoppers.
Elm, Dwarf Asiatic **(Commonly called Chinese elm.)**	**Ulmus pumila** (cover)	Easily transplanted, rapid growing tree; it will withstand severe droughts and much abuse.	Rather small for street planting; poor form of growth, i. e., narrow crotches which split easily; short-lived; early freezes frequently damage it due to early growth habit.
Elm, Chinese	**Ulmus parvifolia**	Graceful form; rich, lustrous appearance; drought resistant; quite free of insect and disease troubles; apparently a long-lived tree.	Slow growing first few years. It has been growing in this state too short a time to give complete assurance as to its durability.
Hackberry **(Illustrated in Figure 2.)**	**Celtis occidentalis and C. mississippiensis**	Fairly rapid grower, making an upright, dignified tree of dense foliage; sturdy tree well adapted to street planting, especially to black, waxy soils.	Leaves and branches susceptible to insect injury; borers are a menace to weakened trees.

TABLE I.—(Continued.)

Common Name	Botanical Name	Advantages	Disadvantages
Locust, Thornless Honey	**Gledisia triacanthos inermis**	Erect, graceful, finely-textured tree; moderately rapid grower, and yet quite sturdy; attractive flowers and fruits; comparatively free of insect and disease troubles; very drought resistant.	Mature tree somewhat small for street tree, although excellent for lawn tree.
Magnolia Southern	**Magnolia grandiflora**	Evergreen; attractive flowers; shapely; relatively resistant to insects and disease.	Susceptible to winter injury; adapted only to southeastern Oklahoma.
Oak, Red, Pin, and Water	**Quercus rubra, Q. palustris, and Q. nigra,** respectively.	Rich, lustrous foliage; beautiful tree forms; strong structural quality in their heavy hard wood.	Require deep rich soil, and moisture for successful growth; very slow growing; difficult to transplant.
Oak, Post	**Quercus stellata**	Very drought resistant; adapted to claypan soils; good form and very resistant to wind damage.	Slow growing; difficult to transplant.
Sycamore	**Platanus occidentalis**	Stately size, white bark, and interesting winter effect; adds dignity to a street or home.	Produces untidy lawn conditions and hay fever in some persons; wood rather brittle; subject to leaf-feeding insects and to drought damage.

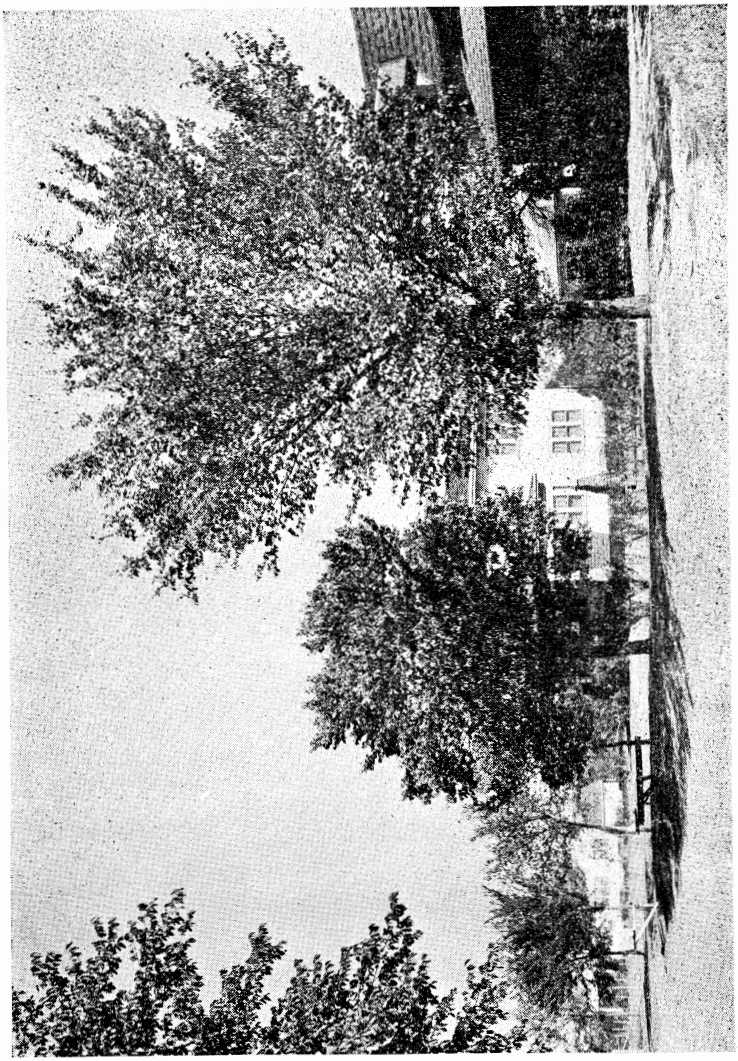

Figure 1. Two American elms showing the variation in habit of growth.

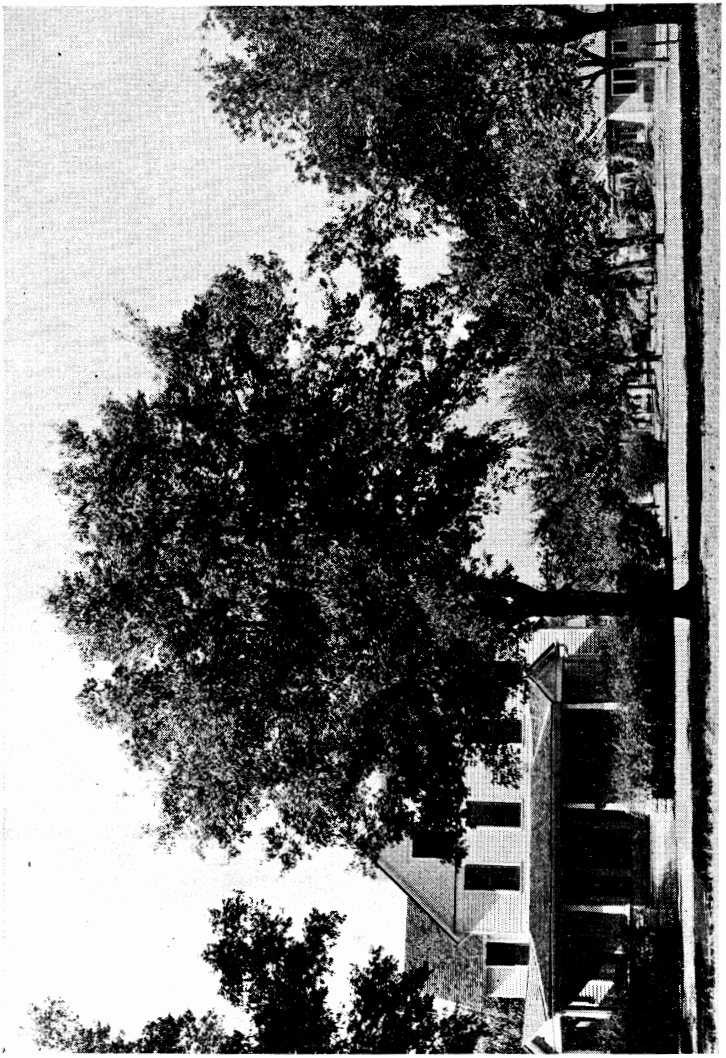

Figure 2. A well developed hackberry. American elms in the background.

TABLE II.—TREES FOR SPECIMEN AND GROUP PLANTING

Trees that are planted as specimens on the lawn assume individuality of form. All of the trees listed in the street tree list are adapted for specimen planting. Others that lend themselves to individual or group lawn planting are as follows:

Common Name	Botanical Name	Height	Advantages	Disadvantages
Apricot	**Prunus armeniaca**	20 feet	Grows rapidly; wide spreading top; very drought resistant; excellent windbreak.	As a fruit tree, its is unsuccessful because the early blossoms are so frequently killed by frost.
Chittam	**Bumelia lanuginosa**	30 feet	Heavy, dark, persistent, lustrous foliage; shining black fruit; drought resistant; adapted to sandy soil.	Thorny; difficult to transplant due to deep taproot.
Cypress	**Taxodium distichum**	100 feet	Feathery, attractive foliage; drought resistant; symmetrical form; largest tree in state.	Difficult to transplant.
Coffee tree	**Gymnocladus dioica**	30 feet	Supplies interesting contrast by its coarse texture; interesting seed pods; long lived.	Very slow growing; sparse foliage; coarse; needs water for good growth.
Hawthorn	**Crataegus** species	20 feet	Attractive blossoms and fruit.	Drought spoils summer appearance; thorny; not well adapted to western part of state.
Hickory	**Hicoria** species	50-70 ft.	Tall, strong tree; fine in groups and groves.	Needs deep, rich soil; adapted only to eastern Oklahoma; slow growing; difficult to transplant.

TABLE II.—(Continued.)

Common Name	Botanical Name	Height	Advantages	Disadvantages
Hop tree (Water Ash)	**Ptelea trifoliata**	10 feet	Small tree having many uses; interesting clover-like leaves; persistent disc-like seeds; excellent for shrub groups.	Watering or moist location needed for best growth.
Locust, Black	**Robinia pseudo-acacia**	40 feet	Very showy blossoms; rapid growing; easily transplanted; can manufacture own nitrogen.	Short-lived tree; borers a very serious menace; useless on uplands; thorny; wood brittle.
Mulberry, Paper	**Papyrius papyrifera**	30 feet	Well-shaped, round-headed tree; attractive gray-green leaves; rapid grower.	Subject to serious winter injury.
Pear, Keiffer	**Pyrus serotina X P. communis**	30 feet	One of our most drought resistant trees; dependable fruiting; attractive flowers; persistent leaves; adapted to claypan soils.	Somewhat coarse; subject to blight.
Pecan	**Carya pecan**	80 feet	Excellent tree for southern or eastern Oklahoma; beautiful form; valuable nuts.	Needs moisture and deep, friable soil; foliage insects and diseases serious; difficult to transplant.
Pine, Austrian **(Illustrated in Figure 3.)**	**Pinus nigra**	50 feet	Evergreen; beautiful form, sedate and dignified; long lived.	Must be transplanted with ball of earth on roots; rather slow growing.
Poplar, Lombardy	**Populus nigra italica**	60 feet	Gives quick landscaping effects; easily propagated and transplanted; its columnar form gives it value as accent plant.	Short-lived tree; subject to wind damage, borers, and diseases.

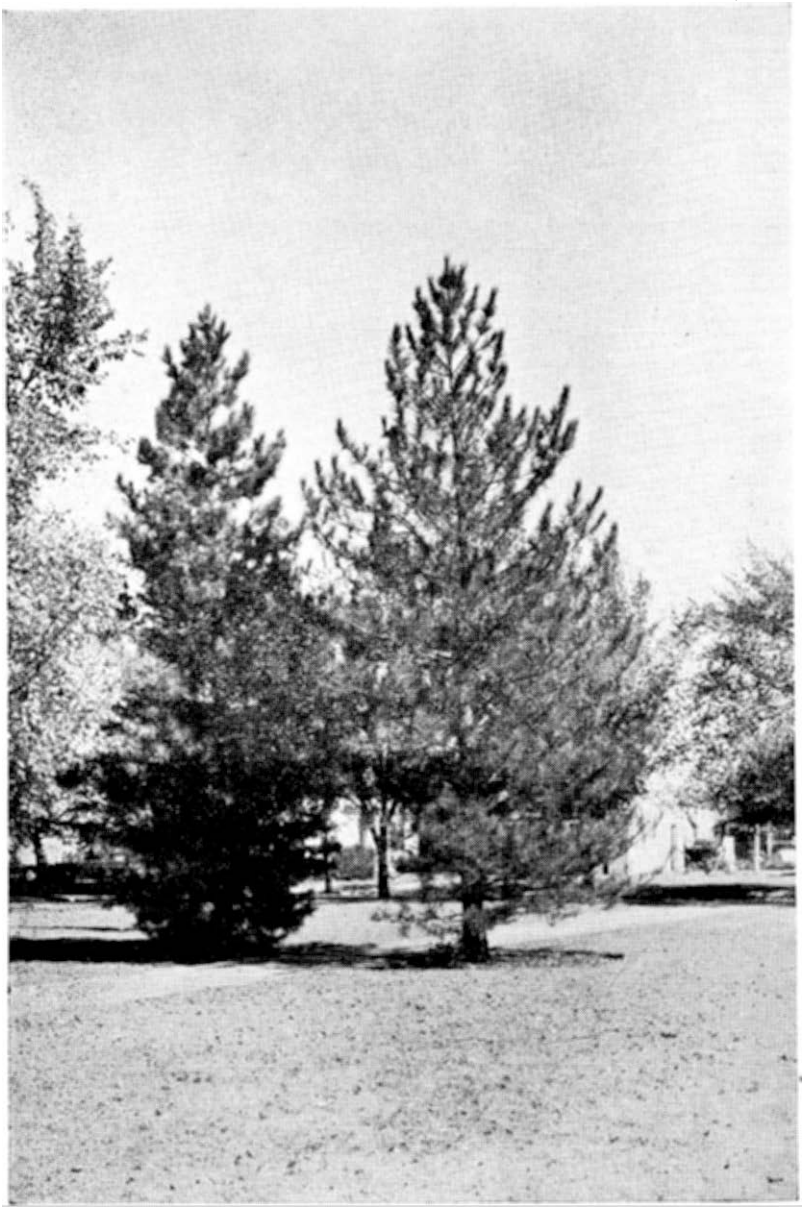

Figure 3. Austrian pines as lawn specimens.

TABLE II.—(Continued.)

Common Name	Botanical Name	Height	Advantages	Disadvantages
Poplar, White	**Populus alba**	40 feet	Interesting in contrast with other trees; useful for quick shade due to rapid growth and spreading irregular top.	Short-lived tree; borers and diseases a menace; branches easily broken; suckers freely.
Redbud*	**Cercis canadensis**	20 feet	A most attractive tree in flower; once well established it is very drought resistant.	Somewhat difficult to transplant; needs water when becoming established; subject to leaf injury by leaf-rollers and to the flat-headed apple tree borer.
Russian Olive	**Eleagnus angustifolia**	30 feet	Silvery foliage very attractive when contrasted with green; fruit valuable as bird food; relatively drought resistant.	Subject to bacterial disease when not irrigated.
Sassafras	**Sassafras officinalis**	30 feet	Beautiful fall color.	Suckers badly; adapted only to eastern Oklahoma; soft, weak, brittle wood.
Soapberry	**Sapindus drummondii**	30 feet	Adapted to dry limestone uplands; graceful growth; abundant flower and attractive fruit; drought resistant.	Adverse public opinion because it is found so abundantly in wild (although in cultivation it does not have the weedy character of the wild tree).
Sweet Gum	**Liquidambar stryaciflua**	70 feet	Appears to be adapted to both bottoms and upland; rugged, interesting tree in form and fruit; glossy attractive foliage; good fall color.	Slow growing when young.

*State flower of Oklahoma.

TABLE II.—(Continued.)

Common Name	Botanical Name	Height	Advantages	Disadvantages
Tree of Heaven	**Ailanthus altissima**	40 feet	One of our most drought resistant trees; rapid grower; attractive fruit on female tree.	Soft, weak wood; very coarse form; ill-scented flowers; suckers freely.
Walnut	**Juglans nigra**	50 feet	Attractive form and foliage; nuts valuable; resistant to wind damage.	Needs deep friable soil or water for continued growth; leaf-eating pests are serious, borers a menace; drought makes thin foliage.
Willow, Weeping	**Salix babylonica**	35 feet	Shapely form when protected from the wind; relatively resistant to insects.	Short lived; unshapely form when exposed to wind; high water requirement.

This completes the list of deciduous trees for street planting. Mention should be made, however, of some shrubs or small trees which are very well adapted to Oklahoma conditions and which could be planted on parkways, boulevards, or along highway entrances to our cities. These include the flowering willow (*Chilopsis linearis*), crape myrtle (*Lagerstroemia indica*), chaste tree or vitex (*Vitex agnus-castus*), the single-flowered shrub althaea (*Hibiscus syriacus*), mesquite (*Prosopis juliflora*), and juniper (species of *Juniperus*). The mesquite is particularly useful in southwestern Oklahoma, since it is adapted to calcareous clay soils, and a dry, hot climate. Crape myrtle, on the other hand, will succeed only in moist areas. In the northern part of the state it is subject to winter injury. In selecting junipers, it is well to remember that most junipers harbor the apple-rust parasite and hence may become a menace to nearby orchards. *Juniperus asheii,* a native Oklahoman, is said to be resistant to this disease.

Very few native trees occur west of the twenty-five inch rainfall belt in Oklahoma except along streams or on other areas where moisture is present in the soil as a result of seepage. Some of the old sandy land in western Oklahoma is covered with "shinoak," but the major portion of this area was covered with sagebrush under natural conditions. Soils in regions of limited rainfall frequently contain large quantities of lime. This condition may cause chlorosis of the leaves on shrubs and trees when the organic matter in the soil is low. Juniper, black locust, and mesquite are three trees which will grow on highly basic soils. The Chinese elms have also demonstrated their ability to withstand severe drought. Honey locust will make a rapid growth on the deep sandy land in western Oklahoma if sufficient quantities of organic matter are present in the soil, or if the young trees are fertilized with ammonium sulfate or other nitrogenous fertilizer.

II. CULTURE OF SHADE TREES

SELECTING THE SITE. The amount of ground space available for street tree planting is often limited in two directions by street and sidewalk. Ten feet of width in the parking strip is most desirable, but six feet is often all that exists. This makes adequate spacing between trees absolutely essential for satisfactory development. Large trees such as American elm, ash, sycamore, and poplar should be planted forty to fifty feet apart. Medium-sized trees such as honey locust, hackberry, and Chinese elm should be planted thirty to forty feet apart. The wider spacing is recommended in regions of limited rainfall or where soil conditions are not favorable for a maximum absorption of water. For group plantings on lawns, small trees may be spaced twenty-five feet apart.

SOIL CONDITIONS WHICH AFFECT TREE DEVELOPMENT. Tree growth is quite variable under natural conditions in Oklahoma because of differences in soil and character of rainfall. Soils which absorb water readily and do not have compact subsoils will produce healthy trees when other factors are favorable for plant development. Impervious subsoils interfere with moisture penetration and root development; consequently tree growth will depend upon the depth of the surface soil and factors which affect the absorption and utilization of water. Trees are the dominant type of vegetation in humid regions, and different varieties are found on different soils as a result of natural selection. There is also a difference in the fertility requirements of different trees and their adaptation to acid or non-acid soils. In subhumid or semiarid regions, soil is an important factor in tree development because water must be absorbed during periods of abundant rainfall to be utilized during periods of drought. Grass is the dominant type of vegetation in semiarid climates, and trees occur only on the more porous soils where moisture conditions are favorable, or on areas of relatively low fertility where competition from grass is limited. The major portion of the root system of the average tree occurs in the surface three or four feet of soil. Some species develop a root system very near the surface of the ground and consequently make a better growth on shallow soils than other species which have a taproot. Trees growing in dry climates have a shallower root system than similar trees growing in regions of more abundant rainfall. Such trees as mesquite will grow very well in southwestern Oklahoma on dense clay soils where other trees cannot survive because of unfavorable soil and climatic conditions.

On the average, ten thousand gallons of water evaporate from the leaves of a mature tree in one season. This volume of water would fill a tank thirty feet square and approximately eighteen inches deep, and represents the quantity of water which must penetrate into the soil and be absorbed by roots in order that normal development can occur. During periods of drought, trees can obtain some moisture from the subsoil; however, under natural conditions on upland soil, subsoil moisture is not replenished rapidly in regions of limited rainfall or in soils containing a high percentage of clay; consequently trees are severely injured or killed during a series of drought years because of the direct effect of desiccation or the combined effect of limited moisture, insect damage, and tree diseases.

Trees which are planted on steep slopes or in parkings between a sidewalk and a paved street do not have a chance to develop normally because of limited opportunity for moisture replacement. Close spacing on relatively level areas of land will produce a similar effect. Studies which have been conducted on the relation between depth of surface soil and tree development indicate that eighteen inches of fine sandy loam soils in central Oklahoma will support a large tree under average conditions if soil conditions are favorable for the absorption of rain, even though the subsoil is a dense compact clay. Twelve inches of surface soil is sufficient to maintain a tree where competition from grass is eliminated and the surface of the ground is nearly level so that rainfall does not escape by runoff. Under natural conditions in Oklahoma, trees and grass do not occupy the same area. Here the ground beneath trees occurring in woods or along creek banks is either bare or supports a few shrubs which can survive in partial shade and can compete with tree roots for water and nutrients. When trees are planted in lawns, they are in direct competition with grass for moisture; consequently the first season is a critical period when a tree is transferred from nursery or forest to a new location. In order to eliminate the unfavorable effects of impervious or infertile subsoil on tree development, small pits three or four feet in diameter are frequently dug, and good soil placed in these excavations in order to provide more favorable conditions for root development during the early stages of growth. Recent investigations in regions of limited rainfall have shown that tree roots extend in all directions from the trunk a distance equal to one and one-half times the height of the tree. Where a small pit is dug to provide more favorable conditions for young trees, it is of little value as far as feeding roots are concerned after two or three years, al-

though a cultivated area may be maintained around the tree and small quantities of water can be conserved on this area. Beyond this zone, most of the tree roots are in direct competition with grass for moisture. If a tree survives until the canopy is large enough to reduce the quantity of sunlight which reaches the ground, the vigor of the grass soon declines. Unless the lower branches of the tree are removed, the grass will eventually die due to the unfavorable environment produced by partial shade and competition for moisture and nutrients. In order to protect the tree trunk from borers, the lower branches should be left on to provide shade, which prevents sunscald; consequently good trees and good grass on the same area cannot occur without considerable effort when the season is hot and dry.

The best method of increasing the moisture content of soil in order to aid tree development has not been determined for the Great Plains region. Experiments conducted at the Oklahoma Agricultural Experiment Station show that all of the rainfall can be absorbed on level areas of sandy soil, while less than twenty percent of the rainfall enters the subsurface layers of soil on sloping areas of undisturbed land. The capillary moisture capacity of a circular area of porous soil thirty feet in diameter and three feet deep is about 6,000 gallons. When a soil is relatively dry, one inch of rain will moisten a layer approvimately five inches deep; consequently it requires about seven inches of rainfall to wet a dry sandy loam soil to a depth of thirty-six inches. Under many conditions, water should be diverted if possible from adjacent land to the area where tree roots develop to increase the storage capacity in the soil, in order to protect trees during periods of prolonged drought. A soil which will permit water to move rapidly into the subsoil and is favorable for the penetration of tree roots is shown in Figure 4.

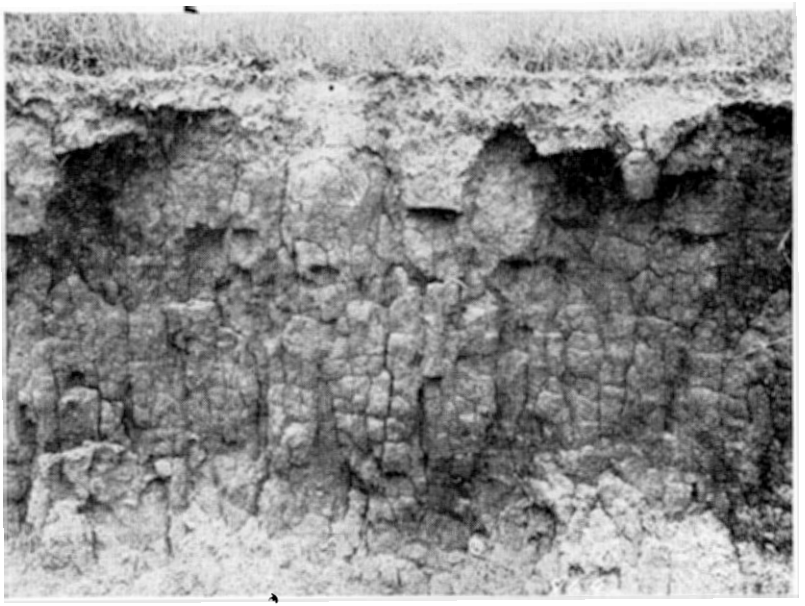

Figure 4. Soil profile showing a sandy clay subsoil which is favorable for moisture movement and root penetration.

Recent studies indicate that tree development on soils containing more than twenty-five percent of clay depends upon the structure and pore space of the soil. When soils have a high density and do not absorb water readily, the soil should be removed from a large pit where the tree will be planted, and sufficient quantities of very fine sand should be mixed with it to permit a more rapid absorption of water and provide conditions which are more favorable for root penetration. This is an expensive process but vigorous, healthy trees cannot be grown under such conditions without soil modification. The layer of clay which is found immediately below the surface of claypan soils is more impervious to water under normal conditions than any other portion of the soil profile. Fig. 5 illustrates a soil with a dense clay subsoil which restricts moisture movement and root development. In some instances it may be desirable to remove all of this plastic material; since a portion of the subsoil must be discarded, equivalent to the quantity of sand which is added. The portion to be discarded should come from the dark-colored clay layer immediately below the more friable surface horizon. The problem of drainage in these pits is not important if two or three inches of water placed in the bottom of the holes will penetrate into

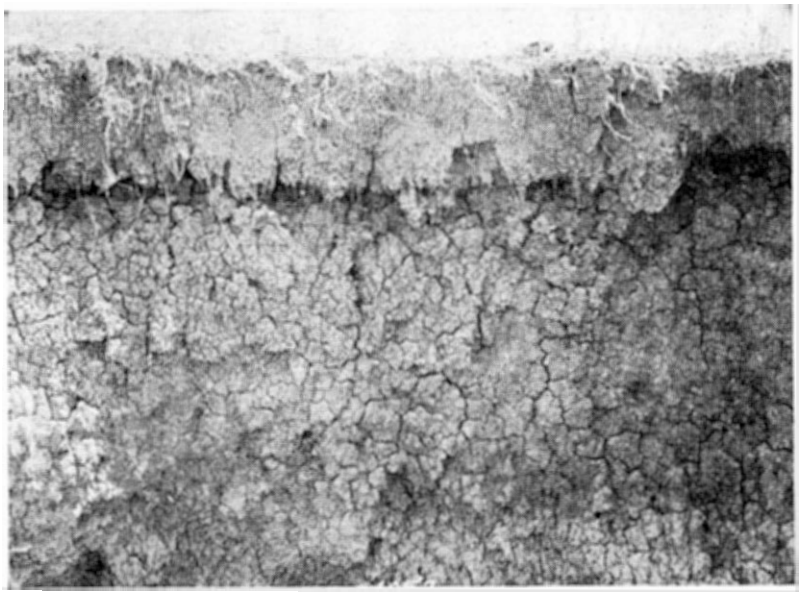

Figure 5. Soil profile with a dense compact clay occurring at a depth of nine inches below the surface of the ground. Water does not penetrate into this subsoil rapidly and root systems are damaged due to the shrinking of the clay during periods of drought.

the subsoil in eight or ten hours. If water will not penetrate into the subsoil, tile drainage may be required to remove excess water which may accumulate in the bottom of the pits during periods or seasons of excessive rainfall. Figure 6 shows sev-

Figure 6. Soil removed from pits thirty feet in diameter surrounding young trees in order to modify a dense clay subsoil by the addition of very fine sand. Thirty tons of very fine sand were mixed in each of these pits and an equivalent amount of dense clay was discarded.

eral pits which were dug around small trees in order to modify the subsoil by the addition of fine sand. Figure 7 illustrates a method of water conservation by constructing a ridge of earth on the lower side of a tree in order to prevent runoff when torrential rains occur. If a change in grade is needed to conserve rainfall it should occur if possible before the tree is planted.

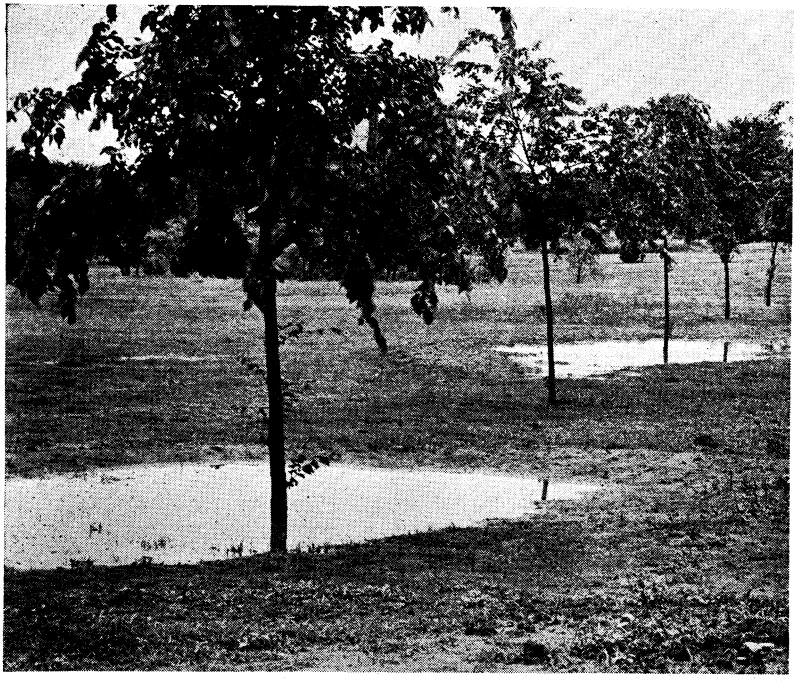

Figure 7. Rainwater collecting around trees on an area about thirty feet in diameter. Much of this moisture will penetrate into the subsoil. The soil around the second and fourth tree from the left has not been graded to prevent runoff and water which should penetrate into the soil is lost during periods of torriental rainfall.

Organic fertilizers are not so satisfactory as sand to improve the physical condition of clay soils. Coarse sand should not be used for this purpose because fine particles of clay will surround the coarse sand grains; consequently they have no appreciable effect on porosity. A very fine sand which is too fine for use in concrete or plaster should be used. Very fine sandy soil which does not show any plasticity when water is added is an excellent material to use in the modification of

subsoils. Occasionally soils are too sandy for the optimum growth of trees. This condition is not common in the average town or city, and it rarely occurs in rural communities where land is suitable for cultivation.

PLANTING. Nursery grown trees that are six to eight feet tall and one to two inches in diameter are most successfully transplanted. Larger trees are more difficult to handle, although by no means impossible to move. Nursery grown trees are recommended when the roots have been pruned several times, making the root system compact and easy to dig. Native trees, if used, should be selected from more exposed locations, as the edge of the woods, rather than in sheltered locations. These native trees should be root pruned in the spring and moved the following winter. This pruning is done by digging a trench around the tree two or three feet from the stem and a foot deep, thereby causing new roots to form.

The time for transplanting deciduous shade trees in Oklahoma is during their dormant season—late fall, winter, and early spring. In the sections of Oklahoma where the winters lack extreme severity, if the fall rains provide sufficient moisture, fall planting has its advantages. The trees should be planted two to three weeks after the leaves have fallen, as this gives the tree a chance to become rather firmly fixed in the soil before the colder weather arrives. In dry falls and winters, arrangements must be made for an artificial supply of water if the fall transplanting is to succeed. Spring planting should be accomplished before leaf growth has begun. This will be prior to the first of March in southern Oklahoma and before the first of April in the northern part of the state.

Small deciduous shade trees are moved with no soil on their roots, but this does not indicate that they should be handled carelessly. Care should be taken that as much of the root system as possible is left on the plant and uninjured. No attempt should be made to pull the plant from the ground by the stem before the ground is thoroughly loosened around the roots.

The treatment given the tree after digging and before replanting can spell success or failure of the transplanting operations. The sooner these plants can be replanted, the greater their chance of survival. During transit, the roots should be covered with wet moss, wet burlap, sawdust, or soft mud, never allowing them to become dry. If the trees cannot be planted as soon as they arrive, they should be "heeled in" by placing them upright close together in a trench dug in moist, loamy soil, and the dirt then packed around their roots.

The actual planting operation should be followed carefully step by step, and careful supervision is highly desirable. The holes should be made large enough so that the roots may be spread out naturally without cramping. If the holes are dug in heavy clay subsoil, be sure that the hole is dug deep enough to accommodate a six-inch layer of drainage material under the good top soil used in the lower portion of the hole. This permits surplus water to drain away from the roots, since excess water sometimes causes root injury. If the trees are to be planted in relatively poor soil, an effort should be made to secure good soil to place about the roots.

The tree should be planted at about the same depth it was growing in the nursery as determined by the earth ring on the trunk. This part of the operation is very important. The tips and bruised portions of the roots are carefully removed with pruning shears or knife, and the roots spread out in the hole so that they are evenly distributed. Well-rotted manure may be mixed with the soil, but no fresh manure should come in contact with the roots. The earth should be placed around the roots in layers, pressed firmly, and worked under the crown. With small trees, the plant should be moved gently up and down and the earth tamped down as the hole is filled. Care should be taken not to break the smaller roots. A tamping stick should be used with larger trees.

Water should be poured in the hole after it has been three-fourths filled with soil. When this water has soaked in, fill the hole with soil so that the surface is slightly lower than the surrounding area (Figure 7). If too much settling occurs this should be filled in with more soil later.

All broken branches or bruised branches should be trimmed and small branches should be cut back to the next larger branch that is to help form the scaffold or skeleton structure of the tree. Where narrow crotches are evident, one of the branches forming the crotch should be removed, as this will develop a weak spot in the structure of the tree later in life. Do not cut back the leader or main stem in most cases, as a forked tree may result.

Large trees should be staked or guyed. A stake is driven in the ground alongside the tree with a rubber covered wire attaching it to the tree. Until the tree becomes firmly established, keep the soil packed around the trunk.

A cultivated depressed area three or four feet in diameter should be maintained around the tree after planting. The competition of grass roots is thereby eliminated. This depressed area should be flooded with water during the summers of the first two or three years. The trunks of recently transplanted trees should be wrapped as specified for borer control on page 32. Figure 8 illustrates the various practices which are beneficial in transplanting and caring for young trees.

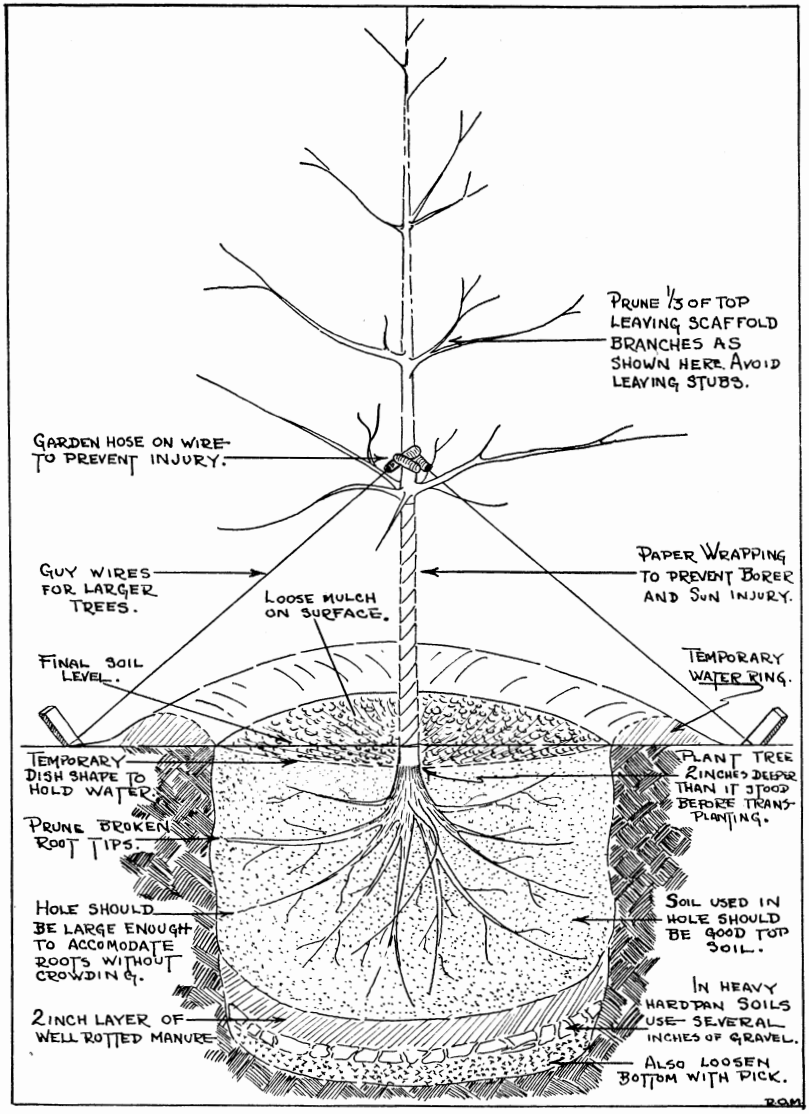

Figure 8.

ROUTINE CULTURE OF ESTABLISHED TREES. Since many of our streets have mature trees, the problem is not altogether one of establishing new plantings, but maintaining a healthy

growing condition in the older trees. This vigorous condition is our best insurance against insects and diseases.

Watering and Mulching. The drought has killed many of Oklahoma's trees and weakened others. Large trees are difficult and expensive to water. The most satisfactory method of watering is to build a six-inch levee of soil around the area under the tree and flood it frequently during the dry periods. It is also possible to conserve rainfall by this method. A very good practice is to grade the land around shade trees so that each tree stands in a slight depression which collects the water from a considerable radius during rains. This practice is illustrated in Figure 7.

Fertilization. Many trees have been faithfully watered during the dry season and still show yellow foliage. In some cases overwatering and drowning of the roots may be responsible for this condition, but there is no doubt that many of Oklahoma's trees need feeding. Tree feeding is a standard practice and a very beneficial practice when properly executed. If a healthy, vigorous growth can be secured by fertilization, the cost of the fertilizer is relatively insignificant.

Nitrogen is the most important limiting element in the growth of trees and shrubs, and ammonium sulfate is the best fertilizer to apply under average conditions to increase the quantity of available nitrogen in the soil. This fertilizer should be applied in late winter or early spring. It can be broadcast on the surface of the ground in a circle beneath the tips of the branches of a tree, or it can be placed in holes spaced about two feet apart in concentric circles beneath the tips of the branches. Holes approximately three-fourths of an inch in diameter and eighteen inches deep can be made with a soil auger or an iron pipe driven into the earth. Two ounces of ammonium sulfate should be placed in each hole. This will represent two to five pounds of fertilizer per average tree. The fertilizer is soluble in water and will slowly diffuse into the soil where it will be absorbed by the feeding roots. The average soil contains sufficient minerals such as potassium, calcium, magnesium, iron, phosphorus, and sulphur to support a good growth of vegetation if nitrogen is applied; consequently complete fertilizers are usually of little value except for the nitrogen which they contain.

Pruning. Moderate annual pruning to control the shape of the tree and remove dead wood is to be recommended. This may best be done at any convenient time during the dormant season. Shade trees at times tend to develop large, loose tops, which are especially subject to wind damage. It then be-

comes necessary to stimulate a denser growth by pruning. In such cases it is a common tendency to cut them back so severly as to allow only the bare trunk and a few feet of the main branches to remain. Despite the fact that some of our trees will survive such drastic "heading back," this should be regarded as "tree butchery" and not pruning. Furthermore, dehorning does not accomplish what is desired, but results only in making the head of the tree more dense. If such heavy pruning has to be done for the sake of controlling the size of the tree, it really implies that a wrong choice was made in the kind of tree at the start.

In pruning shade trees, begin at the top and finish at the bottom. No branch should be removed from a tree without there being a good reason for so doing. Interfering branches, or those which are dead and broken, should first be removed. If necessary to cut back the top, always attempt to prune back to a younger or smaller lateral branch. Heading back the branches in this manner rather than stubbing back to within a few feet of the crotch will give much more satisfaction and lasting results. It is desirable to prune so that the leader grows into the direction of the prevailing wind to avoid producing a tree which is overdeveloped on the leeward side.

The removal of larger limbs must be judiciously done, and severe pruning at one time is rarely necessary. Bringing old or neglected trees back into shape in one year should seldom be attempted. It is better to prune out some of the old branches one year and then to wait a season before completing the desired transformation.

Where large branches must be removed, splitting of the bark or trunk may be prevented by first making one cut beneath the branch a foot or two away from the trunk, and then a second cut on the upper side of the limb, two or three inches outside the first cut. The recommended methods for removing large branches and pruning V-shaped crotches are illustrated in Figures 9 and 10. Wherever a branch is removed entirely, the cut should be smooth and even with the trunk or main limb, for such wounds heal more quickly. If a long stub is left, there is no method of inducing the sap to flow toward the wound to heal it, and it eventually decays, which serves to carry disease and insects to the heart of the tree. It is advisable to treat all wounds over two inches in diameter to prevent decay, using an antiseptic and waterproof tree paint as suggested on page 41.

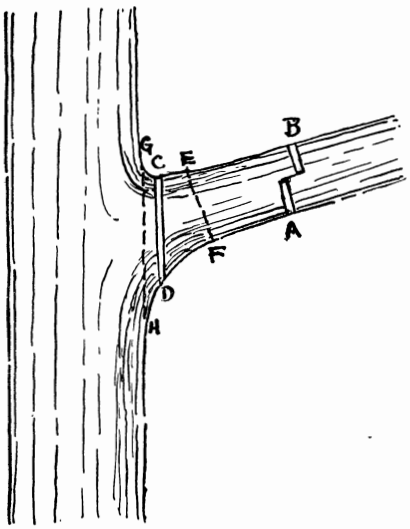

Figure 9.

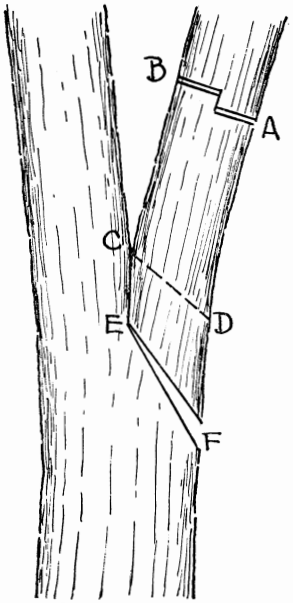

Figure 10

Figure 9. Recommended method for removing large branches. A medium sized or large limb should not be removed by a single saw cut, as this would probably strip the bark and wood below the cut. The removal of a large limb is best accomplished as indicated above.

A preliminary under cut (A) should be made about a foot from the final cut (C-D). Sawing at this point (A) should continue until the saw binds. Then a second cut (B) is made an inch or two beyond the undercut. The lines E-F and G-H indicate improper places to make the final cut. Cut C-D leaves a minimum sized wound with no stub to decay.

Figure 10. Pruning a V-crotch. Preliminary cuts are made at A first, then at B. A cut as CD is desirable as the weight of the falling branch is likely to tear a long strip of bark from the trunk. A final cut should be made from point F, sawing in the direction of E.

III. CONTROLLING TREE TROUBLES

TREE PESTS. There are a number of species of insect pests which at times may cause important injury to shade trees. Chief among these in Oklahoma, however, are the flat-headed apple tree borer and the brown elm scale.

The Flat-headed Apple Tree Borer[2] (Figures 11, 12, 13, and 14) is one of the most serious insect pests affecting shade trees in Oklahoma. It is especially injurious to recently transplanted trees and to older trees which have been devitalized because of unfavorable soil or moisture conditions or have been attacked by other insects and fungus diseases. It attacks many kinds of trees.

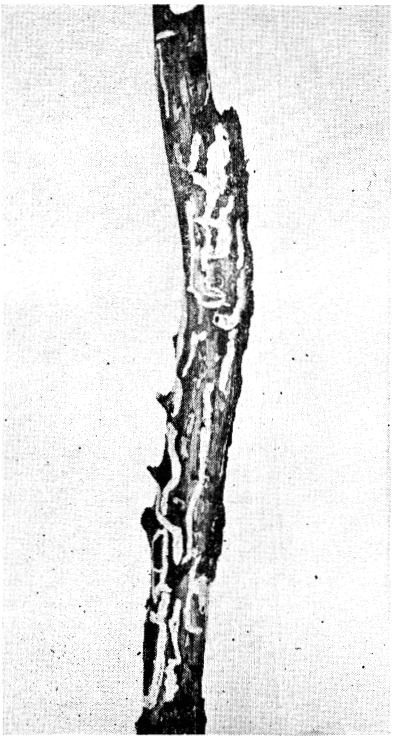

Figure 11. A young tree girdled by the flat-headed apple tree borer, showing the characteristic tunnels beneath the bark.

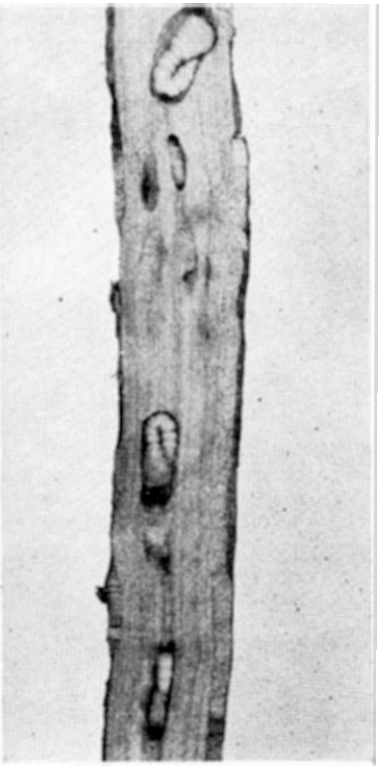

Figure 12. Flat-headed apple tree borers hibernating in the heartwood.

Symptoms of flat-head attack are dying limbs, sickly, yellowed foliage, and the presence of small clean-cut holes through the bark on the main trunk or larger branches. This borer does not force frass and sawdust from its galleries, but its work can be detected by dead areas in the bark. By pushing on suspected places with the hand, the bark will give way

[2] *Chrysobothris femorata.*

somewhat, as if there were a hollow space beneath. Its work is readily detected by cutting away the bark with a sharp knife and disclosing the shallow tortuous galleries just beneath, which are tightly packed with sawdust as illustrated in Figure 11. During the summer, the borers will be located in these tunnels.

Figure 13. Food for flat-heads. This recently transplanted tree is almost sure to be killed by borers. It is too large, the entire trunk is exposed to attack, and it has been cut back too severely.

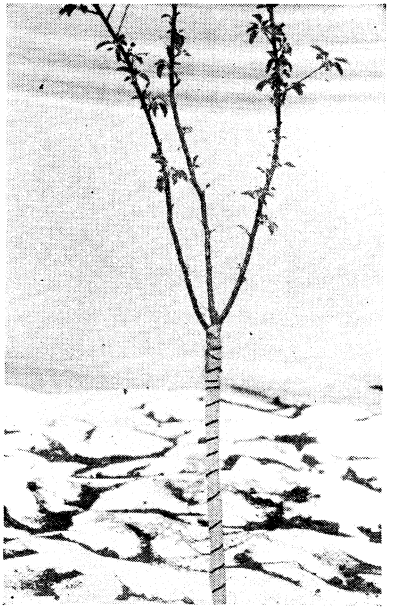

Figure 14. Illustrating the proper method of wrapping transplanted trees in order to minimize borer injury.

The borers are segmented, whitish or yellowish, more or less flattened worms, with a large swollen segment just in back of the head. They range from one-fourth to one inch in length. During the winter, they are found only by cutting into the heartwood into which they have penetrated (Figure 12).

Flat-head apple tree borer damage may be prevented by attention to the following measures:

1. Wrap recently transplanted trees with paper from a few inches below the soil surface to the lowest limb (Figures 8 and 14). Paper especially manufactured for this purpose may be used[3]; but a medium heavy grade wrapping paper will serve the purpose. In either case the paper should be four inches wide and wrapped tightly around the trunk in a spiral. This paper should be in place not later than April 30 and should be left on the tree until October 1. If not torn, it will prevent the beetles from laying eggs on the more vital parts of the tree. Care should be used to replace any paper rotted due to watering, especially around the base. If the young trees have recovered from transplanting and are growing vigorously, they need not be wrapped a second year.

2. Avoid pruning off the lower branches of shade trees unless it is absolutely necessary. The main trunk should be shaded as much as possible, as the beetles prefer to lay eggs in the bright sunlight.

3. If the tree has been injured in any way during the borer season, treat the injured surface with some good tree paint[4] to prevent bleeding, which attracts the beetles. Avoid cutting branches during the beetle season or from May to September, as the female beetles are attracted to all injured places.

4. Burn all dead trees and branches in the neighborhood before April 30 to destroy the borers before they have an opportunity to mature and infest other trees.

5. Keep the tree growing vigorously by watering during dry periods and by the use of nitrogenous fertilizers, because the borers seldom attack a living healthy tree.

6. Do not allow the tree to become defoliated by leaf-feeding caterpillars during the borer season since living trees with few or no leaves are attractive to the beetles for egg laying.

Whitewashing tree trunks or painting them with various washes will not prevent infestation by the flat-headed apple tree borer, and therefore these operations are not recommended for this purpose.

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[3] Weissinger Paper Company, Lansing, Michigan; Arkell Safety Bag Company, 10 East Tenth Street, New York, N. Y.

[4] See page 41.

The *brown elm scale* or *European fruit lecanium*[5] can be controlled by spraying elms during the dormant season with a four percent dormant oil spray. The tree may be sprayed at any time when not in leaf, during or shortly after blooming, but when the leaf buds are still dormant. The bloom may be killed, but this does not hurt the tree and will not prevent its leafing out at the normal time.

Use a spray machine capable of developing a fine spray or mist and of sufficient power and capacity to reach all the branches. The lower branches are usually the most heavily infested. It is not necessary to spray the trunk and larger limbs. Either miscible oil or oil emulsion may be used at four percent strength. In spraying to control the brown elm scale, the following precautions should be observed:

1. Don't spray when it is windy.
2. Don't spray when the temperature is below 40° F.
3. Don't spray when the temperature is likely to drop below 32° F. within twenty-four hours after spraying.
4. Don't use a spray machine that has been used for sulphur spraying unless it has been thoroughly cleaned out.
5. Don't get spray on automobiles which may be parked under trees, or on houses. (Small amount of spray will do no harm to the above.)

The successful use of oil sprays demands a thorough knowledge of dormant spraying, and only an expert should be employed.

Besides the elm scale and tree borers, there are many other insects that attack trees. The most conspicuous are those *leaf-feeding caterpillars,* beetles, or slugs that may strip the tree or make it unsightly. Most of these are easily controlled by spraying the tree with arsenate of lead. The amount to use depends upon the insect to be controlled and the susceptibility of the tree to spray injury.

Of a more insidious nature are spider mites and plant lice that suck the sap from the leaves and smaller branches. *Spider mites* or red spiders are quite often injurious in hot dry weather. They suck the leaves dry, causing them to turn brown and fall. They are easily controlled by dusting the tree with 200 to 325 mesh conditioned sulphur prepared especially for dusting purposes.

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[5] *Lecanium corni.*

Plant lice cause leaf malformations, yellowing, or leaf shedding. They are combatted by a contact poison spray in which nicotine sulphate is the killing agent. It is necessary to spray so as to hit the plant lice, usually found on the lower surfaces of the leaves. A good formula is nicotine sulphate one to two pints, water one hundred gallons, in which four or five pounds of soap have been dissolved as a wetting agent.

Some insects are general feeders, while others attack only trees of one species. Very often a serious pest will disappear at the end of a few weeks, not to reappear for several years, but at a different date the same year or next year there may be an entirely different species at work. It is impossible to predict where or when this or that pest will appear, but it is essential to protect the trees immediately when any insect is causing serious damage. A few days' delay may mean the stripping of the tree or a serious setback. This means that any city large enough should designate someone, the park superintendent or tree warden, to be solely responsible for the care of the city's shade trees. His expert services should be available at all times. He should have at his disposal a power spraying machine of sufficient power and capacity to reach the tallest tree in town with the spray. These machines are too expensive for the average citizen to own or even for a small group who wish to protect their trees. The following concerns manufacture spraying machinery and accessories:

1. John Bean Manufacturing Company. Lansing, Michigan.
2. Field Force Pump Company. Elmira, N. Y.
3. Fitzhenry-Guptill Company. 135 First Street, East Cambridge, Massachusetts.
4. "Friend" Manufacturing Company. Gasport, N. Y.
5. The Hardie Manufacturing Company. Hudson, Michigan.
6. F. E. Myers and Brothers Company. Ashland, Ohio.
7. Niagara Sprayer and Chemical Company. Middleport, N. Y.
8. Universal Power Sprayer Company. Plymouth, Michigan.

TREE DISEASES. The most destructive diseases of shade trees in Oklahoma are the heart rots, cankers, and dieback of twigs and branches. At times root rot, wilt, and leaf spot diseases may also be serious problems.

Heart rot is a progressive decaying of the wood inside tree trunks. It is due to any one of several different fungi, and the appearance of the affected wood ranges from simple discoloration to a soft powdery or stringy consistency, or complete destruction, depending on the type of fungus causing the decay and on the length of time the tree has been affected. Some heart rots are located only in the lowest three or four feet of the trunk; some involve the whole trunk or even extend out into the main branches.

The destructive effect of heart rot is twofold. The trees are weakened mechanically and may be broken down by high winds, and in addition the decay may interfere with the life activities of the tree, so that it suffers from lack of water or nutrition, with resulting dieback or even death.

In the course of time, in affected trees, the fungi which cause heart rot become evident by producing bracket-like mushroom or toadstool growths which break out especially on the stubs of cut limbs, or wherever dead wood is exposed. These fungus growths produce millions of microscopic spores which, blown by the wind or washed by the rain, can spread to other trees and there reproduce the disease. By the time the fungus fruiting bodies appear on a tree, decay has probably reached a very advanced stage, so advanced that it may be too late for any satisfactory control measures.

Control of heart rot is mainly a matter of prevention. Once a tree is badly affected, so that a large portion of the trunk is decayed, there is little which can be done, and unless such trees have a great aesthetic or historical value, it is better that they be removed. The life of such badly decayed trees may be prolonged by expert tree surgery and by such devices as bracing with guy wires and heavy fertilization, but as in the case of a badly decayed tooth, the results frequently do not warrant the expense involved.

Heart rot may be prevented by the following measures:

1. Heart rot rarely attacks vigorous trees. Attention to the water and nutritional requirements of trees as discussed on pages 17-27 will do much to postpone heart rot until the period of normal old age in the tree.

2. Heart rot fungi enter trees only through wounds which have failed to heal. Unnecessary wounds should be prevented, and all wounds should be promptly trimmed smooth and protected with a coat of tree paint (see page 41). Trees which are exposed to frequent bruis-

ing may be protected by a guard of heavy wire netting. Linemen should be instructed not to use spurs in climbing shade trees. When it is necessary to remove a limb of a tree, the final cut should be flush with the main trunk, as a projecting dead stub offers ready entrance to heart rot fungi.

3. Heart rot fungi spread from decayed, fallen or standing wood to healthy trees. Decayed wood, especially wood bearing fungus fruits, should be removed from the vi-

Figure 15. Dieback, resulting in a condition known as "stag-head" due to the combined effect of drought and wood disease.

cinity of trees and burned. Similarly diseases and dead branches of standing trees should be promptly cut out to prevent further spread of the trouble.

Cankers of shade trees are caused by numerous species of bacteria and fungi. The symptoms frequently observed consist of dead twigs scattered over the tree, large dead branches in an otherwise green tree (Figure 15), and open wounds which may be bleeding or leaking a gummy ooze which frequently has a strong alcoholic or sour odor. In addition there may be sunken, dead patches in living branches which gradually enlarge from year to year, and in the course of time may girdle the limbs and kill them by cutting off the water supply from the roots. Frequently these cankers are beset with small black or orange pimple-like fungus fruits, which in moist weather discharge an abundance of spores capable of reproducing the cankers in healthy trees. Dieback may be due to cankers of the branches, to a generally weakened condition of an undernourished tree, or to extremes of climate which exceed the limits of resistance of the tree. Cankers attack weakened, devitalized trees more readily than vigorous trees. They usually require wounds for getting their first foothold in a tree.

The measures for controlling them, accordingly, are similar to the measures for controlling heart rot, i. e.:

1. Regular inspection of trees and prompt removal of cankered and dead branches, with clean cutting and disinfection of the pruning wounds.

2. Prompt removal and burning of decayed woody trash from the vicinity of trees.

3. Attention to measures which build up the vigor of the trees and provide adequate moisture and nitrogenous fertilizer.

4. In special cases it may sometimes be desirable to spray the trees with a fungicide as an additional precaution. Spraying, however, is not recommended as a routine procedure. It should only be resorted to on the advice of a competent pathologist, and under his direction. This is because spraying, to be satisfactory, requires an exact knowledge of the habits of the parasite responsible for the trouble, and because spraying which is not intelligently carried out is costly and may be ineffective or even injurious to trees.

Leaf-Spot diseases of various types commonly cause varying degrees of injury to trees, but in many cases they are not severe enough to interfere with the life processes of shade trees or seriously to disfigure them. They may be recognized by more or less circular dead patches on the leaves which cut across the veins of the leaf and which often bear on their dead surface tiny dark granular or powdery fungous growths. Not all dead patches on leaves are due to contagious diseases. Spray injury, gas injury, the burning of hot sun on wet leaves, and other causes may produce dead spots on leaves. Often these injuries from unfavorable environment or chemicals can be distinguished from the leaf spot diseases by the fact that the dead areas are between the ribs of the leaves and do not cut across the veins. This is not invariably true, however, and since there are numerous kinds of parasites which cause leaf spots, it is best in the case of serious leaf spot trouble to consult a specialist before resorting to special control practices. Much of the trouble from leaf spot diseases may be prevented by raking up and burning the fallen leaves in the autumn, since the parasites pass the winter on these fallen leaves. In special cases, and on competent advice, serious leaf spot injury can usually be prevented by spraying with a fungicide such as Bordeaux mixture, ammonical copper carbonate, or lime sulphur. Such spraying is a preventative and not a cure. Once the spots have become abundant on a tree, it is too late in the current year to prevent injury. Spraying should anticipate the damage and not follow it.

Wilt of shade trees, caused by one or the other of two types of fungus parasites, known technically as Verticillium and Fusarium, has become a serious problem in some parts of the United States in recent years, particularly in the east. As yet it has aroused no serious concern in Oklahoma, but it is well to be on the guard against it. Trees affected with wilt are characterized by two readily recognizable symptoms: namely, a sudden drooping of the leaves of large parts of the tree shortly followed by death of the tree, and a pink, green, or dark discoloration of the wood under the bark. This discoloration extends throughout all parts of the tree and even into the small twigs. Trees may droop from other causes, such as drought or gas poisoning, but in these cases the wood under the bark is not discolored as in wilt disease. Once a tree is infected with a wilt disease, its death follows rapidly and inevitably. Since the disease is readily contagious to other trees, affected trees should be immediately removed and burned.

Root rot of one type or another frequently causes serious losses of shade trees as well as of orchard and forest trees. In Oklahoma the most dangerous form of root rot is Texas root rot, which also affects cotton, legumes, and many other plants. At present the disease is restricted to the southern counties, particularly the two southernmost tiers. The Chinese elm, which has been frequently used as a shade tree in the state, is rated as "extremely susceptible," and numerous other shade trees can be affected.

Trees affected by the Texas root rot fungus die suddenly. The disease is recognized with certainty by the presence of fine strands of yellow fungus threads on the roots and by an examination of these threads under the microscope.

Trees affected with Texas root rot should be removed as completely as possible and burned. The site of the tree may be grassed over, or if it is felt desirable to replant a tree, a variety of tree may be selected which is highly resistant to the disease. Among the trees which have been reported as resistant are live oak, sycamore, osage orange, hickory, pecan, and hackberry.

TREE SPECIALISTS AND TREE SURGERY. It has been pointed out that the tree owner is from time to time confronted with pest or disease problems which require immediate diagnosis and expert treatment. A few cities are provided with officers who are equipped to meet this need, but in most cases the tree owner is dependent upon private individuals or firms specializing in tree care. Some of these commercial tree specialists are well trained in entomology, pathology, tree nutrition, and tree surgery, and are responsible and dependable. At present, however, Oklahoma has no supervision of practicing tree consultants, and there has been no way of protecting tree owners from the costly and injurious malpractices of the few untrained or unscrupulous individuals who victimize tree owners under the guise of tree experts. Members of the staff of the Oklahama Experiment Station have from time to time been called upon for advice regarding dying trees, where the primary cause of the trouble was the ill-advised work of such charlatans. These cases not only represent injury to the tree owner, but they reflect upon the integrity and ability of the well-trained, dependable commercial tree specialist. Both the reputable tree experts and the tree owners of the state would be protected by the adoption of a measure which will make it possible for the tree owner to know the dependability of any given tree specialist. Such a measure does not need to take the form of a punitive license law. More satisfactory results would probably be secured by examination and certification of tree spe-

cialists, leaving the tree owner free to hire either a certified or an uncertified tree worker, just as a farmer is free to plant either certified or uncertified seed. As in the case of certified seed, the value of employing certified workers for tree care would soon become evident.

It is the essence of this bulletin that problems in tree welfare are largely preventable by cultural and sanitary measures. Cure in advanced cases of tree disorders is often impossible or too costly to warrant the expense. In some cases, however, the life of badly affected trees may be greatly prolonged by painstaking measures such as bracing and cavity work. These measures are particularly justified in cases where the trees are of unusual worth because they enhance the value of real estate for residential purposes or because of their rarity or historical associations. The "Washington Elm" in Cambridge, Massachusetts, which was already a massive tree in 1775, was kept alive until a few years ago, long beyond its normal period of life, by the most minute surgical and cultural attention.

The functions of the tree specialist include tree surgery, tree spraying, tree feeding, and all points concerned with tree care. Since, however, most of these topics have been discussed above, the present section is concerned only with tree surgery, the most obvious and in many respects the most controversial aspect of tree care.

Tree surgery includes pruning, which has been discussed, and cavity work. The purpose of cavity work is to remove the decayed wood from the heartwood and sapwood of trees and then to fill or dress the exposed cavity in such a way as to retard further decay. It will not prevent further decay entirely, because once heartwood shows obvious signs of decay, the delicate threads of the fungus causing it extend up and down the tree for many feet, far beyond the power of the tree surgeon to remove them or disinfect the wood. Decay, however, is greatly accelerated by moisture, and a principal function of cavity work is to remove the water-holding rotted wood and permit the exposed portion of the advancing rot to dry out.

Cavities are frequently filled with cement, asphalt, wood strips, or plastic chemical compounds which harden to form a solid filling. Contrary to general belief, such fillings do not strengthen the tree. Their chief value is to give a smooth outer surface over which the newly developed bark and callus wood may roll and eventually seal the opening with newly formed wood. In this sense alone they serve to strengthen the tree. Some tree surgeons prefer to leave cavities open

after cleaning them out and painting them with a disinfectant. This is done because filling will often allow water to accumulate behind the filling material and aggravate the decay.

In either case the discolored wood should be carefully removed with a chisel and the cavity scraped smooth and painted, first with shellac or commercial creosote to disinfect the wood and then with thick coal tar or asphalt to make it waterproof. The lowest point of the cavity should be drained to the outside to prevent water accumulation in the cavity. Bordeaux paint may be used for the first coat. This is prepared by mixing Bordeaux powder with linseed oil to the consistency of thick paint. For a waterproof paint, beside the tar or asphalt mentioned above, there are a number of commercial tree paints which are satisfactory. A list of tree paint manufacturers and dealers will be supplied by the Station on request. House paints or any lead paint should not be used on trees.

Bracing or guying weak limbs or trees is usually through the use of wires attached to the ground or to other limbs on trees. In bracing a whole tree, three or four guy wires are drawn back at an angle of forty-five degrees with the ground and securely attached. At the point where the wire is attached to the tree, it should be in a large loop to avoid strangling the branch or tree, and the wire should be prevented from chafing the tree by padding it with a piece of garden hose or with burlap. (Figure 8). Bolts are often used for strengthening weak crotches and cavities. Their use is indicated in Figure 16, which also illustrates the other surgical practices mentioned above.

Tree surgery in most cases is not as difficult and complicated a procedure as most people imagine. For ordinary cavities, all that is needed is the intelligent use of a gouge, a mallet, and a paintbrush. For those who are interested in obtaining further details on the methods of tree cavity and tree wound work, the U. S. Department of Agriculture Farmers' Bulletin 1726 ("Treatment and Care of Tree Wounds," 1934) provides adequate detailed information.

To those who prefer that the work be done by a commercial tree surgeon, the following recommendations are suggested (ref. cit.):

1. Don't hire a tree surgeon unless you are able to stay around and boss the job.

2. The methods of tree surgery are all well known. Avoid engaging persons with "secret methods" such as boring holes and inserting a "vaccine" or "secret cure-all." As yet there is no scientific basis for their use.

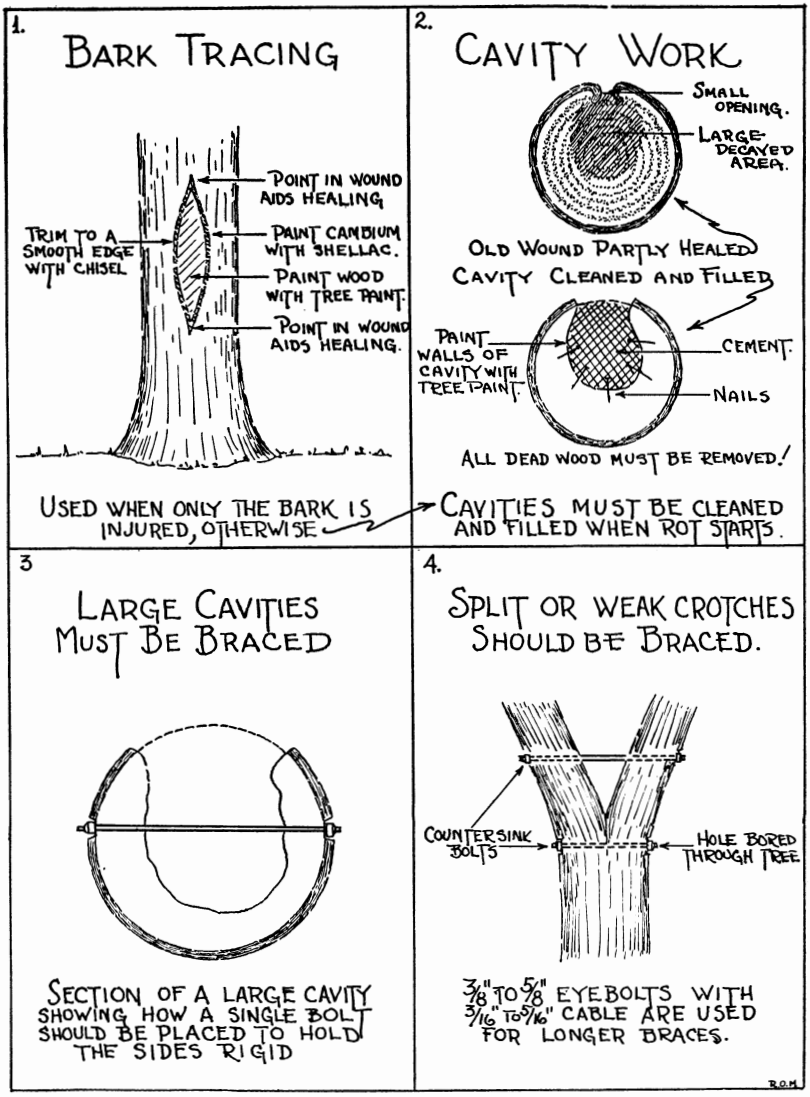

Figure 16.

3. Get a written contract covering the important parts of the work, including:
   a. Type of filling to be used if the caviety is to be filled.
   b. No climbing spurs to be allowed. Soft-soled shoes must be worn.
   c. All decayed, discolored, and wet wood to be removed.
   d. All cut surfaces to be properly disinfected and waterproofed according to specifications.
   e. Ordinary commercial shellac to be applied to all cut surfaces of living wood (cambium) within five minutes of the cutting.
   f. Free repairs of any defects which may appear in the work within one year.
   g. The estimated cost and method of payment.

Finally, remember that decay work today traces back to negligence of small wounds fifteen or twenty years ago and that a few cents' worth of attention now may save a costly and unhappy experience in years to come.

THE PLAN IN OPERATION

The high cost of tree spraying equipment and the necessity of having a tree expert readily available for work where promptness is a crucial factor, both point to the desirability of community action wherever possible in order to provide for tree care. Even small communities of interested citizens can support a well-trained tree expert. Such an expert might be either a private individual or a public officer. There are distinct advantages attached to the appointment of a public officer as a tree warden, for this purpose:

1. Many of the trees of a community are publicly owned. Prompt care of these trees may at times be hampered by delays necessary in the negotiations between the community authorities and a private tree concern. Unless a regular annual contract is provided for, the publicly owned trees are likely to be neglected at times, and this neglect will not only injure the public trees but these will in turn menace trees on private property.
2. A private tree concern is under no obligation to devote its exclusive attention to the problem of one community. It is available when and if it is not busy elsewhere with more profitable activities.
3. The work of a private tree concern is likely to be a heavier drain on the public budget than that of a public officer on a non-profit-making basis.

4. A public tree officer has authority to remove trees which are a menace to surrounding plantings without resorting to cumbrous and delaying public actions.
5. In selection of a public tree officer, the community has greater control over his training and ability than is the case in selecting a commercial concern from what the trade has to offer.

For these reasons, a community interested in the care of its trees can best meet its needs by the appointment of a public tree warden to assume the responsibility of shade tree management for a community. In order that he may best serve his purpose, the following suggestions are made:

1. He should be thoroughly trained in dendrology, pathology, entomology, and soils. The curricula offered at present at the Oklahoma A. and M. College provide such training, and the college would be constantly in a position to recommend well-trained men for this purpose. His appointment should be based on this training and not on political convenience. It would be well for the garden clubs and other horticultural groups to cooperate with the civic authorities and the appropriate departments of the state college in his selection.
2. He should be adequately provided with spray machines, trucks, ladders, chemicals, and other necessary equipment, housing for this equipment, and such regular or seasonal assistance as may be warranted by the size of community and the seriousness of local tree problems.
3. He should be authorized to order and supervise the treatment or removal of any trees found to be a menace to tree plantings of the community, at a nominal expense to the owner.
4. He should be assigned the following duties and responsibilities:
   a. Supervision and care of city owned trees, including their culture and treatments to protect them from diseases and pests.
   b. Similar care for privately owned trees of the community on a custom or other basis, provided the community so elects, and provided this does not interfere with his duties as concerns publicly owned trees.

c. Supervision or activity as consultant in connection with tree plantings projected for the future in order to avoid the unsatisfying results of planting non-adapted trees or trees which because of their location or high degree of susceptibility to pests or disease promise to develop unsatisfactorily or to become a menace to other trees.

The activity of the public tree warden may be financed in any of several ways, depending on the wishes of the community. Of these ways, one of the most feasible appears to be financing through municipal support plus service charges for treatment of privately owned trees, the private owner being free to choose between the public tree warden or any commercial tree expert, provided this does not in any way endanger the community tree program.