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FARM WIND-BREAKS AND SHELTER-BELTS

THEIR FORMATION AND CARE.

BY

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PREFACE.

This little book on "Farm Wind-breaks and Shelter-belts" is prepared in response to a call for a simple manual on this subject adapted to our western conditions. It is made up largely from matter that has appeared in articles that I have written at various times for my classes in the school and college of Agriculture.

SAMUEL B. GREEN,

College of Agriculture,

April 25, 1906.

University of Minnesota.

239 Aug 7 1900

FARM WIND-BREAKS AND SHELTER-BELTS.

CHAPTER I.

PRAIRIE PLANTING.

Whatever the ulterior object of prairie planting, the subject of protection to the buildings, their occupants and the cattle in the field should always be first considered. Our crops in this section are most liable to injury from the southwest wind of the summer, which dries them out, and the northwest wind of winter, which blows the snow from the land, causing it to lose the snow water. It also causes a loss of evaporation, which goes on even in winter from the bare ground, and from exposed crops, causing them to winter-kill. The same winds are also the most uncomfortable to the occupants of farm buildings, and are most likely to cause dust storms, which should be especially guarded against.

Windbreak is a general name given to anything that gives protection from the wind. On the prairies it is often applied to a single row of trees planted for protection.

Shelterbelt is a term often used to signify several or a large number of rows of trees, but the term is often used interchangeably with windbreak.

Grove is a term that refers to comparatively large bodies of trees which may be planted for shelter, fuel or other purposes.

Protection to Buildings may be furnished by a few rows or a grove of trees. It is generally best to locate the buildings in a grove, or grow one up around them, so that protection may be afforded from every quarter to the best advantage. The garden should also be included in the grove or shelterbelt about the buildings.

Distance of the Trees from the Buildings and Roadways. Of whatever the protection consists, it should not be close

to the buildings or to any paths which are used in winter, for the snow drifts which always form to the leeward of such protection may become a great nuisance under such circumstances during winters of great snowfall. The windbreak had better be placed about one hundred feet back from the buildings, and if shade is wanted it can be obtained from scattered trees near the buildings, which will not drift the snow. The same rule applies to the planting of trees on the north side of a roadway. The drifts of snow which would be formed to the leeward of a windbreak so planted would take longer to thaw in the spring, and would keep the road muddy and in poor condition after those that were not protected had become dry and firm. A row of trees is very appropriate by the side of a street or roadway and affords a pleasant shade, and if not planted too closely together will not drift the snow sufficiently to be an objection.

Protection to Crops by Windbreaks. The objection to windbreaks close to driveways may also be made against their use in fields, for they often keep the land for a short distance to leeward wet and in unfit condition to work after the rest of the field has become dry. This is an objection where spring grains are grown, but to winter grains it is an advantage. On the other hand, the protection of a windbreak may give a much needed or beneficial covering of snow to crops on the leeward side. The protection from dust storms and drying winds has already been mentioned. The important question is how to get the advantages without the disadvantages. In many sections the disadvantage of having snow linger on the field near the windbreak may be overcome by leaving a strip of land near it in permanent meadow, or use it for a rotation that does not take in crops that require very early planting. But even with spring-planted grains it is more than probable that windbreaks properly planted are an advantage when their benefits are considered for a series of years. It oftentimes happens that low windbreaks are more beneficial than high windbreaks in holding the snow on the land, for the high windbreaks often form a great drift that may remain late in the spring, while the low windbreak nowhere forms a large drift, but spreads the snow for long distances. Professor Budd says that in parts of the great continental plain of Russia, where the climatic changes are much the same as in this

section, the use of low windbreaks in wheat fields is very common.

Height of Windbreak. From the preceding paragraph it will be seen that low windbreaks may often serve a better purpose than high ones in protecting fields. Exactly what is meant by a low windbreak may be an open question, but for the purposes of this discussion a low windbreak may be considered one under twenty feet in height. In Russia and at the experiment station at Indian Head, Manitoba, windbreaks of *Artemisia tobolskiana*, which seldom grows more than eight feet high, are often used. About farm buildings windbreaks cannot be too high, and for this purpose the largest, longest-lived trees should be used.

Kinds of Trees for a Windbreak. In too many instances too many tree planters on the prairies have put out exclusively quick-growing, short-lived trees, such as the Cottonwood and Lombardy Poplar, and after fifteen or twenty years they have found their trees dying and nothing coming on to take their places. The quick-growing kinds are very desirable as a protection for the near future, but they are often short lived and should never be planted alone. Among them should be planted a sufficient number of long-lived and perhaps slower-growing kinds, to afford protection in later years, when the short-lived kinds have died out. The soil and location have much to do in determining the longevity of varieties; for instance, the Cottonwood and Lombardy Poplar are generally short-lived trees when planted in this section, but when planted in locations where their roots reach the permanent water level their period of life may be considerably lengthened, and they may then even be regarded as long-lived trees.

In starting a grove or windbreak on the prairie in this section, there is probably no better tree to begin with than the White Willow. It is quick-growing, rather long-lived in most situations, makes good summer fuel and renews itself very rapidly from the stump. The Green Ash would probably rank next as a pioneer tree. The White Elm is also very valuable for this purpose, but generally should follow the White Willow. The Cottonwood may sometimes, though very seldom, be the best to use, but on average prairie land it would be better if the White Willow or Green Ash were always planted instead.

After a good windbreak has been secured it is safe to plant out the hardy coniferous evergreens and such trees as the Mountain Ash, European White Birch and other similar ornamental trees. Wind protection is beneficial to all trees and necessary for many of our best ornamental kinds and often makes the difference between success and failure in growing them.

Distance Apart. In the planting of groves we should aim to get the land shaded by the trees as soon as practicable, and to keep it covered with a canopy of leaves. The United States government recommended the planting of trees four feet apart each way, with the idea that when so planted they would quickly shade the ground and consequently keep out grass and retard evaporation. Some successful plantings have been made on this plan, but when planted so closely together the branches grow into the rows after a few years and cultivation must be discontinued. In this section, where we have so much very bright, sunshiny weather that grass can grow under foliage that would kill it out in a more humid climate, we find that trees planted four feet apart each way seldom afford sufficient shade to kill the grass under them for many years. This is especially true of such trees as the Cottonwood, Lombardy Poplar and White Elm when planted alone, as they have open foliage that does not furnish a dense shade. Among tree planters who have had a large experience in prairie planting, there has been a tendency of late years to plant two feet apart in rows eight feet apart, and some of our most successful planters prefer even more room than this between the rows. When plantings are made 2x8 feet the same number of trees are required for an acre as when planted 4x4 feet, but the former distance has the advantage over the latter in that the space between the rows can be cultivated for perhaps ten years or more, by which time most trees will have formed a dense shade and be able to take care of themselves. Where a much greater distance than eight feet is allowed between the rows we generally fail to get forest conditions for many years, and to that extent fall short of an important requisite in prairie planting. The distances given here might need to be modified to suit different varieties and local climatic conditions.

Clear Plantings. Most of the plantings on our prairies

consist wholly of one kind. In some cases good results are thus obtained, but they are seldom as satisfactory as plantings made up of several different kinds. One of the greatest drawbacks to plantings made up entirely of one kind is the fact that drouth, insects or fungous disease may destroy the whole planting at one time, while in a judiciously mixed planting this could hardly occur.

Mixed Plantings, when properly made, have the following advantages: (1) They make possible the growing of species that form a protection in the least possible time, and still have coming on in the same grove longer-lived and better kinds to take their places. (2) Many kinds that are some-

Fig. 1. A good tree claim in Minnesota near the Dakota line. Located on high prairie. Soil very dry.

what tender are helped very much by being grown among the hardier kinds until well established. In this case the protecting trees are called nurse trees. The Scotch Pine is seldom a success when standing alone on our Western prairies, but when partially protected by some deciduous tree it stands very well. The same is generally true of Hard Maple in this section and of Catalpa and Black Walnut in Southern Minnesota. (3) In good mixed plantings the ground is more likely to be properly shaded and protected from winds than it would be in clear

plantings of such thinly-leaved species as the Cottonwood or White Elm, which do well and afford good shade when mixed with Green Ash or Boxelder. (4) Mixed plantings are most interesting and ornamental. (5) They attract more birds by their better protection and the greater variety of food offered. (6) While the chance of injury to some of the species by climatic changes, diseases and insects is increased, the possibility of total loss from any or all of these causes is reduced to the minimum.

The Most Important Constituent of a Prairie Grove of mixed trees in this section should be some well-known durable kind, as the Elm, Ash or Boxelder, of which there should be a sufficient number to completely shade the ground when the others are gone. On the outside, especially on the north and west, it is often a good plan to put at least a few rows of White Willow or possibly Cottonwood to furnish a quick protection. The rest of the grove should consist of hardy sorts, and may include some of the evergreens and such fruit-bearing trees or shrubs as the Wild Plum, Wild Black Cherry, Russian Mulberry and Juneberry. These latter furnish food for the birds and may often be a help in supplying the home table. The plan of planting with a view of providing some food for birds is not mere sentiment, for they protect our gardens from many insects, and if we furnish an abundance of Russian Mulberry they will not trespass much on our strawberries or raspberries. It is the author's opinion that in all our prairie planting we should pay more attention to using our native fruits and Russian Mulberry as plants of secondary importance.

List of Trees for Mixed Plantings. Some suggestions may be found in the following lists, but several other trees might often be used to give a variety or a tasteful display.

For Porous, Moist Soils in Southern Minnesota and Similar Situations Elsewhere. White Elm, Black Walnut, Green Ash and Hard Maple in equal quantities with a scattering of the fruit plants. The Hackberry may wholly or in part take the place of the White Elm, and the Boxelder the place of the Green Ash. The White Willow, Basswood and Soft Maple would also do well in such a location. One of the main kinds might be replaced by the White or Norway Spruce, Douglas Fir or White Pine. In fact such land as this will grow any of the trees adapted to this section.

For High Prairie Soils in Southern Minnesota and Similar Situations Elsewhere. Green Ash, Boxelder, White Elm and White Willow in equal quantities, with scattering of fruit plants. Basswood might be used to a limited extent, and White Spruce, Red Cedar, Norway Pine, White Pine or Scotch Pine might be used in the place of one of the main kinds.

For Moist, Porous Prairie Soils in Northern Minnesota and Similar Situations Elsewhere. White Willow, White Elm, Boxelder, Basswood and Green Ash in equal quantities, with a scattering of fruit plants. In some localities it might be best to use Cottonwood on the outside of the grove. Hackberry might take the place of part of the White Elm and White Spruce. Arborvitae, Norway Pine, Red Cedar, and some other conifers might be used to a limited extent.

For High Prairie Soils in Northern Minnesota and Similar Situations Elsewhere. Cottonwood, White Willow, Boxelder and White Elm in equal quantities, with a scattering of fruit plants. White Spruce and native Red Cedar might also be used in a small way.

Lists of trees commonly planted, arranged in the order of their hardiness: Deciduous trees—Green Ash, White Willow, White Elm, Boxelder, Basswood, White Poplar, Hackberry, Soft Maple, Canoe Birch and Yellow Locust. Evergreen trees—Red Cedar, Dwarf Mountain Pine, Jack Pine, Bull Pine, White Spruce, Austrian Pine, Scotch Pine, Douglas Spruce, Norway Pine, Norway Spruce and White Pine.

Size of Trees. In the case of deciduous trees it is generally best to start with one year old thrifty seedlings, although trees two years old may often be used to advantage. The Oak, Walnut and similar trees are better started from seeds where they are to remain, and the White Willow should be started from cuttings. Seedling Elm, Ash and Cottonwood may often be pulled from some river bank or lake shore, or bought of nursery men at a very low figure, or they may be raised from the seeds. White Willow cuttings can generally be obtained from some neighbor or from nurseries. In the case of conifers, transplanted seedlings should be used. Whatever the source of any stock that is to be planted, it should be thrifty and vigorous and not weak or diseased.

Methods of Planting. The methods used in prairie planting are much the same as for transplanting in the nursery.

In every case much pains should be taken to have the soil in the best condition. It is generally better to delay planting for a year than to attempt it in poorly prepared soil. Tree plantings have been made on our prairies by sowing tree seeds broadcast in autumn after first carefully preparing the soil, but the plan is seldom successful. A start can, however, be made from seeds by planting the seeds in hills either alone or with corn or beans. In the latter case the tree seedlings often do very well and do not interfere with the growth of the crop. The seedlings are cultivated in the spring after the crop is removed and as they are in rows this is a very simple matter. The common and generally most successful plan with trees that can be easily transplanted is to start with seedlings and plant in rows. The simplest and easiest way of doing this is to furrow one way, mark out the other way and plant the trees in the furrows at the intersections. If Black Walnut or any of the oaks are wanted in a mixed planting it is generally best to plant the other species first and put in the nuts or acorns afterwards. Where it is desirable to plant seedlings or cuttings to fill vacancies, a pointed stick or spade may be used to make the hole. Whatever method is used in planting, it is most important that the soil be packed firmly around the roots, so they will not dry out. If the soil is dry it cannot be made too solid around the roots. If cuttings are used they should be made about 14 inches long, and in planting be pushed into the loose soil in a slanting position, leaving only one bud above the surface, as recommended in the planting of cuttings.

Cultivation should be commenced shortly after planting and be repeated often enough to keep the top three inches of soil loose, so as to form a dust blanket to retard evaporation during dry weather. The soil should never be allowed to become baked hard after a rain, but the crust should be broken up with a horse cultivator as soon after a rain as it can be worked. Cultivation should be discontinued after the first of August, in order to encourage early ripening of the wood. The weeds that grow after this time of year will do no harm.

One of the best tools for early cultivation of small seedlings is Breed's Weeder, which may be worked both ways and cleans out the weeds to perfection. The ordinary corn cultivator is also a good implement for this purpose. Later cultiva-

tion should consist of working the soil with a one-horse cultivator or plow. If the horse implements are properly used there will be no necessity of hand hoeing, for the few weeds that grow in the rows of trees will do no injury to them. Some planters sow oats among the young trees for protection when cultivation ceases, but if field mice are abundant it may be best not to do so. Late in autumn of the first year or two after planting some soil should be turned towards the trees with a plow, to protect them.

Thinning. In growing prairie groves we should always aim to have the tops of the trees just touch one another without serious crowding, but still have the soil shaded and protected from wind. In order to bring this about, the grove must be thinned occasionally, for although the trees would thin themselves if left alone, it would be at the expense of growth and perhaps cause serious injury. Trees that are crowded together may suffer more from drouth than those that have plenty of room for their roots. This is especially true of tender trees on dry land. If the trees begin to crowd one another the poorest should be removed, but this should be done carefully and never to such an extent as to let in the sunlight, which would encourage the growth of grass, weeds and side branches. Thinning may be done at any time, but if the wood taken out is to be used for fence posts or poles it would be better to cut in winter and peel at once to aid in curing.

The Blowing Out of Small Seedlings planted in prairie soil is not uncommon where they are in very exposed situations. The movement of the young seedlings by the wind keeps the soil loose around them, which the severe winds blow away. Occasionally by such means the roots may be left three or four inches out of ground the first season. In such very severe locations it is often a good plan to mulch the soil with straw or similar material until the seedlings are well established, after which they may be cultivated, or the mulching process may be continued until they will take care of themselves.

The Proper Location of the Buildings on a Farm is a very important matter and seldom receives the attention which its importance demands. The position of the buildings determines the location of the drives and of the shelterbelts if any are to be planted. There are factors which should

enter into the study of this question, among the first of which is the lay of the land. Good drainage and good water are the first requisites for the location of a home, after which come convenience and beauty. It is very desirable that the first location be made just right, since when other improvements and buildings have been commenced it can seldom be changed without much extra expense. In the case of most of our farms the subject of plans is conspicuous by its absence, as

Fig. 2. Suggestion for laying out the grounds about the buildings on prairie farms, showing arrangements adapted to a highway located on four different sides. Size 30x37 rods, enclosing five acres, exclusive of shelterbelt on north and west sides five rods wide. Rows of trees indicated. See figure (3) for further details and suggestions.

small cramped grounds about inconveniently arranged buildings bear abundant evidence.

In figure 2 is shown four plans suggestive of the proper location of the shelter belts about farm buildings, located on

level prairies, and varying according to the location of the main highway. Five acres in the form of a rectangle, 25 rods wide and 32 rods long, are included in the land about the buildings, and this has a shelter belt five rods wide on the north and west sides, and the south side two rows of trees ten feet apart, with the trees one rod apart in the rows. Within this enclosure are all the farm buildings, orchard, fruit and vegetable garden, barn-yards, etc. The house should be within 100 feet of the road, and the stock buildings at least 100 feet from the house and garden. About the buildings and garden some supplementary windbreaks and ornamental trees and shrubs will be needed for wind protection and for beautifying the place. This arrangement gives plenty of room for the

Fig. 3 Suggestions in detail for laying out the grounds about the buildings on a prairie farm. Highway on south, size 30x37 rods enclosing five acres; windbreak on north and west five rods wide. Two rows of trees next to highway. Rows of trees indicated.

buildings, barnyards, garden and orchard, and, while all the land enclosed may not be needed for these purposes, the remainder is well adapted to the growing of general farm crops.

The plans are only suggestive and no attempt is made to work out details, and there are comparatively few farms that they would fit exactly. For instance, while it is desirable to have the buildings centrally located, their position must frequently be pushed to one side on account of a swamp or lowland which is not suitable for them, or their position may be determined by a beautiful natural grove. Figure 3 shows a plan for a south front drawn on a larger scale. It may often be desirable to change the shape of the land enclosed, but in the great majority of prairie farms a plan similar to this would work out to good advantage and the area enclosed by windbreaks could often be increased to ten acres to good advantage.

A rule that should be carefully followed in all tree plantings is that the view from the most commonly used rooms of anything that is suggestive of pleasant associations or that is especially interesting or entertaining should not be cut off. Under this head would be included the view, from the living-room windows, of the traveled wagon road or perhaps of the railroad, of the neighboring houses or perhaps a nearby lake, and of the important fields on the farm, especially those where stock is pastured. These views can generally be secured without seriously impairing the value of the windbreaks, by cutting small openings in them or perhaps by simply shortening the trees, so that they will not interfere with the line of sight. Plantings of this kind often add very much to the comfort and actual income from the place and the land occupied by them may generally be regarded as the most productive of any on the farm when its effect on the live stock and gardens and the comfort of the family is considered. It also adds very much to the selling value of a place.

CHAPTER II.

LANDSCAPE GARDENING.

The gardening art offers this advantage to its lovers; that they may everywhere enjoy it and that with comparatively small expense they may practice it on their own account. The poor washerwoman, who has hardly time to look at the statue of Washington in the city park and scarce money enough to buy a chromo, is quite able to grow geraniums in her window and to have a pretty bed of marigolds and phloxes in the yard. The opportunities to cultivate a taste for this sort of landscape art lie all about us, while to only a few comes the freedom of art galleries and exhibitions. How cheap and simple materials may be combined to give an excellent effect can hardly be known until one has seen a few good object lessons in the use of simple and inexpensive materials for outdoor decorations. The high priced novelties of nurserymen's catalogues are not necessary nor often even desirable for finest effects, and too often they are tender and unreliable. Much more of beauty is affected by the skill with which the planting is arranged than by the material used.

In laying out grounds in general the most important thing is to have a plan that shall be sufficiently comprehensive to include the whole scheme of the location of buildings and drives, and the planting of trees and shrubs. This plan should be made with much care and only after much study.

There are two general styles of gardening. The first, which is known as the "formal" or Italian style, is characterized by the uniform and geometrical patterns as seen in the flower beds in our parks. It is best adapted for use about buildings and for very small places. The "natural" style, also known as the English style, which is the most popular kind of ornamental gardening in this country and generally in Europe, may be best seen in this section in the parks of St. Paul and Minneapolis. In it straight lines, regular curves, trimmed trees and anything that tends to take away the soft

effects of natural lines are out of place. This is the style best adapted for farms and country places in general, for the reason that it easily fits into natural conditions and is least expensive in maintenance. It is to the study of this style of gardening that we shall devote ourselves here.

Before considering so large a subject in detail it is important to become thoroughly familiar with the material at our disposal, i. e. the ornamental trees, shrubs, grasses, plants, rocks, views of interesting objects on our own or neighboring grounds, and in proportion as we use all the material at our disposal to good advantage will our work be a success or failure. In planning such work it is important to get the whole family interested, for there is nothing that holds the children to the old home as the trees and plants they have planted or helped to plant and care for.

In establishing new homes, the most important thing to be considered is healthfulness of surroundings, including water supply, after which comes convenience, kind of soil, outlook and general beauty.

Plans. For new homes, consider all the points of interest carefully before beginning the work. This is much more satisfactory than the making of plans for places already established. Where it is a question of improving old grounds a difficult problem is often presented, and to properly treat this kind of a subject requires in many cases great skill.

Healthfulness of Location is of first importance. Avoid low land, especially if swampy, even if it is well drained artificially. Good drainage is a most important factor in making for healthfulness of location. Provide properly for sewage waste.

Convenience. Build convenient to friends, so as not to be too much isolated. One should consider nearness to railroad, to school, church, library, etc.; main streets or side streets. On farms build for convenience of situation for doing work. Build economically; a house begins to lose in value from the day it is completed.

Height of Land. Among the advantages of high land may be mentioned pure air, better drainage, extent of view. Among the disadvantages of high land are the extra effort to reach such places, greater exposure to wind, extra cost of maintain-

ing drives and walks on steep slopes and extra cost of heating house in exposed situations.

Slope. Southern or southeastern slopes are best in cold weather, as they are protected from the cold winds, and, if the outlook is good should be preferred to west or northwestern slope. Yet with proper tree plantings northern slopes can be made very pleasant.

Good Water is a most important feature. Nothing causes more misery than poor water. Source of water should be carefully investigated. The sources of contamination in the country and in villages are cesspools, sink drains, stable yards, etc. The best water supply is from a clean reservoir, as by long exposure to sun and air it becomes purified, but such water does not sparkle like that fresh from wells. Clean cisterns afford a good supply of healthful drinking water. Soft water is better than hard for drinking or other purposes.

Kind of Soil. On this depends much of the success of our ornamental planting. One kind of soil will not suit all kinds of plants; yet in any fairly good soil most of our best ornamental plants will grow well.

Rocks, Water, Distant Views and other natural features of our location should be considered and may add wonderful beauty to our grounds if properly handled. "Ledges" and "boulders" serve as a nucleus around which to group ornamental trees, shrubs and vines. "Water" in the near vicinity may not always be desirable, but where exposed to full circulation of air, and if the land near by is considerably elevated it may often produce much beauty. But too often it becomes stagnant and a breeding place for mosquitoes. A brook, on the other hand, has not the quiet restfulness of the lake, but is more satisfactory, especially if it can be arranged so as to get its ideal ripple and gurgle. In order to have any near-by water enjoyable it should not be contaminated by sewage or other waste. Association of thoughts have much to do with enjoyment.

An Increase in Value of Locations in growing towns and cities may generally be regarded as certain, if good judgment is displayed in selection and buying. The increase in value of places due to proper planting is illustrated in many ways.

Amount of Land to Start With. Use only what can be well cared for. Do not build houses or other improvements

so expensive as to be beyond your means to maintain. Happiness is not increased by living beyond one's income.

Location of House. Where possible, put at some distance from street, and it is often best to locate on one side of lot. Where many houses are already built on a street it often detracts from its beauty to set it very much out of line with the others.

The Approach to House should be such as will be in accord with its pretensions. In the case of large grounds this may be made a grand feature of ornamentation by being planted with fine trees, but in small grounds it should occupy as little space as practicable and should be as inconspicuous as possible. There is nothing that tends to reduce the apparent size of grounds as to cut them up with walks and drives, and the wider the drives the worse their appearance. The drives may often come in on the north side and so avoid interfering with the view from the windows of the south side. The same is true of the staircase and front door. They should not be placed on the pleasantest side of the house but this should be reserved for living rooms.

The Architecture of the house should be in keeping with the surroundings. A large pretentious house, built in a quiet and secluded place, is not in good taste.

The Cost of House and Grounds generally exceeds the estimates 25 to 50 per cent, due to changes made in plans after contract is let. This should be borne in mind in building. Consider plans carefully before letting the contract.

The Cellar. There is little necessity for large cellars for storage in villages as with convenient stores it is not necessary. They should be large enough for heating plant and fuel. They must be dry in order to be sanitary and to prevent heating plant from rust. They should be ventilated in summer especially. If possible do not store vegetables under dwelling, but use a storage cellar outside.

Perfect Ventilation in the house is very important. It is probably best to have the hot air come in above and go out on the same side below. A house heats best when some system of ventilation is provided.

Preliminary Grading. When excavating for a cellar, scrape surface soil to one side for surfacing later. In making fills, save the black soil to go on top of inferior material. The

surface of the lawn should slope away from the house in all directions, so there shall be no standing surface water, but some hollows may be left near trees and shrubbery at a distance from the house, in the case of gravelly land, to catch the water from summer showers—which is all needed on such soil. Where water stands on the lawn in winter it will often kill out the grass. Trees and shrubbery which it is intended to save should be protected during building and grading operations or they will be injured.

Slopes should be easy and gradual. Terraces should be avoided as they are hard to maintain in good order and add no beauty.

Lawn. This may be considered the canvas onto which we are to make our home picture by trees, shrubs and other materials and the buildings. The whole thing, when finished, will be an index of our knowledge of the grouping of these units, and very often it is also an index of the character of the owner. For a good lawn we must have good soil, and no after treatment by special manuring or special grass seed can fully make up for carelessness in the preparation of the soil in the beginning. The soil should be pulverized deep, raked fine, and heavily manured.

Grass Seed and Seed Sowing. Our best lawns are made up of nearly pure Kentucky Blue Grass. As this grass does not start quickly it is customary to sow a little Red Top and White Clover with it, as these show quickly the first season, but later on are killed out by the Blue Grass. Perhaps for this section a mixture of 3 bushels of Blue Grass, 3 pounds solid Red Top and 3 pounds White Clover per acre is as good as any for seeding lawns.

The time for sowing grass seed will depend upon circumstances. As a rule early spring is the best time, but if water is plentiful, so the seed can be kept from drying out, August will be found a very good time. July and August are generally so hot and dry that seed is very uncertain when sown at that time. In sowing the seed much care should be taken to scatter it evenly, and it should be raked in and rolled. Rolling is important as it leaves a smooth surface.

Where it is desirable to get a grass cover at once oats may be sown with the grass and be cut off when six inches high, and if afterwards frequently cut with a lawn mower makes a

very good, coarse lawn and does not interfere with the development of the seed of finer grasses.

Sodding is sometimes resorted to in order to get a lawn quickly. It has the advantage that it can be done at any time and gives a lawn at once; but it is very expensive and generally no better than seeding. It is a good plan, however, to border the walks with sod to define their lines.

Mowing Lawns. The lawn mower should not be allowed on the new lawn until it is well established, and the first cuttings should be done by hand. After the lawn is established it should be frequently cut, especially during the cool weather of spring and early autumn—if a fine close turf is the object. Most of the clippings may be allowed to remain on the lawn, when they are not heavy enough to smother out the grass, but when heavy they should be carried away.

Renewing Old Lawns is most easily accomplished by the use of very fine, well rotted compost, or rich loam, which should be scattered thinly over the grass about one-half inch deep, so the grass will push up through it. Grass may also be sown in it. Covering lawns in autumn, or at other times, with coarse stable fertilizer leaves the lawn unsightly and often results in killing it out in spots. Tankage is a good fertilizer for this purpose, to be used at the rate of 1,000 lbs. per acre. The most quickly acting fertilizing substance is nitrate of soda, which may be applied at the rate of 150 lbs. per acre in two or three weeks, but not oftener. It gives the grass a dark green appearance, as well as makes it grow rapidly, but it is not needed where proper attention has been given to preparing the soil.

Re-Seeding may be resorted to where bare spots come in the lawn. This should be done in early spring. The annual grasses are often very unsightly and annoying, but close cutting with the lawn mower and hand weeding will generally remedy the trouble. Before re-seeding it is a good plan to re-surface the bare spots with fresh loam.

The Use of Trees about the home is desirable for furnishing shade during the hot days of our summer months and for the protection they give from the cold winds of winter. They are also necessary in many places to cover up unsightly or unpleasant objects, to open up vistas, to form backgrounds for other ornamental materials, for their own individual beauty, and also for the variety they afford in their varying shades of color

and form. Trees, as well as other woody plants, vary in their aspect with each season. Some trees and shrubs, like the Scarlet Maple and the Sheepberry, are noted for their fine autumn coloring, and others for some conspicuous features in winter, as for instance the White Birch and the Golden Willow, while all are attractive during the growing season. Some trees produce beautiful flowers and fruit and others attractive foliage; some take on the regular spiry form, and others grow with well-rounded outline; some have a spreading, delicate habit, while others are compact, close and massive in their build.

Distance Between Trees should vary according to the variety and soil, and to the objects in view. Thus the White Elm in good soil should eventually have at least forty feet for best results, while on poor soil thirty feet would be enough. It is, however, a good plan to plant rather close at first and thin out later on. This is especially true of the conifers in this climate, which generally do best when planted in groups, as in this way they protect one another. This is especially true of western Minnesota and Dakota where they are not at home.

Where To Obtain Trees. As a rule trees and shrubs do best if obtained from some good nursery, as such trees generally have better roots than those obtained from the woods, but Elms, Maples and Basswoods generally do very well when dug from our woods. To do this successfully young trees should be selected. If these are cut around with a spade in the spring of the preceding year, about one foot from the trunks, they will grow much better than if moved without this preparation. In the case of Oaks, Hickories and other tap-rooted trees, this is most important, while Elms and Ash do very well without this preparation.

Time to Plant. Autumn planting may be done in case of the Elm, when we have very favorable conditions, but as a rule very early spring planting is better for all trees. In wind swept locations it is extremely doubtful if autumn planting should ever be practiced with any but herbaceous plants which may be easily protected. Coniferous trees may be successfully moved at any time when we have favorable conditions, but spring is the best time.

How to Dig a Tree. More trees die from injuries received in digging than from any other cause. A good root system is most desirable. In digging a tree set the spade in

the ground with one edge toward the trunk, so as not to cut the roots, and then throw off the soil down to the roots in a circle, varying from one to four feet, according to the size of the trees. Then cut off the roots at a reasonable distance from the trunk, when with the aid of a strong spade the tree can very likely be loosened. If, however, it has one or more tap roots, it will be necessary to dig under and cut them off. Small trees can often be lifted by the spade without much uncovering of the roots. In moving large trees a trench must be dug around them two or three feet deep, and the deep roots cut off. The soil should then be partially shaken off until the ball is light enough to be dragged out of the hole. Sometimes large trees can best be moved in winter, after the ball of earth is frozen, but the holes should be prepared in advance, and the frost kept out, so the planting work can be properly done in winter.

Pruning Trees for Transplanting. In digging trees the root system is necessarily much injured and it is a good plan to shorten in the top correspondingly. When pruning is not practiced the trees seldom start as well as when severely pruned, but it is not a good plan to prune so severely as to disfigure the trees. Pruning at time of transplanting is often necessary in order to start branches at the desired height. If low branching trees are desired, it is often necessary to prune them severely at the top. This is especially the case with Elms and other trees taken from thickets where they have grown very tall. In such cases good results may be obtained by cutting the trunk to a bare pole—12 feet high. The roots also require a little pruning, which should consist of cutting off the badly bruised portion. When large branches are cut off they should be covered with shellac, or painted.

Shrubs can seldom be used as screens, but are valuable for defining division lines between city lots, for the great variety of color and form which is found among them and especially for their use in grouping about the borders and in other places to give a softening effect to tree planting. They offer a much greater variety of material than the trees. Beginners generally understand the value of a collection of trees as windbreaks and as street trees, but shrubs are too often planted as individuals and without regard to their collective effect. By using them in masses, they may be made

to produce strong and very pleasing effects. They may even be combined with herbaceous plants and their effect greatly heightened in this way. We have some very beautiful shrubs in our woods, and among the best are the Kinnikinnick or Dogwood, the Silky Cornel, High Bush Cranberry, Juneberry, Burning Bush, Elderberry, Sheepberry. These can often be gathered from the woods without any serious expense. Among the hardiest and best of the introduced plants are the Lilacs, Tartarian Honeysuckles, Hydrangea, Spireas, Caragana and Snowball. Among the best hardy vines or climbing shrubs are the Virginia Creeper, Wild Grape, Clematis and Bittersweet, all of which are native in our woodlands and thickets.

Fig. 4. Showing best method of cutting back Willows to get best renewal from the stump.

Herbaceous plants can often be used to good advantage and will give good results. They are very easily protected in winter. Among the best and hardiest are the Peonies and Irises, which, with slight protection, are perfectly hardy and most satisfactory. But many others are easily grown.

The Pruning of Trees and Shrubs, or of any other plant, should never be attempted unless with some definite purpose in view. In the case of trees it is seldom that more pruning is needed other than to cut off awkward branches or those that interfere with travel. The best time to do this is probably in June.

In the case of shrubs, sufficient pruning should be given to keep the plant in good form. In no case should they be pruned to stiff, formal shapes. Every shrub has its own peculiar graceful form, and pruning should be done to develop it and not to change it. As a general rule, shrubs should be pruned by taking out the stems or branches from the inside, to make room for new shoots. The shrubs that bloom early in spring form their flowers the year before and hence should be pruned immediately after they are done flowering. Shrubs that flower in August should be pruned in the early spring, so as not to interfere with their flowering.

Fruit Trees may often be worked into the ornamental features of the planting design. Such trees as the plum, apple, crab-apple and cherry have good form and foliage and are especially beautiful when in flower or in fruit and to many persons have in interest that mere ornamental plants do not possess.

The Grounds About Our School Houses should be large enough to afford good play grounds and a chance for ornamentation at the same time. Where the grounds are small they must generally be used for play grounds; where they are large enough it would add much to their interest to have a variety of trees and shrubs and a few vines of our most hardy kinds. These should be labeled plainly with their common names, as without labels they are of little interest to the amateur. If this feature of our school grounds could be more generally developed it would become most valuable in teaching habits of observation. In this work much depends upon the teacher—who has here a rare opportunity of teaching object lessons to the whole community.

CHAPTER III.

PROPAGATION OF PLANTS.

Trees are Grown from Seeds or by Division. The latter term includes increase by cuttings, layers, buds and grafts. Plants grown from seeds are generally more vigorous and longer lived than those of the same species propagated in any other way. Trees should be grown from seeds when it is practicable to do so, but willows and some other trees are apparent exceptions to this rule and seem to do as well when grown from cuttings as when grown from seeds. Varieties do not generally perpetuate their peculiar characteristics when grown from seeds, and must therefore be propagated by some method of division.

The Most Desirable Trees from Which to Propagate are those of good form and healthy growth; the latter is the one most important requisite, especially if new plants are to be grown by any method of division. It is not so essential in selecting seeds, as even weak plants may produce good seedlings, but unhealthy cuttings, layers or grafts are of very uncertain growth. In general, it is best that the stock trees be healthy throughout, but a tree may have a rotten trunk due to some injury and still have perfectly healthy branches and be a desirable tree from which to propagate.

SEEDS.

Sources of Seeds. In growing trees from seeds the source of the seeds is very important. It may be given as a safe general rule that seeds are most desirable which come from trees grown in as severe a climate as that in which the seeds are to be sown. It has been found that trees of Boxelder and Red Cedar grown from seeds gathered in Missouri are not nearly so hardy in this section as those from seeds grown in our own state. It has also been found that seeds from the western slopes of the Rocky Mountains, where the climate is very hu-

mid, produce trees which are not so well adapted to withstanding the conditions of this section as trees grown from seeds from the eastern slopes, where the summers are very dry and hot and the winter very dry and cold. Our climate is especially trying to trees, and it is necessary to exercise much more care in the selection of tree seeds here than it is in the more favored climate of the eastern and western coast states.

There are Conditions Under Which Every Species of Tree Thrives Best and makes its greatest growth, but the trees produced under these conditions are not always the hardiest. As we reach the limits of their growth, trees have a tendency on account of drouth or cold to become smaller, more compact in form and to fruit younger; e. g., the Boxelder is a large tree in Kansas and Missouri, but as it gets towards the Manitoba line we find it becomes dwarfed and more bushy in habit. Towards the southern limit of its range the tree becomes more open in habit and more liable to disease. The Scotch Pine seeds imported into this country are generally saved from the small scrubby trees that are found in the higher altitudes of the mountains of Europe, because such trees produce the most seeds and they are most easily gathered from them, while seeds are seldom gathered from the large timber trees of this species, and it is very likely that this poor seed stock is responsible for much of the scrubby appearance of many Scotch Pine plantations in this section.

Trees Have a Strong Tendency to Perpetuate Qualities which have been developed in them by climate and soil conditions. Hence, even though an essential point in considering the value of any tree is its hardiness, the question of size is important and should be taken into account, as we generally wish to grow trees of as large size as practicable. We may conclude, then, that since trees from a very cold climate generally lack in hardiness, and those from a very severe climate may lack in size, it is best to procure seeds from the best trees grown near by or from those grown under similar climatic conditions elsewhere. It is not generally necessary to limit this range very closely, as a hundred miles north or south of a given point will seldom make much difference in hardiness, unless the climatic conditions are very dissimilar.

The Place Where the Trees that We are to Set Out are

Grown is not of so great importance as the source of the seeds from which they are grown; e. g., seedlings of Red Cedar grown in Missouri from seeds of native Minnesota trees would be safer to plant here than seedlings raised in Minnesota from the seeds of native Missouri trees.

Seedling Variations. In our common trees variations are not sufficiently marked but that we think of the trees as coming true from seeds, and yet careful observation will show to any one that each seedling plant is different from neighboring plants of the same species. Sometimes a seedling will occur that possesses especially pleasing or curious characteristics that are very marked and desirable. In such cases the seedling is generally propagated by some method of bud-division and makes a new variety. In this way have originated such highly esteemed kinds as Wier's Cut-leaf Maple, which was a chance seedling of the Soft Maple, the Weeping American Elm, Cut-leaf Birch, Weeping Mountain Ash, Pyramidal Arborvitae, and a host of other kinds that are propagated by bud-division by nurserymen. The person who is on the lookout for these or other variations will have no trouble in finding many that may perhaps be worth naming and propagating.

Gathering Seeds. All kinds of seeds should be gathered when ripe. In some cases it is best to pick them from the trees even before they are quite ripe, after which they will ripen if kept dry. Unripe seeds do not keep as well as perfectly ripe seeds. Most kinds of tree seeds are most cheaply gathered from the ground. In some cases this method can be greatly facilitated by cleaning up the land under the trees so it will be smooth and even. Seeds of some species can often be swept up at little expense from under trees growing along the highway.

Germination of Seeds. There are many conditions which affect the germination of seeds:

(1) Seeds which are thoroughly ripened before they are gathered produce the best plants. Very immature seeds will very often grow, but the tendency with them is to produce weak plants. (2) Freshly gathered seeds, as a rule, are preferable to old seeds for sowing, and seeds that have never been allowed to become very dry are more likely to grow than those which have been severely dried. This is especially true of most of the kinds of seeds that ripen in early summer,

the most of which lose their vitality very quickly when stored. (3) Some seeds, such as those of the Plum, Cherry and Black Walnut, require severe freezing when moist in order to germinate. (4) Seeds that are covered with water will not generally grow. This is true at least of our northern tree seeds. (5) The seeds of some trees germinate at a temperature near freezing, while others require a much higher temperature. (6) After seeds of some plants have become very dry, scalding may aid them in germinating, while with others scalding is injurious. It is sometimes desirable to soak seeds for one or two days in tepid water, and then mix with sand and freeze before sowing. Lindley records that seeds found in raspberry jam grew after passing through the heat necessary to boil syrup (240 degrees Fahr.) and that seeds of *Acacia* and *Lophantha* grew after being boiled five minutes, but our common tree seeds will not stand such treatment.

Stratification, as the term is used in this connection, refers to the storing of seeds mixed with layers of earth, leaves or other material. It is customary to apply the term solely to seeds that are mixed in this way and kept frozen over winter. It is the common practice with the seeds of such trees as the Black Walnut, Hickory, Basswood, Plum, Cherry and Mountain Ash. Where only small quantities are to be cared for they are generally mixed in boxes and the boxes buried in well drained soil out of doors, but where large quantities are to be handled they may be mixed with soil on the surface of the ground and left until spring; such a pile is termed a pit. One of the best materials with which to cover seed pits is inverted grass sod. It is a good plan to have the material that is mixed with the seed so fine that it will easily go through a screen and leave the seeds separated for sowing.

Wintering Acorns and Other Nuts in Large Quantities. On account of the great liability to injury where a large amount of nuts are stored in heaps, and on account of the impracticability many times of stratifying them with sand, the following plan is resorted to in some sections:

A house is made, preferably with a sandy floor, so as to secure good drainage, and is covered with sod roof and sides, so as to keep out most of the frost. This may be of any size, but perhaps 20 feet in width and any length would be very convenient. The nuts are spread over the ground about 18 inches

thick, and are kept stirred until frozen in winter. As soon as they thaw out, they are turned once a day. In this way they are prevented from moulding, and from the other injuries that are so common to nuts stored in large quantities. It would be desirable to keep the temperature from ever going much below freezing.

Seeds May be Classified Into Three Groups: (1) Those that ripen in spring and early summer, (2) deciduous tree seeds that ripen in autumn, and (3) coniferous tree seeds.

Seeds that Ripen in Spring and Early Summer should be gathered as soon as ripe, and, with the exception of the Red Elm, sown within a few days or weeks, as they retain their vitality but a short time. (Red Elm seed will not grow until the following spring.) In raising seedlings of this class it is important to have land that will retain its moisture during the summer months or else that which can be conveniently irrigated, since these seeds must often be sown during very hot, dry weather, and as they cannot be covered deeply they are very liable to fail with any but the best conditions. The thousands of seedlings of Cottonwood, Elm, and Soft Maple that spring up on the sand bars along our rivers and lake shores show what are the best conditions for these seeds to germinate.

Cottonwood Seedlings can be grown by scattering the branches bearing unopened seed pods along rows in moist soil and covering the seed lightly when it falls, but they are of so uncertain growth that most of our nurserymen depend upon the sand bars and lake shores for their supply.

Elm, Soft Maple and Mulberry seeds generally grow well on any good moist soil. They should be sown thickly in drills eight inches wide and three feet apart, or in narrow drills. Elm seeds should be covered with about one-half inch of soil, Mulberry with about one-fourth inch and Soft Maple with about one inch. If the weather is dry the soil over the seeds should be well packed, and if the weather continues dry the rows should be watered. Watering, however, is seldom necessary on retentive soil if the soil has been properly packed. With proper conditions seeds so planted will start quickly and grow rapidly; the Elm will grow from six to eighteen inches and the Soft Maple twelve to twenty-four inches high before the first autumn. Such seedlings are large enough for perma-

nent setting in forest plantations or windbreaks. They may be allowed to grow in the seed bed another year without injury, but should be transplanted before the growth of the third season begins.

Seeds of Deciduous Trees that Ripen in Autumn may be sown to advantage in the autumn; provided, (1) the soil is not of such a nature as to become too solidly packed over them before spring; (2) they are not liable to dry up or wash out; or (3) they are not subject to injuries from rodents, insects or other animals. In many locations some or all of these possible injuries may make spring sowing most desirable with most kinds of seeds. Our most successful nurserymen, however, prefer to sow in autumn, and try to bring about the conditions that make it successful.

In the Matter of Storing Seeds it is difficult to lay down any exact rule to follow, and here, as in all other similar matters, considerable must be left to good judgment. As a rule, however, it is perfectly safe to winter over all of the seeds of hardy plants which ripen in autumn, by burying them in sand out of doors.

Tree Seeds that Ripen in Autumn may be divided into four classes, which require different methods of treatment to grow them, viz., dry seeds, seeds with fleshy coverings, nut seeds and leguminous tree seeds.

Dry Seeds, like those of the Ash, Birch, Hard Maple and Boxelder, are very certain to grow when sown in the spring in drills as soon as the soil can be easily worked, in the same way as recommended for Soft Maple and Elm. If not sown until spring they will have to be kept over winter, and when only a small quantity is to be kept over this is best done by spreading the seeds on the surface of the hard ground, covering with an inverted box and digging a ditch around it to carry off the water, or the seeds may be mixed with sand and kept in a dry, cool place. Large quantities may be kept on dry ground under a shed. These seeds will stand considerable drying, but if allowed to become very dry, hot, or moist, their vitality may be injured or destroyed.

Seeds with Fleshy Coverings, as those of the Cherry and Plum should be kept from getting dry before planting. The best way to handle them is to separate them from the pulp, mix with moist sand out of doors, and keep them moist until

Fig. 5. Some common winged seeds; (1) Black Ash; (2) White Ash; (3) Willow; (4) Soft Maple; (5) Sugar Maple; (6) Red Elm; (7) White Elm; (8) White Birch; (9) Tam-arack; (10) Noble Fir; (11) Hardy Catalpa; (12) Pine; (13) Noble Fir; (14) Tam-arack.

planted. It is generally safe to sow such seeds in the autumn on good land, but some growers prefer to sow them in the spring. This class of seeds requires to be frozen before germinating. If allowed to get dry before being frozen, they should be mixed with moist sand for a few days until plump, or they may be soaked in water, but care must be taken that they do not get water soaked. Sometimes the dry, hard shells of such seeds seem to be waterproof. In this case, if the seeds are of special value, it is a good plan to file a hole through the shell, so as to let the seed become moist. Most seeds of this class grow the first year if properly handled, but some of them—for example, the Red Cedar and the Wild Thorn—even with the best management, will remain dormant in the ground for one year before growing.

Nut Seeds, as those of the Oak, Hickory and Walnut, should be handled as recommended for seeds with fleshy coverings, but are more sensitive about being severely dried. As they do not transplant readily, it is very desirable to plant them where they are to remain permanently. They should be covered about two inches deep.

Seeds of Leguminous Trees, as those of the Black Locust, Honey Locust and Coffeetree, will stand severe drying for a long time and still grow, provided they are treated with hot water just before planting. In this case the hot water should be poured over the seeds shortly before they are sown, and be allowed to stand until cool, when it will be found that some of the seeds have swollen up; these should be picked out, and the remainder be treated again with hot water, and the process repeated until all have swollen. Seedlings of this class generally transplant readily, and are managed in the same way that is here recommended for the Ashes and Maples.

Seeds of Leguminous Trees, as those of the Black Locust, and Arborvitae, are dry and winged, but the Red Cedar has a fleshy, berry-like covering surrounding its seed. The seeds that grow in cones are most easily gathered before being shed from the cones. The cones should be gathered before they open, and then dried, after which those of most species will open, and the seeds can be threshed out. Cones of a few trees, as those of the Jack Pine, will not open without artificial heat. These can be opened by gently heating them over a stove or in an oven to a temperature of from 100 to 150 degrees Fahr

Seeds of this class grow readily when sown, but must be very carefully stored or they will lose their vitality. They should be kept similarly to the seed of the Ash and Boxelder, but are more liable to injury than these kinds from too much moisture or heat, and for this reason some careful growers prefer to always keep them mixed with dry sand in a cool shed.

The seeds of the Red Cedar hang on the tree all winter, and must be picked by hand. They should be soaked in strong lye for twenty-four hours, the fleshy covering removed by rubbing them against a fine sieve, and then stratified in sand, where they will be frozen during the winter. Even with this treatment they will seldom grow until the second year.

Raising Coniferous Trees from Seed. The land selected for sowing the seed should have a light, porous surface soil, preferably underlaid with a moist subsoil that will not dry out easily. It should be so located as to have good circulation of air over it, that the plants may dry off quickly after rains, and it must be so shaded as to keep off about one-half of the sunlight. This latter permits a play of light and shade over the bed all day, and is about the condition under which we find nature raising such seedlings where trees partially shade the ground and protect them from the constant rays of the sun. In practice we aim to secure these conditions as follows: A piece of well drained, rather sandy soil, in an airy place, is selected, and laid out in beds four feet wide. In May the seeds are sown rather thickly (about three good seeds to a square inch), either broadcast or in rows, and covered with about one-fourth inch of sandy loam and then with about one-fourth inch of clear sand. Some of the smaller seeds, like those of White Spruce, should not be covered more than one-fourth inch. Before the seedlings break the ground, a framework, six feet above the beds, is made, and covered with laths, laid about one and one-half inches apart, running north and south, or with sufficient brush to shut out about one-half the sunlight. If the bed is very much exposed to the winds it should have similar protection on all sides. In such a place as this, or in woodlands where these conditions can be fulfilled, evergreens can be raised with much certainty, while if planted in the open ground most kinds are sure to fail.

The most common cause of failure with those who try to raise evergreens is what is known as "damping off," which

occurs only while the plants are growing rapidly the first year. In such a case the seeds start well, and the seedlings grow vigorously for a short time, or until we have a spell of damp weather, and then die off with great rapidity. It seems that the sunlight and the mud that has been spattered on the plants so weaken them that they are liable to disease. For this reason we shade the bed and cover with sand, which will not allow the mud to be spattered over the seedlings, and in very moist warm weather we occasionally apply dry sand to dry off the plants. For most kind of conifers the shade is required for at least two years.

Coniferous tree seedlings grow very slowly when young, seldom making a growth of more than two or three inches the first year. The most rapid growing of our pines seldom produce a growth of more than sixteen inches in the first four years, and should not be moved to their permanent place until

Fig. 6. Evergreen seed bed shaded with a screen of old brush placed on a frame.

about this time. They should, however, be transplanted from the seed bed to a temporary place when two years old, to prevent crowding and to facilitate root growth.

On the approach of winter the beds of coniferous seedlings should be covered with about three inches of straw or leaves, evergreen branches, or other material that will afford protection from the sun and from alternate freezing and thawing. This should be removed in the spring after all danger from drying cold winds has passed.

Depth to Cover Seeds. Most of our tree seeds should, in good soil, be covered from one-half to three-quarters of an

inch; but this is rather too much for such small seeds as the Birch, Alder and Cottonwood, while the Black Walnut, Native Plum, Acorns and other large seeds and seeds of Boxelder, Ash, Soft Maple and Basswood may often be covered two inches to advantage if the soil is somewhat dry. It is a good rule not to cover any tree seeds deeper than is necessary to secure permanent moisture, and on wet or heavy land only a very thin covering is desirable. If the land is very heavy, it is a good plan not only to cover lightly but to sow more thickly than usual, as a large number of seeds may be able to push up through the surface soil when a few would fail to do this.

The Amount of Seeds of Deciduous Trees to Sow on a given area depends very much on the kind and quality of the seeds and the soil in which they are to be sown. As a rule, thick is better than thin sowing. The seeds of Boxelder, Ash and Maple should be sown at the rate of about one good seed to the square inch; Elm and Birch should be sown twice as thick. Plums and cherries sown in drills should be allowed about one inch of row for each good seed. Black Walnut, Butternut, Hickory and similar seeds should preferably be planted three or four in a place, and all but one seedling cut out when nicely started. If sown in drills they should be placed from three to six inches apart. Rather thick seeding does not seem to be any hindrance to the making of a good growth by seedlings of most of our broad-leaved trees the first year, but if left thick in the seed bed the second year they are often seriously stunted. On this account such seedlings should be transplanted or thinned out before the beginning of the second year. In nursery planting it is a good plan to sow in freshly stirred land, as the seeds are far more likely to get a good start in it than in soil that has remained untilled long enough to become crusty and lumpy. Then, if the seeds are planted immediately after cultivation has been given, and while the soil is still moist, they have at least as good a chance as the weeds to start, while otherwise the weeds are soon ahead of the seedlings.

It is important to keep the soil loose and mellow between the seedlings, and to keep the weeds very carefully removed until at least the middle of July, after which they may sometimes be left to advantage to afford winter protection; but in the case of very small seedlings this protection is best given by

a light mulch, put on in autumn and taken off in spring, and the weeds should be kept out.

If the seeds of Red Cedar, the Thorn, Mountain Ash, and other seeds that require a long time to start, are sown in the spring, and do not germinate, it is a good plan to cover the bed with about an inch or two of hay or leaves, keep out weeds, and let this mulch remain until the following spring, when the seeds will probably be in condition to grow, and the mulch should then be removed.

TABLE SHOWING THE APPROXIMATE HEIGHTS OF ONE-YEAR OLD SEEDLINGS GROWN ON GOOD AVERAGE SOIL.

BOTANICAL NAMES.	COMMON NAMES.	Height in Inches.
PINUS STROBUS	White Pine	3
PINUS FLEXILIS	Western White Pine.	3
PINUS RESINOSA.	Red Pine	3
PINUS DIVARICATA.	Jack Pine	3
PINUS PONDEROSA SCOPULORUM ...	Rock Pine	3
PINUS SYLVESTRIS	Scotch Pine	3
PINUS LARICIO AUSTRIACA	Austrian Pine	3
LARIX LARICINA.	Tamarack.	3
LARIX EUROPEA.	European Larch	3
PICEA CANADENSIS.	White Spruce.	2
PICEA MARIANA	Black Spruce	2
PICEA PUNGENS	Blue Spruce	3
PICEA ENGELMANNI	Engelmann Spruce	3
PICEA EXCELSA	Norway Spruce	2
TSUGA CANADENSIS	Hemlock.	3
PSEUDOTSUGA TAXIFOLIA	Douglas Spruce	4
ABIES BALSAMEA	Balsam Fir.	3
ABIES CONCOLOR	White Fir.	2

TABLE SHOWING THE APPROXIMATE HEIGHTS OF ONE YEAR OLD SEEDLINGS GROWN ON GOOD AVERAGE SOIL.

BOTANICAL NAMES.	COMMON NAMES.	Height in Inches.
THUJA OCCIDENTALIS.....	Arborvitæ	2
JUNIPERUS VIRGINIANA.....	Red Cedar	3
JUNIPERUS COMMUNIS.....	Common Juniper.....	2
JUGLANS NIGRA	Black Walnut	12
JUGLANS CINEREA	Butternut.....	12
HICORIA OVATA	Shellbark Hickory.....	8
HICORIA MINIMA	Bitternut Hickory.....	4
SALIX NIGRA.....	Black Willow.....	10
SALIX AMYGDALOIDES	Peachleaf Willow	10
SALIX ALBA.....	White Willow	10
SALIX LUCIDA.....	Shining Willow	6
POPULUS TREMULOIDES.....	Aspen	10
POPULUS GRANDIDENTA	Large-tooth Poplar	12
POPULUS BALSAMIFERA	Balsam Poplar	10
POPULUS DELTOIDES	Cottonwood	16
BETULA Papyrifera.....	Canoe Birch.....	4-8
BETULA ALBA.....	European White Birch.....	6-10
BETULA LUTEA.....	Yellow Birch	4-8
Ostrya virginiana	Hop Hornbeam.....	4-6
Carpinus caroliniana	Blue Beech.....	4-6
QUERCUS ALBA.....	White Oak	4-8
QUERCUS MACROCARPA	Burr Oak	4-8
QUERCUS RUBRA.....	Red Oak.....	6-12
QUERCUS COCCINEA.....	Scarlet Oak	6-12
ULMUS AMERICANA	White Elm.....	6-12
ULMUS RACEMOSA	Cork Elm	6-10
ULMUS PUBESCENS.....	Slippery Elm	10-20
CELTIS OCCIDENTALIS	Hackberry	8-10
MORUS RUBRA	Red Mulberry	6-10

TABLE SHOWING THE APPROXIMATE HEIGHTS OF ONE-YEAR OLD SEEDLINGS GROWN ON GOOD AVERAGE SOIL.

BOTANICAL NAMES.	COMMON NAMES.	Height in Inches.
MORUS ALBA TARTARICA.	Russian Mulberry.....	6-12
PYRUS IOENSIS.	Wild Crab.....	4-8
PYRUS AMERICANA.	American Mountain Ash ...	8
PYRUS SAMBUCIFOLIA	Elderleaf Mountain Ash.	4-8
AMELANCHIER CANADENSIS	Juneberry.	8
CRATAEGUS TOMENTOSA	Black Thorn.....	4-8
PRUNUS AMERICANA	Wild Plum	15
PRUNUS PENNSYLVANICA	Wild Red Cherry.....	12
PRUNUS SEROTINA.	Wild Cherry Black	12
PRUNUS VIRGINIANA	Choke Cherry.	12
GLEDITSIA TRIACANTHOS.	Honey Locust	8-12
GYMNOCLADUS DIOICUS.	Coffeetree.	8-12
ROBINIA PSEUDACACIA	Locust.	24
ACER SACCHARUM	Sugar Maple.	12
ACER PLATANOIDES	Norway Maple.	12
ACER RUBRUM	Red Maple	10
ACER SACCHARINUM.....	Soft Maple	24
ACER PENNSYLVANICUM	Striped Maple	4
ACER TARTARICUM.	Tartarian Maple	4
ACER NEGUNDO	Boxelder.	12
ÆSCULUS HIPPOCASTANUM	Horse Chestnut	6
ÆSCULUS GLABRA.	Ohio Buckeye	4-6
RHAMNUS CATHARICUS	Buckthorn	6-12
TILIA AMERICANA.....	Basswood	6-12
ELAEAGNUS AUGUSTIFOLIA.	Russian Olive	12
FRAXINUS AMERICANA.....	White Ash	12
FRAXINUS LANCEOLATA.....	Green Ash	12
FRAXINUS NIGRA	Black Ash.....	8
CATALPA SPECIOSA.	Hardy Catalpa.....	24
VIBURNUM LENTAGO	Black Haw.	4-6

CUTTINGS.

Cuttings are pieces of the branches or roots which have the power of growing and forming new plants when placed in moist sand, soil or other material. For example, the pieces of the twigs on branches of many kinds of willows and poplars, when taken while the tree is dormant, will root when placed in moist soil, but there are few other trees that grow as readily from cuttings as these. Cuttings of the roots of many kinds of trees, as the White Poplar, Wild Plum, Yellow Locust, and many others that sprout from the roots, will grow if treated about the same way as branch cuttings.

In growing trees from cuttings the source of the cuttings is not of so great importance as the source of the seed from which the stock trees were grown, for the qualities of individual trees are probably not permanently or greatly changed by climate. For instance, trees grown from the cuttings of Russian Poplars would be as hardy in Minnesota if the cuttings came from St. Louis, where they had been growing for years, as they would be if imported direct from Siberia. However, owing to a longer growing season at St. Louis, the wood might be of a more open texture, and perhaps might not resist cold as well as Minnesota-grown wood; but after one season's growth in Minnesota it would probably be as hardy. The same would hold true of plants propagated by any method of division. With the exception of Willows and Poplars, very few of our ornamental trees grow readily from cuttings. The best time to make cuttings is in the fall, as soon as the leaves will strip easily from the twigs. Most of the willows and poplars will grow readily from cuttings made in the spring, and even those made in summer will generally grow if planted in moist soil. For this purpose the smaller branches with leaves removed should be used. They may also be rooted from growing twigs with the leaves left on, provided the cut surfaces are placed in water, as they would be if stuck in the soil of a swamp or treated the same as cuttings of geraniums. These latter ways, however, are not to be depended upon for general propagation purposes.

The Form and Size of Cuttings is a matter upon which there is a great difference of opinion. Cuttings of the Willow from one bud each and only an inch or two long up to those a

foot or more in diameter and ten or twelve feet in length can generally be made to grow, but probably the most convenient size for general planting is one-half inch in diameter and twelve inches in length. They are generally tied in bunches of 100 or 200 each for convenience in handling, and care should

Fig. 7 A bunch of Willow cuttings.

be taken to keep all the butt ends one way to facilitate planting. Very large cuttings are liable to decay in the center, and are not best to use, although they often make a very rapid growth. Poles of willows and poplars are sometimes laid in furrows where they will generally sprout wherever the bark is laid bare and often make good trees.

Fig. 8. Planted cuttings, showing angle and depth at which to plant cuttings.

In Planting Cuttings of ordinary size it is a good plan to have the soil loose, and then, after marking off the rows, the cuttings can be pushed into the land the proper depth. If not

desirable to plow all the land, it may be loosened just where the rows are to come. Where a subsoil plow can be obtained, it can be made very useful for this purpose.

Cuttings should be planted at an angle of about forty-five degrees, leaving only one bud above the surface of the ground and the soil should be packed firmly around them. Those set in a slanting position settle with the soil and remain firm, while those set vertically may become loosened by the settling of the soil near them, leaving too much of them exposed above the surface, unless very great care is exercised in planting. The rows in the nursery should be about four feet apart, and the cuttings about six inches apart in the rows, though a much less distance may sometimes be sufficient. In packing the soil over the cuttings great pains should be taken to get it very solid around the lower end, and if the soil is very dry, the firmest pressure of the full weight of a man over the base of each cutting is not too great; in fact, when the soil is dry it cannot be made too firm over the cutting. When the soil is moist, however, only enough pressure should be used to bring the particles in close contact and close up the air spaces.

The Cultivation of Cuttings should commence shortly after they are planted, and the top soil should be kept loosened to the depth of about three inches, which, while not disturbing the solid soil around the base of the cuttings, prevents evaporation from the soil.

Time of Planting Cuttings. Spring cuttings may be planted at once where they are to grow. Autumn cuttings may be planted out at once, provided the land is not wet, but when planted at this season they should be covered with soil turned toward them with a plow. In the spring this covering should be raked off before the buds swell. The ground being warm in autumn often causes autumn-planted cuttings of some kinds to root before cold weather sets in, and if made up before the first of October they may thus score quite a gain over spring-planted cuttings. If not desirable to plant in the autumn, the bundles of cuttings may be kept over winter, buried in moist soil, preferably that which is somewhat sandy, where there is no standing water; but much care should be taken to keep them from drying out. To this end the bundles should be buried so as not to touch each other, and have two or three

inches of soil packed in between them. If they are kept in a cellar, moist sawdust will be found to be good material to keep them in.

The amount of growth made by cuttings varies much, according to the kind of plant, size of cuttings, soil, etc. The most of our willows will make a growth of three or four feet, on good soil, in one season, from ordinary cuttings.

The Solar Pit. There are many trees that will not grow from cuttings unless they have their roots started a little before planting. This is most easily accomplished by means of what is called the "solar pit," which owes its success to the fact that cuttings root first at the warmer end. It is made and used as follows: The bundles of cuttings are heeled in as recommended. In the spring they are taken out, and buried

Fig. 9. The solar pit showing bundles of cuttings in place under glass.

close together, with the butt ends uppermost, in a warm sunny spot, and covered with about six inches of soil. A hotbed frame, with sash, is then put over the spot, to warm the soil. Sometimes, instead of using sash, the soil over the cuttings is covered with a foot or more of fermenting manure. In either case the soil is warmed, and the formation of roots encouraged. In using the solar pit the rooting process should not be carried so far as to permit roots to show plainly, as they are liable to be broken off in planting out; but the cuttings should be planted out as soon as they show signs of healing over on the butt end. This healing over process is called callousing, and in many plants necessarily precedes the formation of roots.

LAYERS.

Layers are portions of the branches of trees, shrubs or vines which are covered with earth without being separated from the parent plant and there take root and grow. These are cut off from the main plant in autumn or spring, and form

new plants. Almost all trees and other plants can be rooted in this way, but, while some root very easily, others require so long a time to do so as to make it impracticable with them.

The growing of trees from layers is seldom practiced in this country, but in some European nurseries it is a common means by which to increase special varieties of trees. For this purpose what is commonly known as mound layering is often used. This consists simply of drawing the soil up around the sprouts that come from the stump of a tree, covering the base of them about a foot in depth. It may be done at any time of the year after the sprouts are two or more feet high, but preferably in the spring. After the sprouts have become well rooted they may be removed in spring or autumn and treated the same as seedlings. Layering is sometimes practiced in European forests to fill up vacancies, and a similar method is often employed in nurseries.

GRAFTAGE.

Graftage refers to the growing of one plant on the stem, root or branch of another plant. There are several forms of graftage, which are generally known as grafting, budding and inarching. It is a common practice to use graftage in the growing of the different varieties of fruit trees, and it is also used to some extent in the growing of some of the varieties of ornamental trees that cannot be grown from seed. Trees that are grown by any form of graftage are seldom as long-lived as those grown on their own roots, and these methods should be avoided when it is practicable to do so. These methods are not much used in common practice, and consequently are not discussed at length here.

Inarching is a rather unusual way of growing plants. It works on the principle that when the growing stems, branches and roots of the same or closely allied plants are held closely together for some time they become united. Such unions of roots are frequently found in woodlands; in some cases the roots of the same trees, and in others the roots of different trees, become grown together. Occasionally also trees are found grown together by their branches or stems. Inarching is sometimes used for growing the Cutleaf Birch, in which case the sprouts from a stump of a Cutleaf Birch, or the twigs

from a small tree laid on the ground, are tied to small Birch seedlings, which have been grown in pots and plunged to their rims in the ground near the tree. In doing this the bark is removed for about two inches at the point of contact of the twig and seedling, which are then tied firmly together. It should be done by the middle of June, but will often be successful if done even a month later. They should be kept together until the leaves fall, and then the branches from the parent tree should be cut away, leaving the seedlings with the twigs grown fast to them. These should be carefully heeled-in over winter, and in the spring the seedlings should be cut off just above the union, so as to throw all their strength into the adopted twig of the Cutleaf Birch. This method may also be used to replace lost branches on trees or vines.

CHAPTER IV.

NURSERY PRACTICE.

Nursery. This term is applied to a plot of land used for raising plants that are intended for planting elsewhere for their final growth.

Soil and Cultivation. The best soil for a general nursery is a deep, rich, reasonably level, retentive upland. It is customary to grow most of the nursery crops in rows, so that they may be readily cultivated. The land should be plowed deeply when the crop is planted, and the surface soil kept loose and fine during all the early part of the growing season, or until about the middle of July. If the land that has to be used for a nursery is rather shallow, it should be gradually deepened by plowing from year to year, and, if inclined to dry out, the addition of large quantities of organic matter, together with constant cultivation, will do much to remedy these defects.

The cultivation of a nursery or young forest plantation, provided the latter is planted in rows, should consist in keeping the land stirred to the depth of three inches, thus giving a dust blanket, which will protect from drouth. After the first of August much cultivation is likely to encourage a late autumn growth, which should be avoided; but a moderate quantity of buckwheat or oats may be sown then, and be allowed to grow the remainder of the season, to serve as a winter protection—to hold snows, and prevent the heaving out of the young seedlings by frost.

GRADES OF NURSERY STOCK.

Nursery stock of different kinds has come to be known by such convenient names as seedlings, transplants, street trees, forest-pulled seedlings, etc.

Seedlings are young plants, grown from seed, that have never been transplanted, and are generally designated by their size or age. They form the cheapest class of nursery stock, and are used largely for starting windbreaks.

Transplants are seedlings that have been at least once transplanted, and are designated by the size and number of times they have been moved. They are higher in price than seedlings, but with some kinds of trees they are much more likely to grow, and may be well worth the extra price. Evergreens, especially pines, will seldom do well unless transplanted before being set in a permanent place.

Street Trees include the trees of large size which are used for street, shade and ornamental purposes. To be of the best quality they should have been transplanted two or more times and have received some attention in the way of pruning so as to give them a good form. Such trees vary much in quality and price, but the best are necessarily rather expensive.

Forest-pulled Deciduous Trees of small size can often be obtained at a very low price, and may be as desirable as those that are nursery grown.

Forest-pulled Evergreen Seedlings may also be desirable,

Fig. 10. A bunch of Green Ash Seedlings.

but too often they have poor roots, or have been so injured by poor handling that they are generally worthless.

Forest-pulled Shade Trees sometimes grow very well, but they are always inferior to good nursery-grown trees. They are greatly improved by having their roots shortened two years before they are to be removed, and when so treated grow very well.

TRANSPLANTING.

Transplanting is Simply the Removal of the Plant. It may be to some permanent place, as a park, lawn, or street, or it may be done for the purpose of improving the root system, and to give the tree more room to grow. By shortening the long roots the root system is made more compact and better able to withstand subsequent removal. This may be done by transplanting, or by cutting around the tree with a spade

or tree digger. It is especially desirable to do this to trees that are not easily moved on account of their long branching roots, such as the Birch, or to those that have tap roots, like the Oak and Walnut. It is on account of their having had their roots shortened so they can all be moved with the tree that nursery-grown trees are generally superior to others.

In Transplanting it is Important to take up a sufficient amount of roots to support the plant, and as a rule the more roots the better the conditions for growth. Very long roots should be shortened unless the tree is removed to a permanent place, in which case all the good roots should be left on the tree. All bruised or broken roots should be cut off in either case, and the top of the tree shortened to correspond. In transplanting trees they should be set one or two inches lower than they formerly stood, and the roots should be spread out

Fig. 11. Extra good roots on a forest-grown Elm, used as a street tree.

in the holes without crowding. It is customary to plant many kinds of small trees in furrows made with a plow.

Very Large Trees (those over six inches in diameter) are sometimes successfully planted in winter, by taking them up with a ball of earth. This is done by digging a trench around the tree, late in the autumn, deep enough to cut most of the roots, but far enough away from the tree to leave a large ball of earth. The trench is then filled in with a mulch of some kind, and when the ground is frozen the tree is moved, with the ball of earth attached, to the hole which has been previously prepared and kept free from frost.

After Trees Have Been Moved, or had their roots short-

ened in some other way, they should generally not be transplanted again for at least one or two years, during which time they will have overcome the injuries done to their root system. The time which should thus elapse will vary with the kind of tree, and also with the amount of injury done. Where the injury is severe a much longer time will be required for recovery than where it is slight.

Time to Transplant. Planting of trees should always be done when they are dormant, or just as they start into growth in the spring, which is generally from the middle to last of April. If for any reason it is desirable to risk the moving of trees late in the spring, after the leaves have started, they should be cut back severely, all the leaves removed, and great pains be taken to secure all the roots and to prevent their drying out. Very hardy deciduous trees, as the Elm, Cottonwood, Boxelder and Ash, can often be successfully moved in the fall, if the ground is moist at the time of removal, but great care must be taken to work the soil in very compactly between the roots, so that there will be no large air spaces among them. If the trees are large, it is a good plan to stake them, so they cannot be blown about by the wind. The more tender trees should not be transplanted in this section in autumn, and even the hardiest kinds should never be moved at this season unless the soil is moist.

Transplanting Evergreens. When seedling evergreens are two years old they should be transplanted, and this should be done about once in three years afterwards, until they are moved to their permanent places. As evergreens are very sensitive to being moved, this requires more care than with most deciduous trees. The most important point is to not allow the roots to have even the appearance of being dry. They may be transplanted in the spring, as soon as the ground works easily and the roots have white tips, and they may be safely transplanted even up to the time that the new growth shows about an inch, but at this late time more care must be taken in doing the work than when it is done earlier. Evergreens can sometimes be moved successfully in August, or even in the autumn, if they are to be carried only a short distance and the conditions of the weather and land are favorable; but this is not a time for general planting, and it is seldom advisable to do it at this season.

The Very General Error is Current that June is the best time to plant out evergreens. They may be transplanted at this season successfully if the conditions are just right in every particular, but they are much more liable to failure than when the work is done earlier in the season. At whatever time of the year evergreens are to be moved, the work should be done in such a manner as to protect the roots from having even the appearance of being dry, for if dried ever so little the probabilities of their living are much lessened. The kind of treatment that would be considered all right for apple trees might be fatal to evergreens, as they are much more susceptible to injury from drying.

In addition to the above precautions to be taken when moving evergreens, it is desirable to shorten back the limbs about one-third, to compensate for the loss of roots. Of course this shortening should not be done in such a way as to disfigure the tree, but, when the roots are in any way severely mutilated, the whole top makes more of a draft on them for moisture than the roots can supply. This pruning is not so necessary in the case of young seedling evergreens or nursery-grown trees that have been recently transplanted, for when they are moved their root systems are not seriously injured.

Very Small Evergreens and Other Small Plants are often set in trenches made with a spade, as shown in figure 12. For this method the soil must be loose, and yet sufficiently compact so that it can be cut with a spade and not crumble before the plants can be set out. The beds are made about six feet wide, and a board of this length and six inches wide should be used. The soil is thrown out with a spade (A) to the depth of about six inches, but no wider than necessary to just take in the roots. The plants are then placed in position by hand, and a little soil pushed against them to hold them in place. (B) The trench is then half filled and the soil firmly compacted by the feet. The remainder of the soil is then put in and leveled off, the board is changed to the other side of the row first planted and the planting is continued in the same way. (C and D) Such close planting as this is only desirable when it is intended to give special care to the plants, as by shading or watering. Plants should not remain more than two or three years in so close a bed before they are transplanted. When it is desirable

to set out small seedlings in rows, instead of beds, a tight line may be used in place of the board.

Heeling in. This term is applied to the temporary covering of the roots of trees with earth to keep them from drying out after they are dug or are received from the nursery and until they are planted. If they are to be kept for only a few days, comparatively little care is needed in covering; but if they are to be kept for several weeks, or over winter, especially if the weather is dry, great care must be taken to work the fine soil in among the roots and to pack it solid. A good way of doing this is as follows: Select a dry, mellow piece of ground, and dig a trench just large enough to take in the roots of the trees when laid close together in a single row. Place the trees

Fig. 12. Successive steps in planting young evergreen or other very small seedlings. (a) Board in place and trench partly opened. (b) Seedlings in place and partly covered. (c) New trench partly opened. (d) New trench with seedlings in place.

or seedlings in this trench, in an upright position, a few at a time, and cover the roots firmly and deeply with soil taken from close in front of the first trench, thus making a trench for the next row. In this section, if Maples, Cherries and other trees not of the greatest hardiness are to remain heeled in all winter, it is a good plan to bend the tops down and cover with earth. This is only necessary for winter protection. The neglect to properly heel in nursery stock, as soon as it is received is undoubtedly a frequent cause of failure.

When nursery stock consisting of common tree seedlings, other than evergreen seedlings, are to be planted out in a few days, they may be unpacked and piled up in a moist cellar or even in a tight shed, provided they are moistened a lit-

tle from time to time as reseeded. Temporarily, too, they could be safely left in the bundles and be covered with moist hay or straw to keep out the wind, but this can most safely be done under cover somewhere.

Trees and cuttings will sometimes get so dry in shipment that the bark shrivels. In such cases the best treatment is to bury them entirely for a few days, which will often enable them to recover. Soaking in water will answer the same purpose, but unless very carefully done is likely to injure the wood.

The Packing of Nursery Stock is a matter that calls for much experience to adapt it to the various kinds of nursery stock shipped and to the method of transportation.

Practically all the nursery stock that is used in forest plant-

Fig. 13. Heeling-in. Various stages of the operation: row of trees with roots covered; row bent down and the tops covered.

ing in this country is best shipped when dormant. It will generally be found that the box is the safest package to use in the handling of it but sometimes it may be convenient to ship in bales. Small packages may be sent in bundles or in boxes by mail, and for this purpose, they can best be packed in clean sphagnum moss wrapped with oil paper and afterward with brown paper. Packages that are to go by express do not require as careful packing as those that are to go by freight, as they are not liable to be neglected. In shipping by freight, it is important to pack with exceeding care so that the goods will be safe even if considerably delayed.

Puddling. All dormant nursery stock should have the roots "puddled" before being shipped. This operation consists in dipping the roots of the trees into a thin clay mud. A convenient way to do this is to dig a small deep hole in which the mud is prepared. Such treatment is quite a protection to the roots against drouth.

The Best Material in which to pack nursery stock is probably moist (not wet) sphagnum moss, but as this is often expensive and out of the question in many localities, peat, excelsior or wet chaff will be found to be good substitutes. Of late years, excelsior has been growing in favor with our best nurserymen as packing material. The material used for this purpose is the fine shavings such as is generally wasted at shingle mills. Before using, it should be thoroughly water soaked. It has the advantage of not heating and yet retaining moisture for a long time if covered up.

Nursery Stock in Transit is liable to several injuries. One of the most common is for it to become too dry and in this way lose its vitality. Yet it often happens in shipping nursery stock that is to be several weeks in transit that it is best to pack it so dry that the plants will perhaps shrivel a little, because if packed moist, they will often decay. When moss is to be used for packages that are liable to be a month or more on the way, it should be thoroughly dried so that there will be little moisture apparent in handling it. In such cases the boxes should be thoroughly lined with paper before they are packed. Paper lining for boxes is also very desirable when nursery stock is to be shipped during excessively cold weather as it aids greatly in keeping out frost.

In shipping nursery stock in warm weather, it is often desirable in the case of evergreens to pack the roots in moist moss and leave the tops exposed, shipping the box without any cover, or if covered at all, using only burlap or similar material. In packing such a box, it is a good plan to remove one end and pack in alternate layers of packing material and plants and when the box is full, nail on the end. In this way, the plants can be put in very solid.

It is Customary to Have Seedlings tied in bunches of about 100 each when they are shipped, and whenever small stock is shipped with large stock, it should be in a separate bundle. It is seldom necessary or desirable to put packing

material about the tops but it should be confined to the roots and the center of the bundles and the tops should be left somewhat free so they will not heat. In packing nursery stock in this way it may sometimes be desirable to carefully nail cleats across the box after the stock has been put in to hold it in place and prevent its shifting about in transit. Sometimes it may be desirable to ventilate the cases in which they are packed.

In Packing a Bundle, great care should be taken that after the plants are tied together the packing material is well worked in between and around the roots so as to exclude a free circulation of air about them. After this has been done, and the package well tied together, it should be covered about the roots with more packing material and wrapped with burlap and well sewed on. The tops should be protected with burlap, straw or grass.

Some Important Things to Remember in handling nursery stock:

1—If the roots of trees are frozen out of the ground and thawed again in contact with the air, they will probably die.

2—If the frozen roots of hardy plants are well buried in the ground before thawing at all, they will be uninjured.

3—Deciduous trees that are received in a shrivelled condition may often be revived by burying them, tops and all, in earth for a few days.

4—Manure should never be placed in contact with the roots of trees when they are set, but good black soil should be preferably used for this purpose.

5—If trees are watered, it is important to keep the soil around them cultivated or covered with a good mulch, otherwise the surface will bake hard and will lose moisture very fast.

6—Small thrifty trees are very much to be preferred for transplanting purposes to those that are large, as the latter are liable to be checked in their growth by being moved.

7—The roots of coniferous Evergreens should not be allowed to have even the appearance of dryness, as a very little drying will prevent their growing.

8—Spring is the best time to move all kinds of nursery stock and as a rule plants do best when transplanted before the buds start.

9—Autumn is a good time for transplanting our hardiest deciduous trees, providing that the soil conditions are favorable, but it is not a good time to move coniferous Evergreens.

10—Coniferous Evergreens may be safely moved about the first of August after they have ripened up the first growth of the season, if moved carefully with a ball of earth, but when handled at this time they require much careful attention.

PRUNING.

Pruning should be avoided as much as possible, and yet be done sufficiently to secure the effect desired. If it is begun early in the life of a tree no large branches need ever be removed, the most desirable pruning being the directing of the growth by pinching off the buds that would develop into undesirable branches; but this is impracticable on a large scale, and for this reason, in ordinary practice, it is often necessary to do more extensive pruning.

The Purpose in Pruning Trees is to give them forms that are desirable for the purpose intended. For example, a tree for the lawn or windbreak may be most desirable when covered with branches even down to the ground, while street trees should have a trunk free from branches for eight or ten feet from the ground. Many of the evergreens, and some other trees used for ornament, naturally take on so regular and desirable a form that it is not necessary to prune them, except perhaps to pinch or cut off an extra leading shoot that is likely to make a forked top, while the White Elm, Soft Maple, and others need occasional pruning to remove or shorten awkward branches, at least while the tree is young and growing rapidly.

The Proper Time for Pruning is determined by the effect of the operation upon the health of the tree. Dead branches may be safely removed at any season. The removal of live branches during the growing season lessens the leaf surface, and hence checks growth. Pruning when the tree is dormant results in a more vigorous growth in the remaining branches. Wounds made by pruning just as trees are starting into growth do not heal over as readily as those made earlier in the spring, or during the period of active growth in June.

Wounds made in autumn or early winter generally heal over well, but are more likely to cause bad injuries than if made at the close of the winter. These considerations and practical experience have brought about the following conclusions as to the best time for pruning:

Large Branches are Most Safely Removed during the latter part of winter, before growth starts. Small branches may be safely removed at this time, or during the growing season, preferably about the middle of June; but such very hardy trees as the Elm, Ash, Boxelder, White Willow and Cottonwood may be safely pruned at any time in autumn, winter or spring, while the Mountain Ash, Apple, Plum and Wild Cherry are liable to injury if pruned at any but the most favorable seasons.

Fig. 14. Showing the proper place to make the cut in pruning. A wound made on the dotted line A-B will be promptly healed. One made on the line C-D or E-F will not. In figure 14 the lower branch was cut off too far from the trunk. (After Goff.)

Among the Directions to be Followed in Good Pruning are the following:

(1) Do not cut off a single branch unless you have a good idea of what you wish to accomplish and the probable effect of so doing on the tree; better not prune at all than to do it without considering the consequences.

(2) Avoid doing very much pruning at one time, especially on small street trees, which, if they have all their branches removed from the trunks to their final height, are likely to make too much growth at the top for the trunk to support well in high winds. A better way is to remove a part of the lower branches and shorten back in summer those that are to be removed later; by such treatment a large part of the strength of the

tree goes into the top without increasing the size of the lower branches, which may be removed in a year or two without injury to the tree.

(3) After pruning paint the wounds with good white lead paint, to keep the wood from decaying and the injuries from thus becoming permanent. This is not so necessary on very hardy trees as on those that are somewhat tender.

(4) Where branches rub together it is generally best to remove one of them.

(5) Where bad crotches are being formed by the development of two leaders, severely check the growth of one of them by shortening it, thus throwing more sap into the other and making it the leading shoot.

(6) Prevent the formation of long side branches by shortening those that are liable to become too long. This is espe-

Fig. 15. Showing how to make the cut in pruning large branches. The upper cut, all made from above, permits the branch to split down. The left cut, first made partly from below, prevents splitting down. After Goff.)

cially desirable with the Soft Maple, which has a tendency to form long branches that are likely to break off unless occasionally pruned.

(7) Where trees have lost their leaders, prune so as to develop one of the side branches into a leading shoot. This the tree always attempts to do itself, but a little judicious pruning will greatly aid it.

(8) Every species of tree and shrub has its own natural form, and in pruning do not try to make all of them of one shape. Study the natural form of each kind of tree, and encourage the development of this form.

(9) When trees are full of frost the wood cracks very easily; therefore do not prune in very cold weather, for bad wounds may then be easily formed.

Treatment of Crooked Trees. It is common to have some trees in the nursery that are of vigorous, healthy growth, but so crooked as to be nearly worthless. The proper treatment for most of our shade trees when in this condition in the nursery, if anything is to be made of them, is to cut them off at the surface of the ground, early in the spring, and then select one of the good, strong sprouts that come from the roots of each tree, train it into a straight stem, and cut away the others. Treated in this way well-formed trees may soon be grown. Such treatment may also be desirable with small street trees that have their stems hopelessly injured. However, trees that to the novice may seem hopelessly crooked may only have crooks in them that will be outgrown in a few years.

STREET TREES.

Success with Street Trees is perhaps more dependent on good soil about the roots than on any other one factor. If the land is so very sandy or gravelly as to be subject to drouth, at least two cubic yards (two full two-horse loads) should be taken from where each tree is to be planted and the same amount of good clay or loam substituted for it. If in subsequent years the trees outgrow the limits of the material supplied, more of it should be added, and if this consists largely of stable manure, so much the better, provided it does not come into contact with the roots of the trees. It is important to do this work thoroughly, for one tree well planted is better than a dozen poorly set out.

Kinds of Trees. The best trees for street planting in this section are the White Elm, Hackberry, Green Ash, Basswood, Boxelder and Soft Maple. All of these trees do well in good soil, and with the exception of the Soft Maple they all do well in rather inferior land. Evergreens may sometimes be used to advantage along narrow drives, but they are seldom desirable as street trees. The trees planted should be about two to four inches in diameter near the ground, eight or ten feet high, and of thrifty growth. Much larger trees are sometimes set out, but it is not advisable, as a rule, to plant those that are

over four inches in diameter. Smaller trees are often planted and do well, if properly cared for, but need more attention in directing their growth than those that are larger. But small, thrifty trees are much better for street planting than large stunted trees. In all cases it is more important to have plenty of good roots than a large top, as a top can soon be developed if the roots are good.

Distance Apart. The distance between trees depends on the kind planted and the quality of the land. On rich land in

Fig. 16. Soft Maple not pruned since it was planted out. Liable to break in its crotches at any time. A bad form.

Fig. 17. Soft Maple once pruned showing close head that is not liable to break down. A good form.

Fig. 18. Soft Maple several times pruned preserving a main central axis. A good form.

this section the trees named should be put forty feet apart, in fairly good soil about thirty feet, and in poor soil twenty feet apart. This gives sufficient room for good development, but where a quick effect is wanted it is a good plan to set the trees much thicker than this, and use Cottonwood, Willow or similar fast-growing trees to alternate with one of the kinds named as desirable, with the expectation of cutting out the less valuable when it shall have commenced to crowd the more desirable kinds.

Planting. Provided the soil is in the proper condition, the next consideration is the proper planting of the tree. The preparation for this should consist in digging a hole of sufficient size to take in the roots without crowding. If the sub-soil is very solid clay, it should be thoroughly loosened up,

and where practicable it is a good plan to dig a trench to the loose soil over a water pipe or sewer, for by this means the roots get into loose soil, and drainage is secure, which is often much needed on such land. Sometimes a very stiff hardpan can be broken up to advantage by exploding a small dynamite cartridge in a deep hole made with a crowbar.

Before Setting the tree, it should have all broken and dead roots cut off. It should then be set an inch or two deeper than it had been growing, the discoloration above the roots indicating the depth at which it had stood. If, however, good drainage cannot be secured, the tree can be planted less deep-

Fig. 19. Elm street tree properly trimmed for planting out.

ly, and then have a mound made around it. Fill in about the roots slowly, being careful (should the tree have a great number of fibrous roots) to work the earth well in among them and under the butt of the tree. Fine soil, free from large stones, should be used for this purpose. Pack the soil in firmly, if reasonably dry, with the heels, or, better still, with a rammer, making it as solid as possible around the roots. The object

in doing this is to leave no air spaces about them. It is not a good plan to put water into the hole before the tree is set, but it may be put in when the roots are just covered and allowed to soak away before the remaining soil is put in. As a rule, however, little is gained by watering if the trees have not leafed out and the moist soil is packed firmly around the roots. Water is most needed after growth starts.

Mulching. Newly planted street trees are much helped by a mulch of straw, hay or well-rotted manure. The latter is best, as it also furnishes plant food, but hot manure is liable

Fig. 20. Elm-tree that has been planted five years and was pruned to a bare pole when set out.

to injure the trunk if piled against it. These materials prevent the soil from drying out, and this is especially beneficial if the trees are artificially watered.

Watering should be done thoroughly or not at all. One good watering should keep the ground moist for two or three weeks, in the driest weather we have, if the land is heavily mulched when the water is applied. For a good watering in a dry time about one barrel of water should be given to each street or lawn tree. A hollow should be made around the tree

and covered with mulch before the water is applied. This same amount of water might be applied at the rate of one or two pailfuls a day, and not be of the least benefit to the tree, if applied to the bare surface of the ground.

The Pruning of Street Trees at the time they are set out is an important matter. If the trees are very tall and slender, it is a good plan to cut them off at about ten feet from the ground, and trim off all side branches, as shown in figure 19. For trees that have been pulled from the woods this is generally the best treatment, while for nursery-grown trees that have had plenty of room to develop a good top it may sometimes be best to trim so as to leave part of the top. If the trees are trimmed to bare poles before planting, some little pruning will be required each season for a number of years to develop good tops, while if they had well formed tops in the nursery and were shortened back at planting time much less attention will be necessary.

In a row of Elms or other trees there will often be found peculiar individual shapes. Some of the trees will take on desirable forms, while others will be spreading and awkward, and perhaps have a tendency to crack in the branches. In some cases a little extra pruning will bring such unfortunates into shape, but often they are incorrigible, and are best replaced by other trees with better forms.

Protection should always be given street trees as soon as they are set out, and this should consist of something that will protect them from sun-scald, gnawing of horses and whittling by thoughtless boys. A good temporary cover is afforded by wrapping the trunk with gunny sacking or similar material, but a more desirable protection is afforded by a slatted wooden frame or box for each tree,

CHAPTER V.

TREE PROTECTION —INJURIES TO TREES.

The causes of injury to tree growth are many and various, some affecting principally the cultivated trees in windbreaks and shelterbelts, and others affecting the forest plantations and large areas of timber. Some injure or destroy the trees or tree seeds, and others do damage to the land on which they grow.

Saw-Flies and Tent-Caterpillars. At present perhaps the most serious injuries to cultivated trees in this section result

Fig. 21. White Willow windbreak seriously injured by successive attacks of saw-fly larvae. A common source of injury to willows.

from the neglect to take precautions against leaf-eating insects, such as saw-flies and tent-caterpillars. These injuries may be largely prevented by the use of Paris Green, in a liquid form, applied by means of a force pump, using the solutions from a

barrel carried in a wagon or on a stone boat. An ordinary spraying nozzle should be used, with a sufficient length of hose to reach up into the tree. In order to reach the tops of the trees it may be necessary to have a raised platform on the wagon and to attach the nozzle to the end of a long bamboo pole. In most prairie groves this is practicable, but with very high trees it is very difficult if not entirely impracticable.

Borers and Lice. These sometimes cause serious injury, but it is seldom practicable to combat them successfully. It is generally better to avoid them by planting the kinds that are least subject to injury from their attacks. Where lice are injurious, kerosene emulsion or strong tobacco water are good remedies. In the case of small trees that can be easily enclosed in a tent, the best remedy is tobacco smoke.

Mice and Rabbits. Seedlings and small trees of some kinds are liable to injury from rodents, such as mice and rabbits, which gnaw the bark near the surface of the ground, and perhaps girdle the tree. They are most likely to do this when the ground is covered with snow, for this furnishes them with a protection under which they can do their mischief without fear of being molested. In the case of small seedlings such injuries may be largely prevented by plowing a furrow or setting boards on edge around the seed bed. If, after each snowfall, the snow is trodden down so as to make a solid path between the seedlings and the grass or woodland whence the mice come, they will be kept out, as they will not try to work through the solid snow. Seedlings that are badly girdled in winter should be cut off at the surface of the ground, to encourage sprouts from the roots. To prevent the gnawing of larger trees, paint the trunk with a cement or lime wash made rather thick and containing Paris Green in the proportion of one tablespoonful of Paris Green to a pailful of the wash. If skim milk is used in mixing the wash, instead of water, the material sticks better. Trees that are gnawed badly may often be saved by coating the injured surface with grafting wax, blue clay, or other similar material, soon after the damage is done, so as to prevent the seasoning of the wood, and thus give it a chance to heal over. Where the injury is close to the ground it should be covered with earth.

The Pocket Gopher. Trees are sometimes injured by pocket gophers eating the roots. Trapping or poisoning may

be resorted to, or bisulphide of carbon may be used to suffocate them in their burrows.

Birds. Most of our birds are helpful in various ways, such as distributing seeds and in destroying injurious insects, and such small injurious animals as mice and gophers. They also add to the beauty of our woods and fields, and to our pleasure and recreation. But some kinds are provokingly injurious by eating the seeds we wish to gather, or by digging up newly-sown seeds. Where they are troublesome on seed beds, they may be kept away by covering the bed with wire netting, which will also serve to keep away other animals. If only birds are troublesome, mosquito netting may be used, or the seeds may be given a light coating of red lead and dried in land plaster or flour before sowing.

The sap-sucker does considerable injury to some trees by making holes in the bark for the purpose of securing insects which go there to feed on the sap. They are sometimes so very injurious that it is necessary to destroy them. The Apple, Boxelder, Maple, and most other trees, are subject to their injuries.

Cattle. The pasturing of cows, horses, sheep and other animals in the woodlands is generally a poor practice, as these animals browse off many of the young seedlings, especially those of deciduous trees, such as the Oak, Basswood, Cherry and others, though they seldom eat coniferous trees. They also compact the ground, and destroy many small seedlings by their continued tramping, especially when present in large numbers. This is especially true of sheep on the Western forest reserves. Deer, moose, elk and other similar animals are likewise injurious in forests and when abundant may do much damage, though on account of their comparatively small number they do but slight injury.

Severe Winters. These may injure many kinds of young seedlings, which when two or three years old will be perfectly hardy. Seedlings of such kinds should be dug at the end of the first season's growth, and be heeled in over winter, or protected by a mulch or earth covering in winter.

Alternate Freezing and Thawing. Seedlings are often thrown out of the ground by alternate freezing and thawing, and in this way have their roots broken. This is most likely to happen where the ground is bare; if covered with leaves or

grass, or shaded in other ways, this seldom happens. The best preventive is to mulch the surface soil with leaves or other similar material, but as mice generally like to live in such places poison should be used. It should be placed under the mulch, in tin cans laid on their sides, so they may be readily found in spring and will not be liable to poison the birds. When seedlings are thrown out of the ground by frost they should be pushed back and have the earth pressed against them as soon as the ground is thawed in the spring.

Fig. 22. Heaving out by Frost. (a) Tree in natural position. (b) Drawn up by alternate freezing and thawing.

Late Spring Frosts are common in the low lands of this section. They injure the trees by killing the new spring growth after it has started several inches. A large number of trees are seriously injured in this way, and are classed as **frost tender trees**, and those that are not liable to this injury

are termed **frost hardy trees**. Among conifers the spruces and balsams are much injured by late spring frosts, while our pines and the Tamarack, Red Cedar and Arborvitae are seldom if ever injured in this way. Deciduous trees recover from such injuries more quickly than evergreens. Among the deciduous trees most liable to injury from this cause are the Ash, Mulberry, Oak, Maple, Basswood, Black Walnut, Butternut and Boxelder, though they do not all suffer in the same degree. Among those that are not sensitive to late frosts are the Elm, Willow, Poplar, Birch, Hackberry, Wild Black Cherry and Mountain Ash.

On account of this liability to injury from late frosts, it is customary to study the probability of damage from this cause in given locations, and to plant accordingly. It will often be found that in certain low spots there is greater liability to late frosts, while there is very little injury from this cause on the higher lands. It is customary among European foresters to protect young seedlings of some kinds, particularly Beech, from late frosts until they get up off the ground. For this purpose Birch twenty or more feet high are encouraged at intervals of thirty or forty feet, and the frost tender plants, such as Beech and Spruce, are set out between. The result of this arrangement is that the Birch, which is frost hardy, quite successfully protects the frost tender trees below it. After the frost tender trees are well off the ground, as ten or fifteen feet high, there is comparatively little danger from this source of injury, and the Birch is removed.

Sleet Storms occasionally do much damage by breaking the limbs. Little can be done to relieve the trees, but preventive measures may be taken. If no large crotches are allowed to form in trees, and growth kept as near as possible to one central shaft, or the longer branches shortened so that they will not exert too great a leverage, the losses may be reduced to a minimum. Trees having brittle wood or weak crotches, as the Soft Maple, are much more liable to this injury than those with tough wood, as the willows, oaks and elms, and need more pruning on this account. Evergreens are likely to be broken by heavy snows that freeze on the leaves. This may be prevented on lawn and shade trees by shaking the snow off from them before it freezes.

Frost Cracks are a rather infrequent injury caused by the

cracking of trees from center to outside, due to uneven contraction in very cold weather. It is generally accompanied by a loud report. Such cracks are often eight or ten feet long, and occasionally longer. They generally close up again when the wood thaws out, and during the following summer grow over, only to burst open again the next winter. This alternate bursting open and growing over may continue for many years, until very conspicuous and peculiar wounds are formed. In

Fig. 23. Trees heavily loaded with ice after a sleet storm.

such cracks insects and rot-producing fungi find favorable lodging places, and as a result trees are seriously injured, and are liable to decay in the trunk. There are no practical remedies for such injuries.

Wind. Injuries from wind are common where thinning is done to a great extent at one time about shallow rooted trees, such as Spruce growing on moist soil. These injuries can be avoided only by thinning gradually. In many such cases, on

timber lands, thinning is impracticable, and it is then best to cut all the merchantable timber, for if left it is sure to be blown down.

On our prairies, where the soil is light and easily moved by the wind, it is not uncommon to have young seedling trees seriously injured by the blowing away of the soil around the

Fig. 24. Old frost cracks in Sugar Maple.

roots, which often leaves them uncovered for three or more inches. This injury usually takes place in the spring, and may be almost entirely prevented by seeding the land to oats about the middle of July, at the time of the last cultivation.

Sown at this season the oats form a good sod that serves to hold the soil in place until spring, when it is easily broken up by cultivation, but even then the roots prevent the blowing away of the soil. Occasional strips of grass are also a preventive of this injury, or mulching may be resorted to.

Snow Crust. The settling of a snow crust that has formed on the top of deep snow drifts may cause injury to young trees by stripping off their branches and breaking the stems. It

Fig. 25. Trunk of Soft Maple badly sun-scalded.

Fig. 26. Section of Trunk of Sun-scalded Basswood, showing dead bark and amount of wood decayed. The top and roots of the tree from which this section was cut were perfectly healthy at the time when the trunk broke off at the sun-scald.

may be prevented by breaking up the crust or by thinly scattering over the snow some sand, ashes or other material that will absorb the sun's heat and cause the crust to melt before the snow underneath melts. This injury seldom occurs except under drifts, and a little good judgment in selecting the loca-

tion and arranging the windbreak so as to prevent drifts may obviate this source of injury.

Drouth. Injuries from drouth may be prevented to a great extent by constant cultivation, but where this cannot be done mulching is a good substitute. Attention to thinning at the proper time so as not to get the soil filled with roots will also help to prevent injury from drouth. Willow windbreaks can be grown without any cultivation, after being once well established, in the driest portion of Minnesota, if they are kept mulched with straw or litter for six feet on each side. Mulching also prevents injury from severe freezing of the roots.

Sun-scald. Nearly all of our cultivated trees may be injured by sun-scald. This occurs, almost without exception, on the southwest side of unprotected trees of Hard and Soft Maple, Basswood, Boxelder, Black Walnut, etc. Oaks and all other trees are occasionally affected. It never occurs when the trees are sufficiently close together to shade their trunks, and for this reason the growth of shrubs and low branching trees should be encouraged on the south and west sides of groves where they do not crowd the principal kinds. Street trees liable to this injury may be protected by burlap sacking, straw or other similar material. When injuries from sun-scald occur, the loose bark should be cut off down to the live growth and the wood coated with paint, to prevent its seasoning, or the wound wrapped in cloth. Trees inclined to the northeast are most liable to sun-scald, because the rays of the sun strike the trunk more nearly perpendicular.

Broken Branches and Decay. Large wounds are sometimes formed by the breaking down of a branch, or by decay, which may have started in a wound made by pruning. In such cases the broken and decayed wood should be cleared away, and the exposed surfaces treated with a very heavy coat of white lead paint, grafting wax, or other material that will keep out water and disease. If the wound is very large, or forms a hole in which water is likely to stand, it should be cleaned and painted as recommended, and then covered with a sheet of zinc, carefully tacked on, and the joints closed with grafting wax to keep out water.

Fungus Diseases are quite common sources of injury to trees of all kinds, including those of our forests. They attack the foliage, trunk and roots. Occasionally very serious losses

occur here from those that cause the trunks to rot. They are generally most numerous in sections where there is not much of a circulation of air. This subject is too large for a detailed account of any of them here, and only one is referred to, which, although not very common, is occasionally quite injurious. This is known as the toadstool root fungus, *Agaricus melleus*. This fungus lives upon the roots of pines, spruces, firs, etc., and occasionally kills them. At one stage of its growth it lives on the decaying wood of oaks and similar trees.

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