

The Agricultural Experiment Station
OF THE
Colorado Agricultural College

The Evergreen Trees of Colorado

BY

B. O. LONGYEAR

The Agricultural Experiment Station

FORT COLLINS, COLORADO

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THE EVERGREEN TREES OF COLORADO

By B. O. LONGYEAR

At no time in the history of our country have matters pertaining to our forests been of such general interest as at the present. Such interest is certainly justified when we consider the fact that between three and four times as much timber is used by us each year as our forests can grow in the same length of time. Many of the materials which a few years ago were expected to become substitutes for wood have failed to meet the requirements in many ways. Moreover the continued use of wood for new purposes more than offsets the saving by these substitutes. Hence there is not only apprehension for the future supply of wood but even now certain great industries are being forced to limit their operations because of the scarcity of timber. This is particularly true of the timber from which paper pulp is manufactured.

In Colorado the principal drains upon the timber resources of the state have been to supply material for mining timbers, telegraph poles, railroad ties, fence posts, bridge timbers and native lumber. The growing scarcity of our timber trees is being emphasized by the rapid advance in price which is now felt in all industries requiring such material.

So long as the forests have been left to the disposition of private interests the forests have suffered greatly. The wasteful and careless methods of lumbering that have usually been employed in this country have frequently been followed by the consuming fire fiend. In these ways the larger part of our forest products have often failed to reach the markets but have served to darken the skies with the smoke of a sacrifice in which the gods have no pleasure. Not only have the trees themselves been destroyed but in many cases the burning away of the humus, the slow accumulation of centuries, has laid bare the very rocks and made reforestation impossible. But this is not all. The rapid and complete removal of the forests has in many places shown how great was their influence upon water movements. Thus with the removal of the forests that once surrounded the headwaters of our great streams, disastrous floods in spring and low water in summer have indicated the regulating effects which these forests once produced. In our own state the forests in the higher altitudes serve to check in spring the rapid melting of snow which has drifted among the trees and thereby lengthen the period of stream flow during the growing season.* The most important effects of the forests in this connection, however, are due to the character of the forest floor, which is

* For some of the effects see Bulletin 55, Colo. Exp. Sta.

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composed of the decayed, castoff parts of the trees themselves. This layer of humus material possesses the ability to absorb water like a sponge and in this way check the rapid surface flow of water such as takes place on bare soil. Thus the water from melting snows and from heavy rains is held back to appear later from springs instead of rushing into the streams and giving rise to floods and high water.

NATIONAL FOREST RESERVES.

The extent of the forest reserves in this country indicates the importance which the government places upon the conservation of the forests. The first national forest reservation was established in 1891. On April 1, 1907, the total extent of the forest reserves in the United States comprised one hundred and fifty-three reserves with a grand total of nearly one hundred and forty-eight million acres. California stands at the head of the list with an area of nearly twenty-two million acres, while Colorado comes fifth with eighteen reserves covering nearly sixteen million acres. These vast tracts have not been set aside, however, to become unproductive holdings of the National Government. They are not even closed to the would-be settler on any agricultural lands within their boundaries nor to the prospector and miner in seeking and developing claims. Grazing lands within the forest reserves can still be used as such with the added protection to the industry which the small fee carries with it. Neither is it the primary object of the forest reserve idea to stop the cutting and sale of timber but to regulate it in such a way as to make the forests more productive. In fact, the primary purpose is to prevent wasteful and destructive practices of lumbering, to protect the forests from fire, their most destructive enemy, and to get them in a condition where reforestation may go on and thus make them a perpetual source of timber supply.

The principal forest trees of this state are those commonly known as evergreens. It is the purpose of the present bulletin to help familiarize the people of this state with our native evergreen trees and thereby strengthen the interest in their protection. Brief suggestions and directions are also given for their use in ornamenting the home grounds and in planting for wind-breaks and screens.

THE EVERGREENS.

In popular usage the term evergreen is applied to members of the pine or cone-bearing family of trees. This is due to the fact that most members of this family hold each season's crop of leaves during several years so that at no time are they bare of foliage. Some true cone-bearing trees, however, such as the larches, shed all their leaves each autumn the same as other deciduous trees. On the other hand, some of the broad-leaved trees and shrubs hold

their foliage in a green state over winter or even longer and are therefore true evergreens. This is particularly the case in tropical countries. But as all the cone-bearing trees of this state are evergreens the term as here used is intended to include members of the pine and juniper families only.

The plants of the pine family are chiefly characterized by the fact that their seeds, instead of being contained during all stages of growth in wholly closed seed cases, as in other seed-bearing plants, are at first born naked on the scales of cones. The scales of these cones become dry and more or less woody and hard according to their thickness and form the familiar dry, scaly cones of such trees.

Another character common to the plants of the pine family in this region is found in their needle-shaped leaves. These leaves, on account of the relatively small surface which they expose and the thickness of the epidermis which covers them, are well adapted to endure the drying effects of winter so trying to all kinds of perennial plants.

Most of the cone-bearing trees are possessed of a resinous juice or sap which often exudes from wounds and slowly hardens in the form of drops or masses of pitch. This material, when gathered from certain pines in the southeastern states, constitutes the crude turpentine from which the spirits of turpentine of commerce is obtained, the common resin or rosin being left as a residue. Timber from pine trees in which the wood has become saturated with the pitch of the sap possesses great durability in contact with the soil.

In most species of cone-bearing trees the two sorts of flowers, which are separate, occur on the same trees. The stamen flowers, those which produce the pollen, are crowded in small catkins or cone-like clusters near the ends of the branches. (Plate II, 1.) The pollen, in the form of a yellow powder, is abundantly produced and is carried by the wind to the young pistillate or seed-bearing cones. In the vicinity of extensive spruce and pine forests this pollen powder is often so abundant, during the blossoming period, as to lend the impression that a shower of sulphur has occurred. Soon after the pollen is shed these little cones dry up and fall off, hence are not commonly noticed.

The pistillate or seed-bearing cone consists of an axis upon which are fastened the scales. The scales vary much in shape and texture in different species and furnish some of the principal characters by which the species are distinguished. At the base of each scale of the young cone, and lying attached to its upper surface, is a pair of ovules. During the flowering period the young cones point upward with the scales spread apart. This allows some of

the pollen grains, with which the air may be filled at this period, to slip down to the base of the scales, where they come in contact with the waiting ovules. In a few days the scales close together and the process of fertilization later takes place. This is soon followed by the growth in size of the cones and the development of an embryo within each ovule by which it becomes a seed. (Plate I and II A.)

In some species, e. g., the pines, the scales of the cones remain closed during the whole of the first year and mature their seeds in the second year. In others, such as the spruces, the seeds are matured and dropped at the end of the first season.

In the juniper family, which is closely related to the pine family, these seed-bearing scales become fleshy and united as the cones ripen so that the matured seeds are found imbedded in the pulp of the berry-like fruits.

TRANSPLANTING EVERGREENS.

The root system of the cone-bearing trees is often very extensive, especially in trees that have reached some age, and have grown all their lives undisturbed as in nature. The roots are, moreover, very sensitive to drying and, on account of the resinous character of the sap, when once dry they cannot be revived by soaking. Then, too, an evergreen always has leaves which are continually giving off some moisture, hence at no time can these trees be without moisture at the roots without suffering injury. These facts usually account for the lack of success which so many persons experience in transplanting evergreens. The writer has seen young evergreen trees that had been carelessly dug or even pulled from the soil among the hills, where they had become deeply rooted, and then carried for miles with no protection whatever to the roots. A cottonwood, boxelder or black locust might survive such treatment, but an evergreen should never be expected to grow when handled in this manner.

USE OF FOREST GROWN SEEDLINGS.

The fact that the roots of evergreens are usually slender and that they quickly extend with but little branching to considerable distances, when undisturbed, makes the transplanting of forest grown trees an uncertain matter. This is especially true when trees of some size are being moved by the usual methods. Native forest seedlings are, however, often made use of in forest planting and the same can be done for other uses providing that the small seedlings only are moved. The best time for this work is just as the buds are beginning to swell in spring but before the new growth is out. Somewhat later transplanting can, however, be done with extra care. Such seedlings should not be over ten inches in height

to bear transplanting well, and smaller sizes are better. They should be carefully lifted from the soil with a spade in such a way as to retain as many of the roots as possible. A pail or tub with two or three inches of thin mud or puddle in the bottom should be at hand, into which the roots of the little trees are to be at once placed. If they are to be planted again in a few hours the seedlings may be carried in this condition. But where large numbers are being gathered and where a considerable journey is necessary, the trees may be closely packed, roots down, in boxes, using moist sphagnum moss, fine grass or similar material among the roots. The boxes should be covered, if placed in an open vehicle, for the journey. If the trees are not to be planted out at once they may be heeled in for a few days. This consists of placing the roots in a broad trench with the trees leaning against one side, after which moist soil is shoveled over them until the trees are about half buried. A shady place should be selected for this purpose.

Trees of such small size are usually grown for two or more years in nursery rows or until one to two feet high. In this way they can usually be given much better care than when placed in the wind-break or other permanent quarters. They should be planted in rows about eighteen inches apart and six to eight inches apart in the row for the small sizes.

Transplanting is best accomplished by laying a wide board upon the surface of the soil and then opening a trench along one edge with a spade. The little trees are then planted against the perpendicular side of the trench and moist soil firmly packed about the roots. The trench should be made only a few minutes before planting to avoid drying of the soil, and the trees should be carried in a pail containing a little water. If possible, select a cloudy day for this work and when the soil is moist but not wet. The soil should not be allowed to bake at any time. Careful cultivation must be maintained during the earlier half or two-thirds of the growing season and a winter mulch of coarse manure or straw is desirable.

In transplanting larger trees the same care must be observed as with small ones. It is often possible, in moving them only a short distance, to retain the earth surrounding the roots in a ball. Thorough packing of the soil about the roots should be practiced except where the soil is very sticky or wet.

It is usually desirable to give the nursery partial shade during the first season. This may be accomplished by lath screens supported on stakes about one foot high. Brush laid across wooden bars or wires stretched along the rows may also be used.

NURSERY GROWN STOCK.

This is always to be preferred where only a few trees are

wanted and where one has no time to grow them from seedlings. Nursery grown trees, if properly handled, have been transplanted one or more times. This causes the root system to thicken up, or become condensed in a relatively small space, and thus makes it possible to secure practically all of the roots in a compact mass when dug. Some nurserymen, who make a specialty of growing evergreen stock, furnish trees each with a ball of earth which contains most of the roots and enables one to plant them with confidence. Trees up to eight feet in height may in this way be safely shipped and transplanted, but, of course, they are correspondingly expensive.

Nursery grown seedlings four to ten inches high and one to three years old can be purchased in quantity from the leading nurserymen and are often cheaper than forest grown seedlings if one considers the time and labor required to obtain the latter. Nursery grown stock, whether in seedling or larger sizes, is usually cheaper in the end than forest trees for, not only are the trees more apt to live, but, having been adapted to conditions in the open, they are surer to make a rapid and healthy growth.

THE PROPER TIME TO TRANSPLANT EVERGREENS.

It is generally recommended that evergreens are best transplanted in spring. This is particularly the case in a climate like that which prevails in Colorado. Fall planting is claimed to be satisfactory by some nurserymen and it may prove successful in other climates. But the lack of soil moisture which often prevails here in the winter season, together with the drying winter winds, makes fall planting a very hazardous undertaking. Trees of this class will often bear later transplanting than other kinds. The proper time, however, is when the buds are swelling, as at this time the vital processes of the tree are just commencing. Hence new root growth is taking place which will enable the tree to secure water from the soil and to become established.

PRUNING.

It is seldom necessary to prune carefully dug nursery grown evergreens, when they are transplanted, unless it is desired to change their shape. The same is true of seedling trees, even forest grown.

In transplanting forest grown trees of more than one foot in height it may be desirable to cut back the limbs one-third to reduce the loss of moisture from the leaves.

It is best to preserve the terminal bud, as this gives rise to the leader or main stem. If by any means this bud is destroyed it sometimes occurs that two or three of the next lower whorl of buds will push up equally strong shoots. In this case all but one should

be pinched back or cut off and the remaining one be tied erect to the stub of the leader.

EVERGREENS ON THE LAWN.

Among the evergreen trees of Colorado are to be found some of our most ornamental trees for the home grounds. If rightly placed and properly planted so as to secure a healthy growth they are capable of adding, not merely to the foliage effects of summer, but they also lend a pleasing touch of green to the winter landscape.

They are best situated along the borders of the grounds, where they may form a background for shrubs and flowering plants. Specimen trees should not be freely used, as a rule, except on large grounds. They should be placed at a sufficient distance from other trees so that they can spread out naturally. If planted in sodded ground the sod should be removed and a circle of bare earth four or five feet across, kept well cultivated around each tree for several years. A great many evergreen trees, as well as other kinds, are needlessly lost every year by planting them in sod where they must compete with the grass.

In the pruning of old trees one should hesitate to cut off the limbs close to the trunk if it is expected that new ones will start out as in many of the deciduous trees. The usual manner of pruning evergreens up from the ground for several feet is much to be deplored, especially in the case of specimen trees on the lawn. The beauty of most evergreens in such situations is dependent on their being allowed to develop a natural form with the lower branches extending clear to the ground. This practice of trimming off the lower branches is most often due to planting evergreens where they eventually shut off the light or the view. Thus it is advisable to plan well in advance the position of each tree about the house and to take into account the effects of future growth. If trees of this class are planted on the south side and close to the dwelling there will eventually be an undesirable shading of the house in winter on the side where the sunshine at that season is most available.

Then, too, the planting of evergreens before the front windows is sure in time to give rise to the necessity of trimming the trees up from the bottom, removing them entirely or else leaving them to darken the rooms and obstruct the view. Where privacy and seclusion are sought, however, evergreens are well suited to such purposes. Thus they may be used to screen or hide unsightly places or objects and are splendidly adapted for planting around outbuildings.

EVERGREENS FOR WINDBREAKS.

Evergreens are among the most effective trees for windbreaks. They are especially desirable for giving shelter from cold winds in winter to sheds and barns and yards for stock. They are also desirable to plant around the outside of the deciduous timber plantation to check the sweep of winds which carry away the snow and fallen leaves. Seedling trees which have been twice transplanted and are about one foot high are of a suitable size for this purpose. They should be set far enough apart to allow each tree to spread out without crowding and eventual loss of the lower limbs. Eight or ten feet apart is about as close as such trees as pines and spruces should be planted. If more than one row is used the trees should alternate in the rows and the rows be at least twelve feet apart. Where a low hedge-like effect is desired much closer planting may be done, and the trees cut back when at the proper height.

Thorough cultivation is needed until the trees are well established or as long as there is sufficient room between the rows.

Evergreens can often be established with good results among deciduous trees planted for windbreaks. In fact, many species of evergreens cannot be readily grown during the seedling stages except in partial shade, hence the desirability of shading the young plants in the nursery.

Close shading, however, should not be allowed to continue after the trees have reached a height of four or five feet. Otherwise the trees are apt to lose their lower branches and become spindling, thus greatly reducing their effective windbreak character. If the surrounding trees become too tall and dense they should be thinned out or cut back to give the slower growing evergreens a better chance.

RAISING EVERGREENS FROM SEED.

This is work which is most successfully undertaken by nursery-men or other persons of experience. For those who have time and the necessary patience to wait for several years while the seedlings are growing this is not only a cheap way to secure a large amount of stock, but is also very interesting work. Seeds of most evergreens can usually be purchased from the large seed houses. Where possible, however, it is desirable to save them from native or local growing trees which show the best color, form and hardiness. Seeds of the pines and spruces are best harvested by gathering the cones a little while before they open. When dry, in most cases the scales spread apart and allow the seeds to be readily threshed out. The cones of the lodge pole pine, however, often do not open unless heated to 100 to 150 degrees

Fahrenheit. This may be done on a wire screen placed above a stove, or in an oven.

In the case of junipers and red cedars the berries when ripe should be gathered and soaked for twenty-four hours in strong lye made from wood ashes, and rubbed on a fine sieve to remove the pulp. They should then be stratified by mixing them with moist sand which is to be kept in a box or other receptacle left where freezing will take place. They will not usually grow until the second season.

The seed bed for raising conifers should be on light, porous soil with good underdrainage, but which can be kept from drying out. If only a small number are to be grown good garden soil can be suitably prepared by mixing a considerable proportion of fine sand with the surface two or three inches. If the soil is naturally sandy this would not be necessary.

Beds about four feet wide may be laid off and the seeds sown broadcast or in drills or rows, scattering them about as thickly as with radish or onion seed, for the smaller kinds, and about one inch apart for the larger kinds. The planting is usually done in May, the seeds being covered to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ inches, depending on their size.

If the soil is at all heavy or loamy in character a layer of fine sand should be scattered over the bed to a depth of one-fourth inch. The soil should be moist but not wet when the seeds are sown and the surface must be kept finely pulverized. Where the atmosphere is very dry it is often possible to retain the soil moisture by covering the beds with burlap fastened down with pegs. This will admit the sprinkling of the beds with a watering pot without washing the soil or disturbing the seeds. The burlap covering must be removed as soon as the seedlings begin to break through the soil.

Most evergreens require partial shade during the first two or three years of growth from seed. This is usually accomplished by means of lath screens placed six feet above the beds, the lath being laid about one and one-half inches apart. In place of lath brush may be used laid on a framework of poles supported on posts of the proper height. Although free circulation of air must be given across the evergreen seed bed the seedlings should be protected from strong winds either by lath screens or by brush stuck firmly into the ground around the sides of the bed. Boards ten or twelve inches wide set on edge around the edge of the beds will furnish excellent protection from surface wind-sweep and consequent rapid drying out of the soil.

An excellent plan to follow in raising coniferous seedlings is to inclose the seed beds with twelve-inch boards placed on edge,

making the beds four feet wide and as long as desired. The soil within the bed should be one or two inches higher than that outside the frame. After the soil is carefully leveled and firmed with a piece of board the seeds are sown broadcast and covered to the proper depth by sprinkling fine soil upon them. Lath screens are then laid across the bed and allowed to rest upon the board frame. In this way trouble from strong winds, which might blow down the high screens, is avoided and moisture is readily retained. On cloudy days the screens should be removed, especially while the seedlings are young.

If an open place among trees and in partial shade is available the artificial screen may be omitted. Care should be taken to keep the surface of the soil comparatively dry, for a wet, soggy soil is almost certain to induce "damping off," a disease caused by certain fungi which thrive in poorly drained soils. A thin layer of pure sand spread over the surface of the soil is often used to check or prevent this trouble.

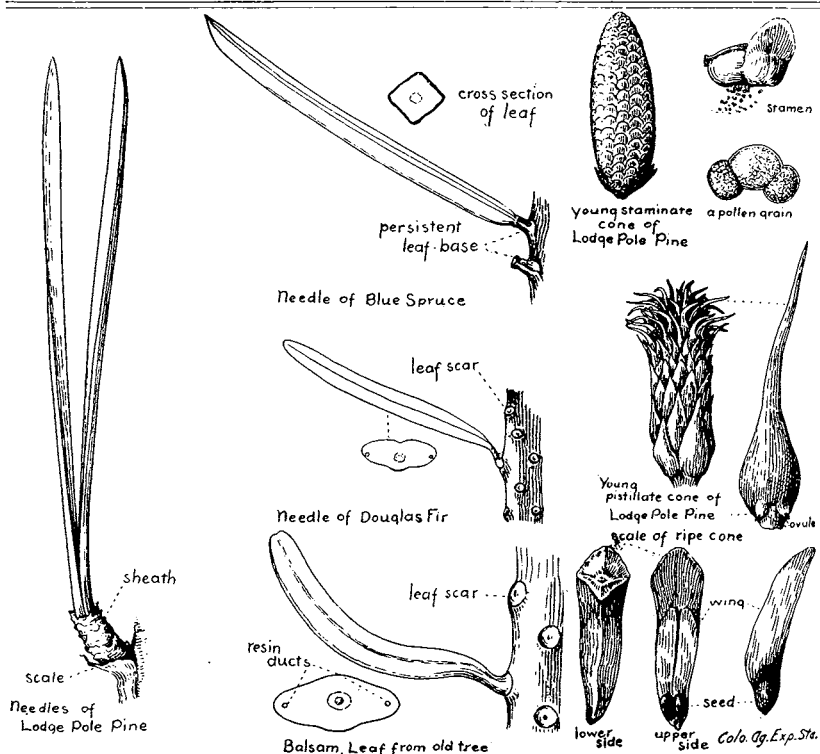


PLATE I.

Drawings showing leaf-characters that distinguish the pines, spruces and firs; also the flowers (young cones) of a pine, all somewhat enlarged.

On the approach of winter the bed of seedlings should be mulched with straw, leaves or evergreen boughs, which will protect the little trees from the injuries of alternate freezing and thawing. In the spring the mulch should be removed a little while before growth begins and careful cultivation with a fine toothed rake be given. At the age of two years the seedlings should be transplanted four to six inches apart in nursery rows as recommended for forest grown seedlings. They will in most cases be too small to transplant to permanent quarters until four years old.

SPECIES OF EVERGREEN TREES IN COLORADO.

The evergreen trees native to this state belong in two families—the pine family and the juniper family. The two families as they occur here may be distinguished by the following characters:

Pine Family.—Foliage leaves needle-shaped; single or in bundles of two to five; fruit a dry, scaly cone; seeds usually furnished with a thin wing.

Juniper Family.—Leaves awl-shaped or scale-shaped, in the latter case entirely covering the twigs; fruit berry-like, juicy or nearly dry; seeds usually without wings.

Of the thirteen evergreens occurring in Colorado which grow to the stature of trees ten belong in the pine family.

Pinaceae—PINE FAMILY.

(Plate I.)

KEY TO THE COLORADO GENERA.

- I. Needles in tufts or bundles of two to five, mostly more than 25 m m. (1 in.) long, surrounded at base by a short sheath; cone scales thick, hard and woody when mature.
 1. *Genus Pinus*.
- II. Needles single, mostly less than 25 m m. (1 in.) long. Cone scales thin, leathery or papery when mature.
 - A. Needles in our species stiff and four angled, each one jointed to a short, hard, brownish base; branchlets rough from the prominent leaf bases which remain long after the upper part has fallen; cones pendulous, with persistent scales.
 2. *Genus Picea*.
 - B. Needles flat, without hard, persistent bases, falling entirely away and leaving rounded scars; branchlets from which the leaves have fallen quite smooth.
 - a. Needles with a narrowed or stalk-like base, scars small, elliptical across the branchlets; cones pendulous, feathered with projecting, three-pointed bracts.
 3. *Genus Pseudotsuga*.
 - b. Needles not narrowed at base, scars quite large, circular in outline; cones erect, dark purple or blackish, the scales falling separately from the axis.
 4. *Genus Abies*.

GENUS *Pinus*—THE PINES.

The pines form the most important group of the cone-bearing trees. As indicated in the key they are most easily recognized by the needles being in bundles of two or more with a short sheath at the base. This sheath, together with the needles which it surrounds at the base, grows from a very short twig which arises just above a small, brownish scale that also represents a form of leaf. The staminate flowers occur in small cone-like clusters crowded around the stems at the base of the new growth of the season. After the blossoming, which occurs quite early in the growing season of the tree, the staminate flower clusters dry up and fall off and thus leave a bare space on the branch which bore them. The pistillate or seed-bearing cones appear near the tips or along the sides of the new growth. At first they are small and are usually overlooked. After the blossoming period they develop rather slowly and do not mature their seeds until the second autumn. The scales of the cone are thick and hard and in some species each is furnished with a sharp curved prickle. Two seeds are borne at the base of each scale. As the seed matures a part of the scale peels off with the seed and forms its wing.

KEY TO THE COLORADO SPECIES OF PINUS.

I. Needles, five in a bundle.

a. Scales of the cone tipped with curved prickles.

1. *Pinus aristata*.

b. Scales of the cone without prickles.

2. *Pinus flexilis*.

II. Needles two to three in a bundle.

A. Needles 8-12.5 c. m. (3-5 in.) long.

3. *Pinus scopulorum*.

B. Needles not over 6 c. m. (2½ in.) long.

a. Needles 3-6 c. m. (1¼-2½ in.) long; seeds small, 4-5 m m. (5/16 in.) long.

4. *Pinus Murrayana*.

b. Needles 2-4 c. m. (¾-1½ in.) long; seeds large, 10-15 m m. (¾-¾ in.) long.

5. *Pinus edulis*,

FOXTAIL PINE, HICKORY PINE.

(*Pinus aristata*, Engelm.)

(Plate II B)

The foxtail pine occurs chiefly in the higher altitudes among the mountains of central and southern Colorado, in Utah, Nevada and southern California and Arizona. It is a small or medium sized tree of bushy habit, seldom reaching a height of 12-15m. The short needles grow in bundles of five closely crowded along



PLATE II.

- A. Flowers or young cones of lodge pole pine.
 1. Staminate flower-clusters.
 2. Pistillate cones on new growth.

- B. Branch and cone of Foxtail pine.

the branchlets in brush-like tufts. The cones are about 8 cm. long and each scale is furnished at the tip with a slender curved bristle. On the branches of young trees the bark is at first smooth and milky white. On trunks of older trees the bark becomes irregularly divided into small scales of a brownish color. The wood is soft and light and possesses but little strength. It is sometimes used for mine timbers and fuel.

This tree is of but little commercial importance and its slow growth does not recommend it for planting where quick effects are desired.

LIMBER PINE, ROCKY MOUNTAIN OR WESTERN WHITE PINE.

(*Pinus flexilis*, James; *Apinus flexilis*. Colo, Exp. Station Bulletin 100, Rydberg.)

(Plate III.)

The common name of this pine is suggested by the long, lateral branches which are quite stout and enable this tree to survive in the wind-swept situations which it usually inhabits. It is of low topped form and stout trunk and occurs often at high altitudes in rocky, exposed places. The needles grow in bundles of five and are about 5 cm. long. At a little distance this tree resembles the foxtail pine, but is readily distinguishable from the latter species by the cones. Those of the limber pine are composed of numerous rather thin scales entirely free from prickles. The seeds are large and approach in size those of the pinon pine. In fact, this pine is not infrequently mistaken for the true pinon. It is readily distinguished by the fact that the needles of the pinon are in bundles of two instead of five as in this species.

The bark of the young branches and stems is smooth, light gray or white, becoming deeply fissured and dark brown or nearly black on old trunks. The light, soft wood is sometimes used for lumber, but is sure to be full of knots.

The limber pine is quite widely distributed, occurring along the eastern slope of the Rockies from Alberta to western Texas and southern California. Its largest size, occasionally 15-20 m. high, is reached in northern New Mexico and Arizona. In Colorado this pine is scattered throughout the higher portions of the mountains.

The limber pine is adapted to planting as an ornamental tree where large size is not desired.

Its hardy character enables it to thrive under cultivation and when thus grown it forms a tree of compact form and pleasing appearance. It is worthy of a place in the home grounds.

BULL PINE, ROCKY MOUNTAIN OR WESTERN YELLOW PINE, ROCK PINE.

(*Pinus scopulorum* (Engelm.) Lemmon)

(Plate IV.)

This is the largest of our pines and forms the principal evergreen of the foothills and ridges along the mountain ranges and in the mountain parks. Outside this state it occurs in western Nebraska and from Montana to Arizona and New Mexico. On the Colorado plateau this tree forms the most extensive pine forests on the continent. From northwestern Nebraska

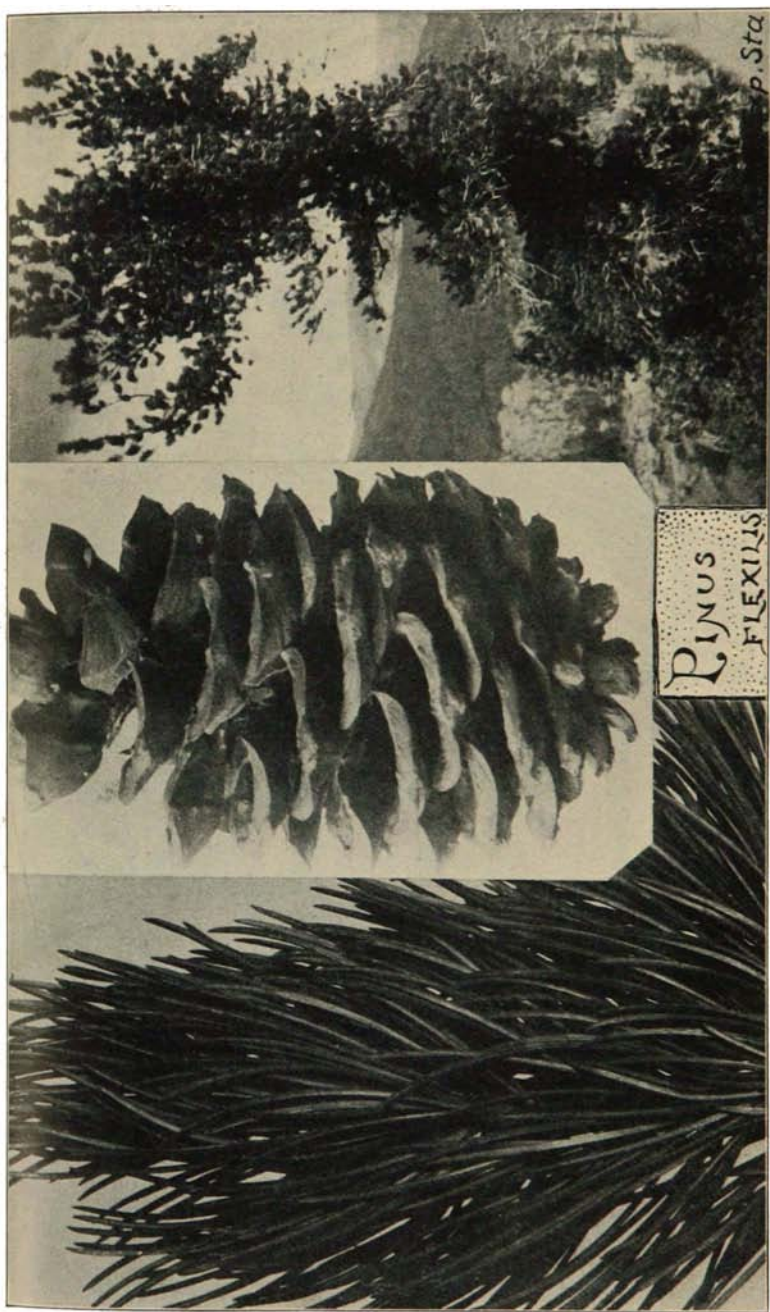
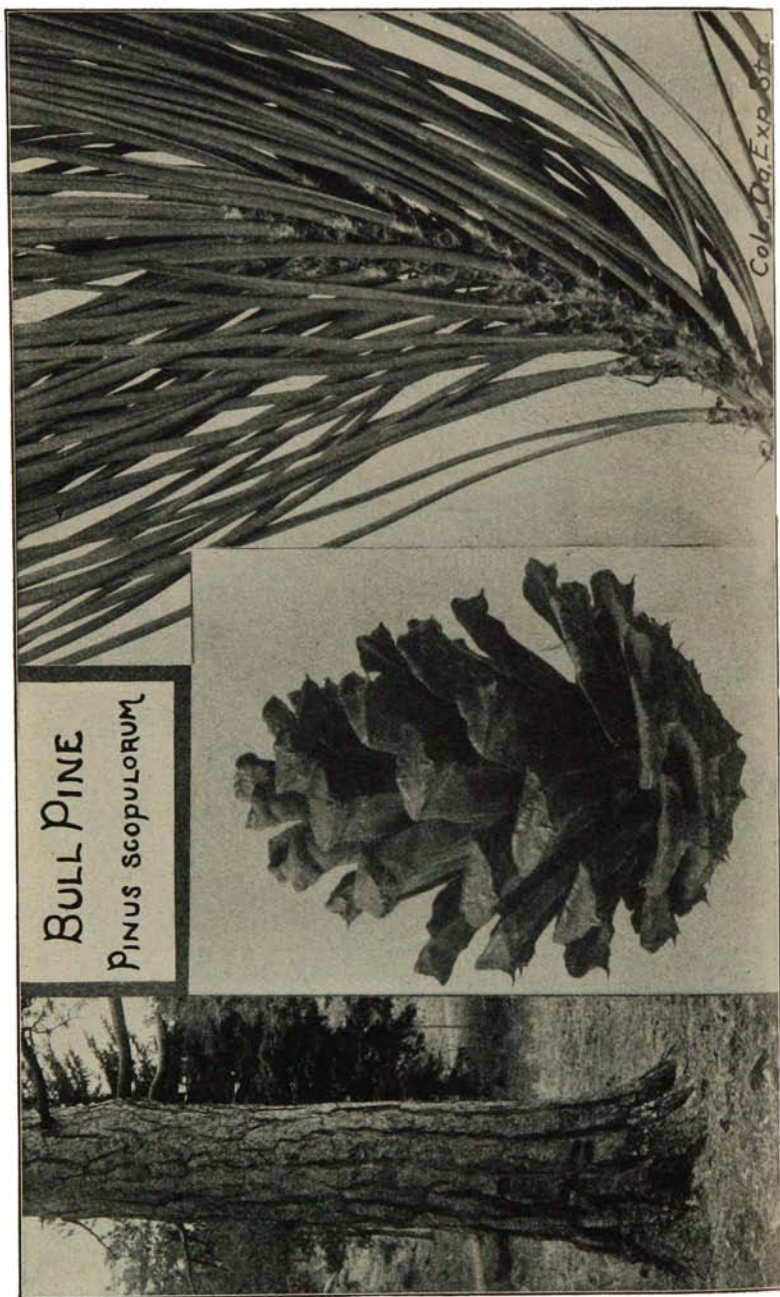


PLATE III.
Needles, cone and tree of Limber pine.



BULL PINE
PINUS SCOPULORUM

Colo. Da. Exp. Sta.

PLATE IV.
Trunk, cone and needles of Bull pine.

and western Texas to the Pacific Ocean and from southern British Columbia to southern California and Mexico this pine is replaced by the species *pinus ponderosa*, of which it is often considered as the variety *scopulorum*.

In Colorado the bull or rock pine forms rather open woods or forests on the slopes of valleys. Here it grows to a height of 24-30 m. (80-100 ft.) high and 1 m. (40 in.) in diameter. On the exposed rocky ridges and slopes it forms a spreading tree of stocky growth. The dark green needles are in bundles of two to three and vary in length from three to six inches. The cones are two to three inches long and the scales are tipped with stout recurved prickles, which on old cones are often missing. On large limbs and trunks the bark is blackish or cinnamon colored and on old trunks becomes thick and deeply furrowed. The wood is heavy and strong, but differs much in quality and is apt to be quite knotty. Its main uses are for lumber, railway ties and mine timbers.

This pine, on account of its deep growing root system, is able to resist drought better than almost any other of our evergreens. Thus it is well adapted to planting on the semi-arid plains and in dry, exposed situations. Under cultivation it is capable of rapid growth in diameter. A tree on the Agricultural College campus has averaged nearly one inch increase in diameter for each two years, the diameter when cut being seven inches at breast height, and with fifteen annual rings of growth. This rate of growth suggests this as a suitable pine for the tree plantation. When planted for lumber the trees may be planted twelve feet apart each way and the lower limbs be pruned off to form clean trunks as the trees grow in height.

This pine is quite easily grown from seeds, which are of good size, and which germinate readily.

(See directions for growing evergreens from seed).

The seedlings do not require shading when young as in the case of most evergreens. They should be transplanted when one or two years old to increase the number of fibrous roots. When four years old they may be set in permanent quarters if growth has been good.

LODGE POLE PINE, BLACK PINE.

(*Pinus Murrayana*, Oreg. Com.)

(Plate V. a. c.)

The lodge pole pine, so named from the use which the Indians once made of it in building their lodges, is a common evergreen in the hills and mountains of the northwestern states. It usually prefers northern slopes, which it covers with a dense growth. The trees are tall and straight and carry most of the foliage toward the top, especially when growing in forests. At a distance masses of this tree are noticeable on account of the yellow green of the foliage. It usually reaches higher altitudes than the rock pine. The needles are in bundles of two and are about two inches in length. The cones nearly equal the leaves in length and are composed of thick, hard scales, each of which is tipped with a slender prickle. The cones often remain closed and attached to the limbs sometimes for many years so that they occasionally become entirely overgrown by the enlarging stem.

A strong heat will cause the cones to open and allow the seeds to fall out. As the seeds may retain their vitality in the closed cones, sometimes for twenty years, a quick forest fire often brings about a reseedling of the burned district where this tree grew, by causing these old, "tight" cones to open.

The wood of the lodge pole pine is soft, light, and lacks durability. It is used to some extent for lumber, railway ties, mine timbers and fuel. The wood, when properly seasoned and treated with preservatives, is greatly improved in durability.

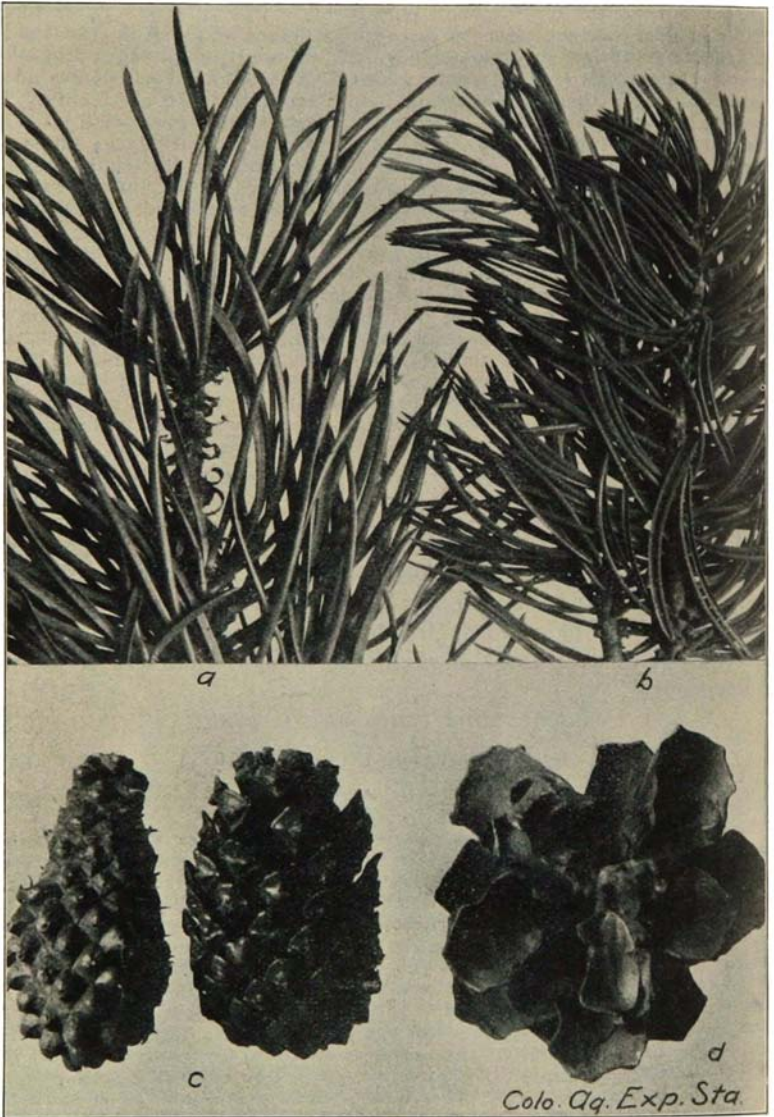


PLATE V.

a. c. Needles and cones of Lodge pole pine.
b. d. Needles and cone of Pinon pine.



PLATE VI.

- a. c. Engelmann spruce tree and foliage.
- b. e. Douglass fir tree and foliage.
- d. Foliage of Blue spruce.

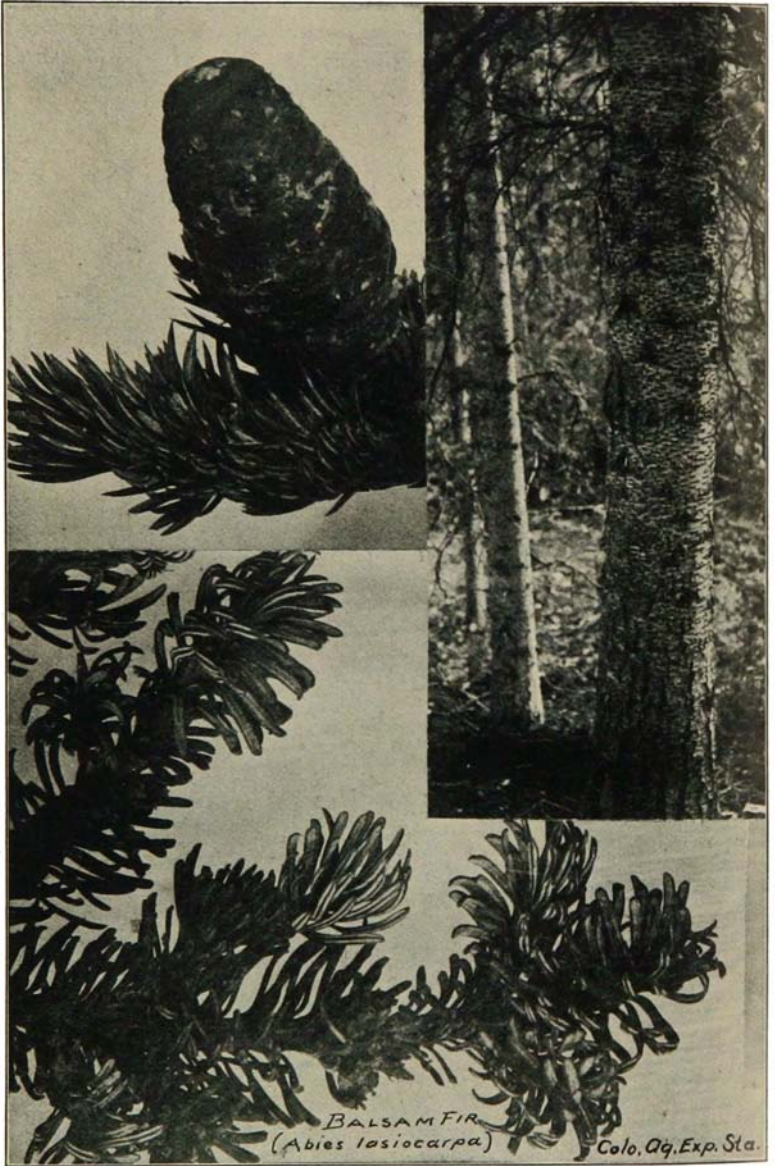


PLATE VII.

Immature cone, foliage and trunk of Balsam fir (*Abies lasiocarpa*)

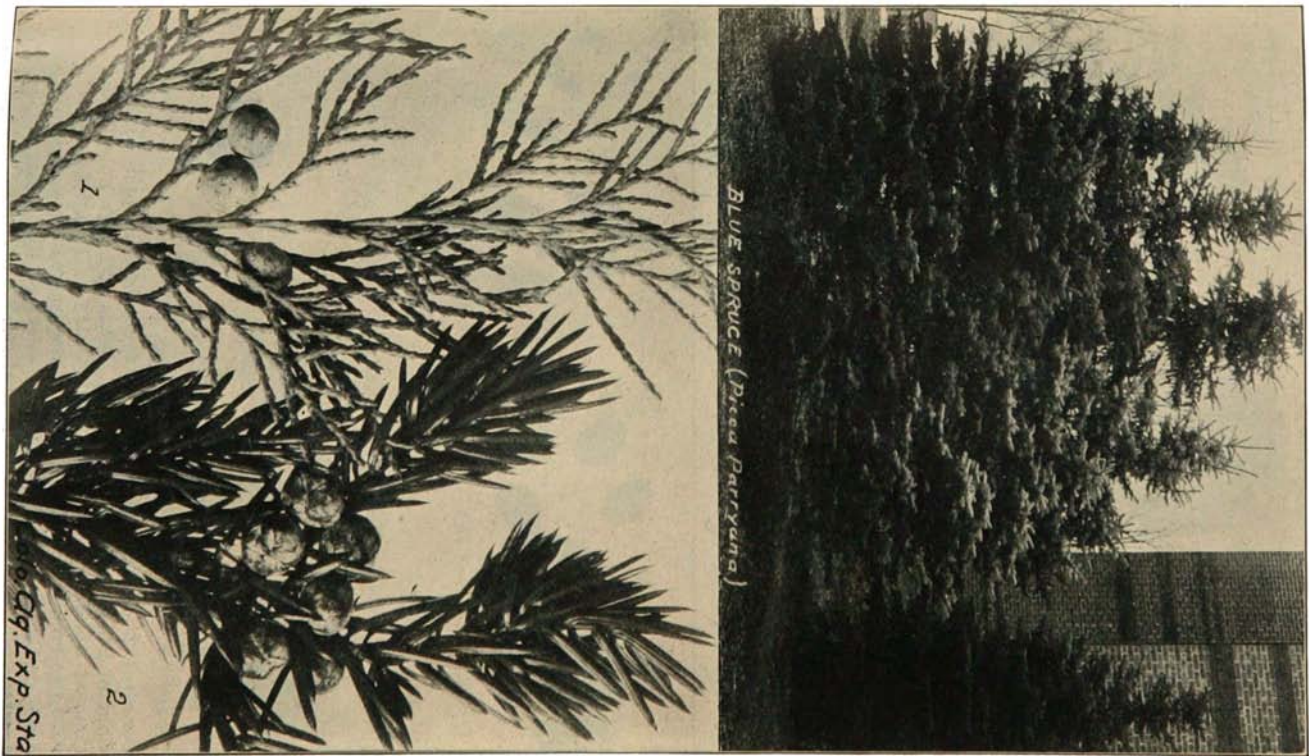


PLATE VIII.

Group of Colorado Blue spruce.

1. Branch showing scale-like leaves and berries of Rocky Mountain Red cedar (natural size).
2. Branch showing awl-shaped leaves and berries of low Juniper, (natural size)

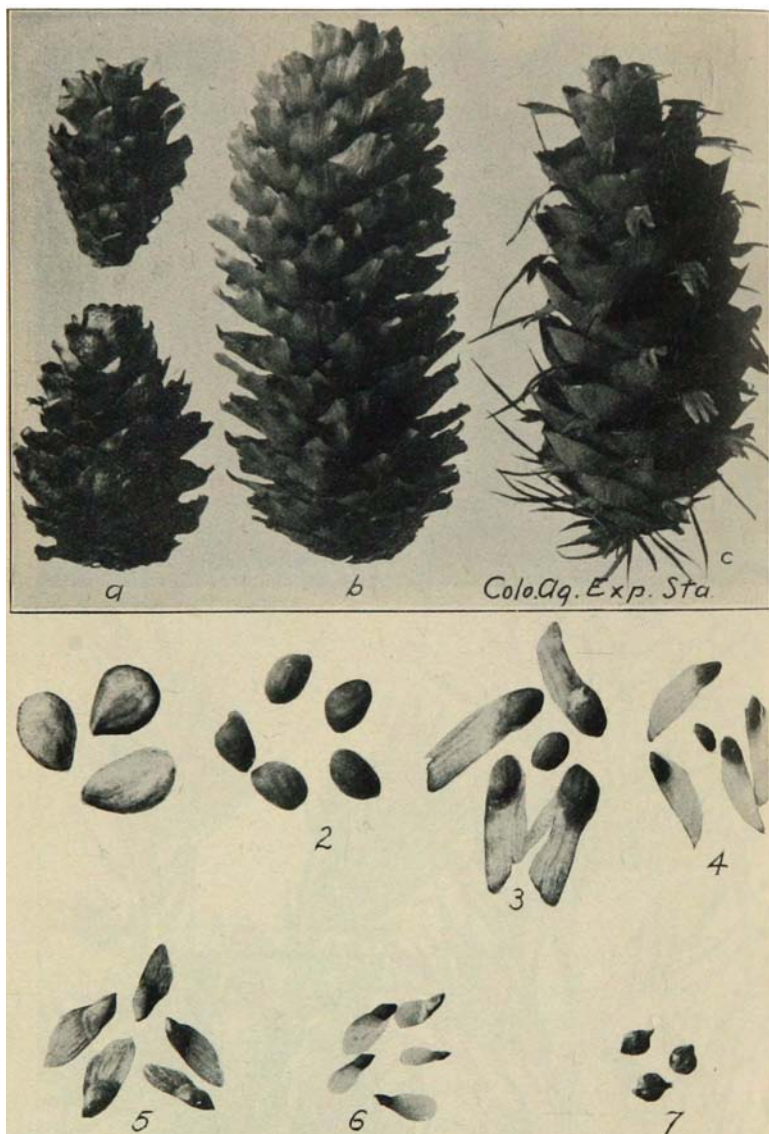


PLATE IX.

- | | |
|------------------------------|------------------------------|
| a. Cones of Engleman spruce. | 3. Seeds of Bull pine. |
| b. Cone of Blue spruce. | 4. Seeds of Lodge Pole Pine. |
| c. Cone of Douglass fir. | 5. Seeds of Douglass fir. |
| 1. Seeds of Pinon pine. | 6. Seeds of Blue spruce. |
| 2. Seeds of Limber pine. | 7. Seeds of Red cedar. |

(all natural size)

The lodge pole pine is capable of making a rapid growth under favorable conditions. It prefers a moist soil and may be used in the wind-break where such conditions prevail. When well established, however, it is hardy and enduring.

PINON, NUT PINE.

(*Pinus Edulis* (Engelm.) *Caryopitys Edulis* Colo. Bulletin 100.)

(Plate V. b. d.)

This is the pine from which the pinon nuts sold by fruit venders in cities are obtained. The tree is of small or medium size, with compact, pyramidal or rounded head. It occurs scattered or in open forests among the eastern and western foothills of Colorado, in southwestern Wyoming and western Texas and Arizona. It is not a tree of the high altitudes. The short, stiff leaves are in bundles of two and about one inch in length. The short, broad cones equal the leaves in length and are composed of few scales. The seeds are the largest of those of any other pine in this region. They are about the size of fruit beans and are wingless when separated from the scales of the cones.

This tree is useful mainly for its edible seeds, although the wood is sometimes made into lumber. It is quite extensively used for fuel and the manufacture of charcoal.

The pinon pine is adapted to growing in dry situations and for this reason may be planted where moisture is lacking. Its low, stocky growth adapts it for planting where a low mass of evergreen foliage is desired. The seeds germinate readily and this tree may be quite readily grown in this way. The seedlings may be transplanted at two years of age to encourage a compact root development.

GENUS *Picea*—THE SPRUCES.

The spruces are tall growing trees with conical or pyramidal form and tapering trunks. The needles are single, which distinguishes these trees from the pines, four angled and sharp tipped. At the base a short stalk-like portion is jointed to the green part of the needle and remains on the branchlet after the upper part of the needle has fallen. This makes the branchlets from which the leaves have fallen very rough and readily serves to distinguish the spruces from the firs.

The bark of the older limbs and trunks is usually dark grayish or reddish brown and consists of thin scales. The cones are hanging or pendulous when ripening and occur in the uppermost parts of the tree. They consist of thin scales each bearing two winged seeds. The seeds mature in the autumn of the first year. They are mostly small, pointed at the base and furnished with long, thin wings.

The spruces furnish some of our most ornamental evergreen trees, besides which they are useful in forming hedges, wind-breaks and shelter belts.

KEY TO THE COLORADO SPECIES OF *Picea*.

A. Needles very stiff and sharp pointed, surface of twigs among the needles entirely glabrous or free from hairiness; cones 5-7.5 c. m. (2-3 in.) long.

1. *Picea Parryana*.

B. Needles less rigid and sharply pointed, surface of the twigs among the needles finely pubescent or hairy; cones about 4 c. m. ($1\frac{1}{2}$ in.) long.

2. *Picea Engelmanni*.

BLUE SPRUCE, COLORADO BLUE SPRUCE, SILVER SPRUCE.

(*Picea Parryana* (Andree) Sarg.)

(Plates VI. d., VIII., IX. b.)

This is one of the most admired and widely known evergreens and is certainly the handsomest of the spruces when well grown. It is somewhat limited in range, being found in Colorado and eastern Utah and northward into Wyoming. It commonly grows in small groups or groves along the streams in the mountain valleys and parks. It usually reaches a height of seventy-five to one hundred feet, occasionally taller, with a trunk one to two feet in diameter. The leaves vary in color from bright green to silvery greenish blue—the new growth being more distinctly bluish or silvery than the older foliage. Young trees are often very symmetrical and beautiful. When old the tree may become somewhat ragged and open and the color of the foliage may lose a degree of its blueness.

The bark is broken into rather small, oblong scales and on old trunks becomes thick and furrowed or grooved lengthwise. This character helps to distinguish the blue from the Engelmann spruce, the latter having the bark broken into rounded plate-like scales even on old trunks.

The cones consist of numerous thin scales narrowed toward the tips. They are usually prominent objects, as they hang in clusters in the upper part of the tree.

The wood is soft, light and weak and is sometimes used for lumber and fuel.

The blue spruce is largely planted for ornament and when well grown forms most beautiful specimen trees. For this purpose the bluest specimens are selected by the nurserymen, as the price which they bring is high in proportion to the blueness. This tree is well adapted to the formation of hedges and when well tended may be made impassible even to the smaller animals.

The blue spruce may be grown from seeds, gathered preferably from the bluest specimens, or native seedlings may be dug from the mountains where they occur. If wanted for specimen trees only the bluest should be saved, although the greener plants are equally useful for hedges and wind-breaks. The finest specimens are usually obtainable through reliable nurserymen who grow them in large numbers, the best ones being propagated by grafting.

The blue spruce is at its best only when grown in a moist soil and under conditions of cultivation. When clothed in the new growth of the season such trees have the appearance of being frosted with pale blue, at which season they are unexcelled in beauty among trees.

THE ENGELMAN SPRUCE.

(*Picea Engelmanni* (Parry) Engelm.)

(Plates VI. a. c., IX. a.)

The Engelmann spruce is frequently confused with the blue spruce, which it often greatly resembles. It is a much larger tree than the blue spruce, in its northern range often growing to a height of 150 feet with a trunk four to five feet in diameter. Old trees are apt to be less regular in form than the blue spruce and the color is seldom so blue as the latter. The needles are less rigid and sharp than those of the blue spruce, so that an experienced nurseryman can usually distinguish the two by grasping the foliage with the bare hand. The leaves, furthermore, possess a disagreeable odor when bruised.

The surface of young twigs, under a hand lens, appears fuzzy or short hairy. This can be distinguished even by the naked eye if the twig is held up so that its outline is seen against the sky. The bark of large trunks is seldom grooved or furrowed as in the blue spruce, but is broken into rounded, plate-like scales of a reddish brown color.

The cones of the Engelmann spruce are seldom over one and a half inches long and the scales are often more rounded than those of the blue spruce.

The Engelmann spruce reaches the highest levels of tree growth and at timber line forms distorted spreading mats of scrubby growth. It is the most abundant of spruces in Colorado and forms extensive forests on the upper slopes and along the mountain streams. In its range it extends in general southward from the mountains of British Columbia through the interior mountain ranges of the continent to northern New Mexico and Arizona. It reaches its greatest beauty and size north of the United States boundary.

The bark is sometimes used for tanning leather. The wood is light and soft and is extensively manufactured into lumber, railway ties and to some extent is used for poles. It is probably our most valuable timber tree. The Engelmann spruce is not often planted for ornament, but is well adapted to such use in this state.

GENUS *Pseudotsuga*—DOUGLASS SPRUCE.

The members of this genus are tall, stately evergreens with much the same form as the spruces. They are nearly intermediate in some characters between the true spruces and the firs. The needles are single on the branchlets and are contracted at the base into a short stalk. They are soft, flattened, blunt at the tips and possess a prominent midrib in the form of a narrow ridge on the lower side. When the needles fall they leave small rounded scars on slightly raised portions of the branch. In these respects the Douglass spruces resemble the true firs. The cones, however, are in most respects like those of the spruces in that they are pendulous or hanging and that they remain entire when mature. The cones are readily recognized from those of the spruces, as well as other members of the pine family, by their feathered appearance, due to the presence of slender-toothed bracts that project from between the scales. This character is so prominent that these trees can be recognized as far as the details of the cones are visible.

Only two species in this genus are known in North America, one of which occurs in Colorado.

DOUGLASS SPRUCE, DOUGLASS FIR, RED FIR.

(*Pseudotsuga mucronata* (Raf.) Sudw.)

(Plates VI. b. e., IX. c., 5.)

The Douglass spruce is known by a number of common names throughout its range. It occurs among the hills and mountains of the greater portion of the Northwest, extending from British Columbia and Alberta on the north to northern Mexico and Texas on the south. It is a tree of conical form when young. It reaches its greatest size in the moist climate near the coast of Washington and Oregon and in the western foothills of the Cascade mountains, where it reaches a height of 200 feet or more with a trunk sometimes 10 to 12 feet in diameter. In the drier inland regions it is usually less

than one hundred feet tall and two or three feet through. The bark remains comparatively thin and smooth for a number of years, but on old trunks becomes thick and deeply cracked and furrowed into gray, coarsely broken ridges. The wood is light red or yellowish in color and variable in density and quality. It is largely manufactured into lumber in its northwestern range, and is extensively employed in construction work, railway ties, piles, and for fuel. Two varieties of this tree, the red and the yellow fir, are distinguished by lumbermen. The former of these is coarse grained and dark colored and is not considered so valuable as the latter. The bark is occasionally used in tanning.

The Douglass spruce is planted quite extensively as an ornamental tree in the eastern United States, and numerous forms or varieties are in cultivation. It is a tree of rapid growth, especially when planted in a moist soil. It has not made as healthy a growth on the Agricultural College grounds at this station as the blue spruce. It is readily grown from seeds, which are of fair size. This evergreen may be recommended for planting in the wind-break and for specimen trees on the lawn.

GENUS *Abies*—THE FIRS, BALSAMS.

The firs are tall growing, conical trees quite similar in appearance to the spruces. They are fond of the higher altitudes where the cold air and the moisture of frequent storms bring them to their greatest perfection. The leaves, like those of the spruces, are simple and grow from all sides of the branchlets. Those on the lower sides of the twigs, however, turn upward in such a way as to form flattened masses of foliage. The branches arise in whorls from the sides of the main trunk so that when viewed from the side such trees appear in the form of circular terraces of foliage disposed with beautiful regularity.

The needles are flattened, usually grooved above and slightly notched at the tip. The cones occur only in the topmost parts of the trees and stand erect on the upper side of the branches. They are mostly purplish or blackish in color, with thin, closely crowded scales. When mature the cones break up by the falling away of the scales, so that complete cones of the firs are never found beneath the tree.

The bark on young trees is smooth, but becomes roughened and broken on old trunks. The wood is mostly soft and brittle and is not prized by the lumbermen.

The name Balsam, which is often applied to the trees of this genus, is suggested by the presence of balsam or resin vesicles in the bark.

The balsam fir of the northeastern states and Canada (*Abies balsamea*) possesses balsam-containing blisters in the bark from which the substance known in commerce as "Canada Balsam" is obtained.

KEY TO THE COLORADO SPECIES OF *Abies*.

- A. Leaves of vigorous lower branches 2.5-4.5 c. m. (1-1½ in.) long; the two resin tubes, as seen in cross section under hand lens, deeply imbedded within the leaf tissue. Cones purple or nearly black.

1. *Abies lasiocarpa*.

B. Leaves of vigorous lower branches 4.5-7.5 c. m. ($1\frac{3}{4}$ -3 in.) long. The two resin tubes close to the lower surface. Cones green, yellow or purple.

2. *Abies concolor*.

BALSAM FIR, ALPINE FIR.

(*Abies lasiocarpa*. Nutt.)

(Plate VII.)

This tree is distributed throughout the mountainous parts of western North America. In Colorado it frequents the high mountain slopes and summits. It is a medium sized tree seldom over 100 feet tall, in this state, and two feet in diameter.

The leaves on the cone-bearing branches are usually short, stiff, and curved upward and tipped with sharp points. The cones are frequently almost black in color and are usually smeared with pitch. The bark on young trunks is quite smooth with numerous transverse scars, but on old trunks becomes cracked and scaly.

The wood of this tree is considered of little value by the lumbermen, as it lacks strength and durability and is adapted only for the coarsest quality of lumber. It is used for fuel to some extent. The writer found, in the cutting of timber from one forest reserve, that this fir was being removed to make room for the more valuable Engelmann spruce with which it was growing. This fir is planted to some extent as an ornamental tree in the northern United States and Europe.

WHITE FIR.

(*Abies concolor*, Lindl.)

The white fir, with its regular whorls of frond-like foliage masses, is a very handsome tree. During the first year or two the leaves are similar in color to those of a good specimen of the silver spruce, which it often rivals in beauty. It is a much larger tree when fully grown than the preceding species. It is the only fir within the arid regions of the Great Basin and of southern New Mexico and Arizona. In Colorado the white fir is found only in the southern half of the state extending to the Pike's Peak region. Some handsome specimens of moderate size are to be seen in North Cheyenne Canon, near Colorado Springs. The leaves are considerably longer than those of the balsam fir and the cones are larger and usually lighter in color. The wood, while coarse grained and not strong nor durable, is sometimes used for lumber of which packing cases are made. The tree is planted to some extent for ornament and is worthy a trial, as well grown specimens are pleasing in form and color and may serve to introduce variety in the evergreen plantings in parks and about the house.

Juniperaceae—JUNIPER FAMILY.

The members of the juniper family are distinguished from those of the pine family principally by the fruit. Thus, instead of forming a dry cone composed of woody or parchment-like scales the junipers possess a berry-like fruit, in the pulp of which the seeds are imbedded. These berries, however, were at first much like the very young cones of the pine family. The scales of which they are composed are enlarged at the outer end and are comparatively few in number. After the ovules are fertilized by pollen from the staminate flowers, which in the junipers occur on distinct trees, the scales grow together and form the so-called juniper

berry. On close examination, marks indicating where the scales were located can be easily seen.

The seeds of the junipers are furnished with hard, bony coatings which enable them to pass unharmed through the alimentary canal of birds, which sometimes feed upon them, and in this way distribute them to new locations.

The junipers are strongly aromatic and from some species volatile oils are obtained which are used in medicine and in the manufacture of perfumes.

The wood of the juniper is close grained, not hard, but durable. Most of the species of junipers which occur in this state are low, spreading, shrubby plants which are not adapted to the production of lumber. These low-growing sorts, however, are well suited for planting in the shrubbery border, on exposed banks and to cover the tops of walled terraces and rockwork.

Two genera of the juniper family are represented in Colorado, but only three species commonly reach the stature of small trees.

KEY TO THE COLORADO GENERA OF THE JUNIPER FAMILY.

- A. Leaves in whorls of three, on mature branches, awl-shaped, spreading, 10-12 m m. ($\frac{3}{8}$ - $\frac{1}{2}$ in.) long, channelled and whitened above, convex and green below. Buds scaly.

Genus Juniperus.

- B. Leaves opposite in pairs, on mature branches, scale-like and flattened against the branchlets to which they are usually grown fast; about 2-3 m m. ($\frac{1}{8}$ in.) long. On young trees and vigorous shoots the leaves are usually longer, slenderly pointed and somewhat spreading. Buds naked.

Genus Sabina.

GENUS *Juniperus*—THE JUNIPERS.

(Plate VIII. 2.)

The species of junipers which occur in Colorado frequent the rocky hills and exposed mountain slopes. They are distinguished from the red cedars or savins principally by the leaves being comparatively long and joined to the branch much like those of the spruces. The berry-like fruit of the junipers is borne close against the side of the branch, while that of the red cedar is on the end of a very short branch.

Two species of the genus are known in this state. The first of these, the mountain or low juniper (*Juniperus sibirica*) (Plate VIII. 2) is a low spreading shrub common in the foothills and rocky places in the mountains. Its leaves are abruptly bent at the base and are deeply grooved on the upper surface.

This shrub is worthy a place in the shrubbery border and from

its hardy, drought-resisting character may be used where moisture is not plentiful

The common juniper (*Juniperus communis*) sometimes reaches a considerable size, especially in its eastern range. In its low form it is scarcely distinguishable from the former species, but is apt to be more erect and with straight, nearly flat leaves with tapering points.

The distilled liquor commonly known as gin owes its flavor to the use of juniper berries in its manufacture.

The common juniper is adapted to forming low hedges, as it endures clipping well.

GENUS *Sabina*—RED CEDARS, SAVINS, JUNIPERS.

(Plate VIII. I.)

The common red cedar is the type of tree of the present genus. The foliage consists usually of two somewhat distinct forms of leaves. Those on the main branchlets are frequently one-fourth to three-eighths inches long on vigorously growing trees, with the pointed tips free and somewhat spreading. On the smaller lateral branchlets the leaves are usually less than one-eighth inch in length, are scale-shaped and broadly pointed. Both forms of leaves adhere closely to the branchlets on which they grow so that the younger stems are entirely covered by the leaves. After one or two years the longer leaves die and turn brown, but do not entirely disappear until the branch is several years older.

The oldest leaves are shed in spring of each year at the beginning of the growing season, but instead of falling singly as in the junipers, the small lateral branchlets drop off, carrying with them the closely adhering scale-leaves.

The heart wood of the red cedars is soft but fine grained and very durable and possesses a pleasing fragrance which is retained almost indefinitely. The wood has been extensively employed in the manufacture of water pails and wooden ware, for interior finish and for cabinets and chests for protecting furs and woollens against the ravages of moths. It is the principal wood used in the manufacture of lead pencils and is probably the only wood sold by the pound. The rapidly diminishing supply for this purpose is being felt by the manufacturers of pencils, who are beginning to consider possible substitutes.

The oil of red cedar, distilled from the leaves and wood, is used to some extent as a perfume, as it imparts the characteristic odor of the wood to cheaper woods.

The berries ripen in the autumn of the season they were produced.

Of the four species of red cedars known in Colorado three are sometimes trees of small or medium size. The characters which separate them are not easily recognized except by botanists.

The Utah red cedar (*Sabina utahensis*) is a bushy tree seldom more than twenty feet high, which occurs in the desert region between the Rocky and Sierra Nevada Mountains. It is found in the western parts of this state on dry mountain slopes and tablelands. It is locally used for fuel and fencing and the fruit, which is a rather dry, sweet berry, is used for food by the Indians, either fresh or ground and baked into cakes.

The single-seeded red cedar (*Sabina monosperma*) occasionally reaches a stature of forty to fifty feet in favorable locations. It occurs along the eastern base of the Rocky Mountains in the southern half of Colorado and extends to western Texas, over the mountain ranges of Nevada and into Mexico. It is often associated in southern Colorado and Utah with the pinon pine.

It is usually an irregular, open-headed tree, with red-brown bark on the naked branchlets and thin, grayish, scaly or shreddy bark on the trunks. The fruit is about one-eighth to one-fourth inch long, black with a whitish bloom and contains usually one or rarely two or three grooved seeds. The wood and fruit of this species are used for the same purposes as in the preceding species.

The Rocky Mountain Red Cedar (*Sabina scopulorum*) (Plate VIII 1.) is widely distributed throughout the northwestern portions of the United States, from the eastern foothills of the Rocky Mountains to the coast of British Columbia and Washington, and from Alberta to western Texas and northern Arizona. It frequents the foothills and river bluffs and is our common red cedar in most parts of Colorado. It reaches a height of thirty to forty feet, when favorably situated, and forms an irregular round topped head.

The berries are bluish black with a bloom and contain one or two bony-shelled, grooved seeds. The fruit is usually somewhat larger than that of the preceding species and ripens at the end of the second season.

The red cedars, on account of their very fine foliage and branchlets, may be effectively used among other evergreens to give variety to the planting. Their foliage is usually somewhat grayish in winter. Although of slow growth their hardiness and the fact that they bear pruning well fits the red cedars for use in forming hedges and windbreaks.