The Evergreens of Colorado

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STATE FORESTER

PUBLICATION NO. 1
FORT COLLINS, COLORADO
1914

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HEN the first settlers in Colorado staked their claims along the streams that issue from the canyons in the foothills or penetrated the mountain fastnesses in search of grazing land, they found vast forests of evergreen trees clothing the rugged mountain sides and reaching down the gulches to the very border of the plains. The development of this country during the past fifty years, however, has worked great changes in these forests. The laying of railways, the construction of bridges, the development of mining and the building of houses, fences and telephone lines, have all made their legitimate demands upon them. But other forces of purely destructive character have also been at work. Insect pests have killed a great many trees and led the way for the attacks of such fungi as bring about the decay of timber. Storms of wind, wet snow or sleet have sometimes uprooted the trees or crushed them to the earth.

The heaviest toll, however, that has been levied upon our forests in Colorado has been here, as elsewhere, by forest fires. These have either consumed the timber, often laying bare the very rock, or licked the foliage from the trees and left their naked trunks to slowly whiten in the sunshine and storms of the years that have followed. Some of the older residents of our state tell of forest fires that burned for forty days without any attempt being made to check them. Forest fires in the mountains were to be expected with the coming of dry weather and as timber was more plentiful than labor, these fires were free to burn themselves out. Today much of the magnificence of our mountin scenery is sadly marred by the ghastly pole patches which mark the location of these fires where the bare rocks often show like tombstones to commemorate the disaster.

In spite of all these drains upon our forest resources, the forests of pine and cedar, of spruce and fir which remain are still the glory of our mountains in Colorado. New generations of trees, moreover, are coming up in many cases to take the place of those that have disappeared and some future period will see again perhaps the evergreen mantle spread over the scars that now appear. Moreover, the real worth of our forests in this country is now being recognized as never before and State and Nation are uniting their efforts to protect and to utilize in more conservative ways the timber that yet remains. No more are fires allowed to burn and spread through the forests, that have required centuries to grow, without heroic efforts being made to check them. Throughout every part of our forest lands today are men whose duties are concerned with the control of the worst enemy of the forest, the fires. The people who visit the mountains for pleasure and recreation, too, are becoming imbued with the true sentiment of forestry so that the menace to our woodlands from this source is being lessened year by year. It is now

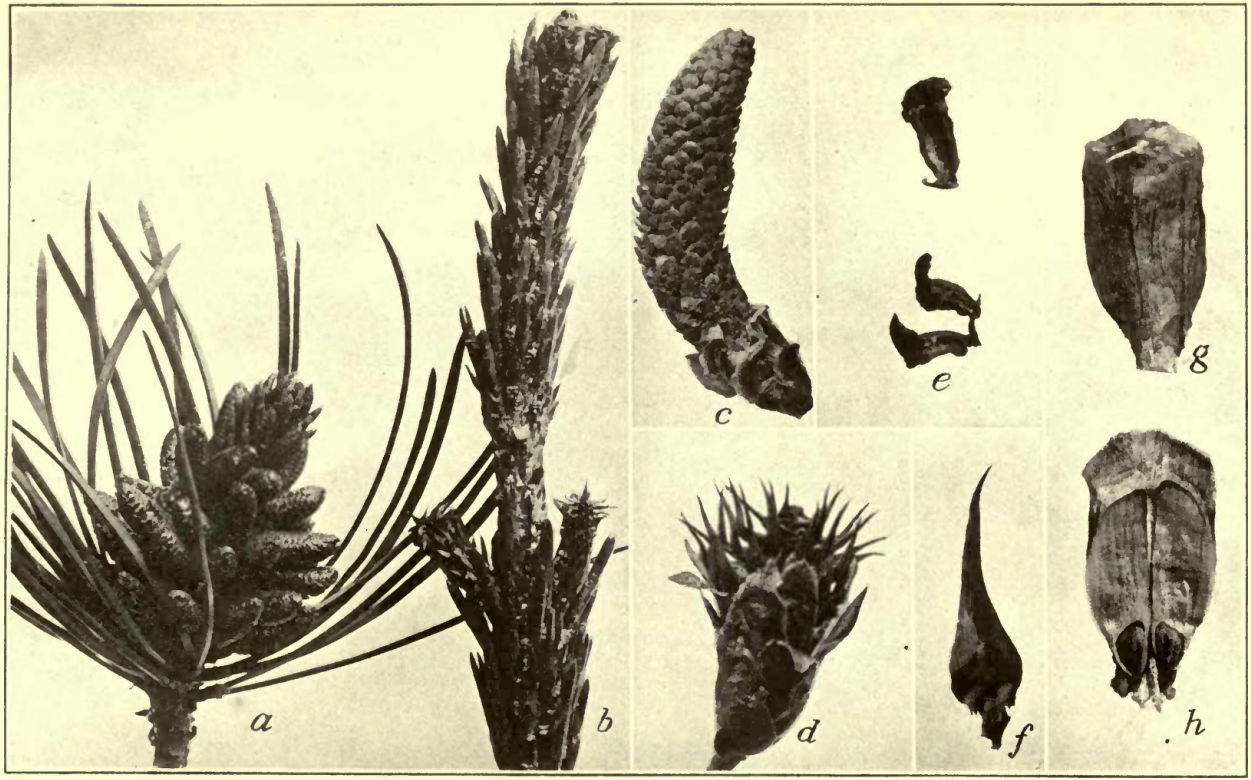


Fig. 1. Flowers and fruit of a pine, on new growth. **a.** Staminate flower cones, x1. **b.** Pistillate flower cones, x1. **c.** A staminate flower cone, x2. **d.** A pistillate flower cone, x2. **e.** Three stamen flowers, x10. **f.** A pistil scale, showing two ovules at base, x10. **g.** A mature cone scale, lower side, x2. **h.** A mature cone scale, upper side and two seeds with wings.

common knowledge that campfires should be put out instead of being left to jeopardise the timber and every true sportsman and woodsman can but take pride in practicing such methods in the mountains as shall not endanger the forests, in whose shelter lie the pleasures that he seeks.

There are richer pastures, however, to be gained from contact with the forests than to make them merely a place in which to hunt or fish or camp. The trees which compose the forests are themselves worthy of our acquaintance. To know the different species by sight or to be able to identify them through careful study is an accomplishment that can but deepen the joy of an outing in the forests of our mountains through the feeling of intimacy and friendliness which comes to us from the trees.

In the following pages such descriptions of our native evergreens are given as should enable almost anyone to learn their names and characteristics. This work is not prepared as a scientific treatise of the subject, but is intended primarily to enable the person without a technical knowledge of botany to become familiar with our trees and thus gain that sympathetic attitude toward them which usually accompanies such knowledge.

THE EVERGREENS

Our true forests in Colorado are composed entirely of trees commonly called Evergreens. By this term we are accustomed to think of such trees as the pines, spruces, cedars, firs, and other of similar botanical characters, but in the southern and tropical forests are to be found trees of widely different characters from these except that they also retain green foliage the year around and in this respect they too are Evergreens. The native evergreen trees of our state, however, all belong to one great and important family, the *Coniferae* or Pine Family. Most of the members of this family are trees in stature, comparatively few being shrubs. Among lumbermen they are classed as soft woods, although the hardest woods among them are much harder than some of the so-called hardwoods among the broad-leaf trees. With very few exceptions, the foliage of the trees in the Pine family consists of needle, or awl, or scale-shaped leaves which remain on the twigs during several years, so that the trees are never without living foliage. Exceptions to this rule are found in the bald cypress of the southern states, in the larches of the north and in the Ginkgo or maidenhair fern tree of Japan. But as none of these trees are native to Colorado, all of our trees of the Pine family are true evergreens.

Another characteristic of the trees in this family is the resinous juice or sap which they possess, and which exudes especially from wounds made in the bark and sap wood of the branches or trunks. This is well illustrated in the blazing of pine or spruce trees in which case the pitch which oozes out, gradually hardens on exposure to the air and forms the material sometimes used as chewing gum.

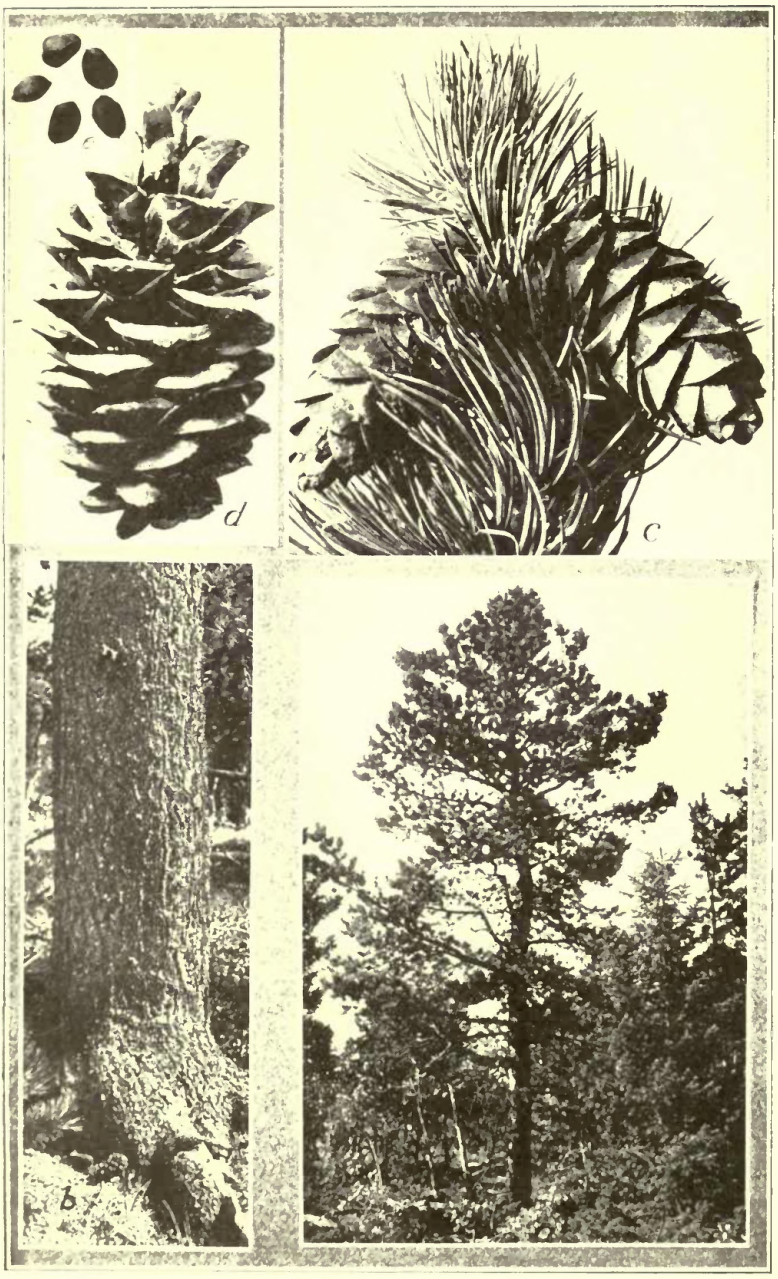
The process of turpentine orcharding as practiced in the southern states consists in cutting box-like cavities into the sides of the trunks of certain species of pines and wounding the bark and sapwood for

Fig. 2. Bristle cone Pine. **a.** Grove on Pike's Peak. **b.** Small trees showing the whitish bark. **c.** Trunk of an old tree. **d.** Cones and needles, ×½.

some distance above them. The crude turpentine or pitch runs down into these cups from which it is dipped out when a sufficient quantity has collected. By a process of distillation, this pitch gives off the spirits of turpentine, which is volatile, while the common resin or rosin of commerce is left behind as a solid residue. The wood of some of our pines often becomes nearly or quite saturated with its own pitch and in this condition possesses great durability. The so-called pitch posts are formed in this way and command a high price as compared with the common type of fence posts.

The most distinctive characters of the members of the Coniferae, however, are found in the flowers and fruits which they bear. The flowers are of two kinds, staminate and pistillate. The staminate flowers are those which produce the pollen. They appear in spring, about the time that the new foliage pushes out, and are borne in small catkins or cone-like clusters near the ends of the twigs. Each cluster of stamen-flowers usually consists of numerous small stamens crowded together upon a short axis which they completely hide. In some species these staminate cones are about one-half or two-thirds of an inch long and contain a hundred or more stamens, while in others they are much smaller and have but few stamens. Each stamen of the cluster consists of a minute double sac filled with the pollen in the form of a yellowish powder. As the tree comes into bloom each little stamen sac splits open in such a way that the pollen is allowed to sift out into the air. When in this condition, a light breeze is sufficient to waft the pollen powder away continuously, while a sudden gust of wind will shake it out in visible quantity in appearance like sulphur dust. In regions where large forests of pine occur, this pollen dust is often so abundant, during the blossoming period, as to lend the impression that a shower of sulphur has occurred. When seen under the high power of a microscope, the pollen is found to consist of little grains each of which is composed of three rounded cells. Two of these cells are air sacs and serve to buoy up the grains in the air, while they are being wafted along. The shedding of pollen usually lasts but a few days after which the staminate flower clusters dry up and fall off, hence are not commonly noticed except by the unusually observant person.

The pistillate cones, which are later to bear the seeds, are usually produced at the ends of very short lateral branches in the upper part of the tree. Each cone consists of a little axis covered with flattened scales. These little scales differ in shape considerably in different species, especially when the cone is mature, and furnish some of the characters by which the species may be distinguished. Each scale represents a pistil, that part of a flower which bears the seed. At the base of each pistil, upon its upper side, are two minute rounded bodies called ovules. These are the rudimentary seeds and instead of being enclosed by the pistil, as in most other families of plants, in the Coniferae or pine family, they are naked or exposed while the tree is in bloom. During the period of blooming, the pistillate flower-cones stand erect upon the twigs which bear them, with the tips of the scales spread outward. Some of the



Limber Pine. **a.** Tree with nine-inch trunk. **b.** An old ... and needles, x½. **d.** Mature, open cone. **e.** Seeds.

pollen grains, with which the air is at this time filled, are caught upon these scales and slip downward, thus coming in contact with the ovules at the base. This constitutes the process of pollination. Soon after the pistillate cones have been pollinated, the pistil scales close together tightly to await the process of fertilization. Fertilization in the members of the pine family is similar to that in other plants, except that it is much slower in some of them. During this process, the pollen grains that have come in contact with the ovules each send out a microscopic tube which finds its way through a minute opening in the coat of the ovule. In this way the cell contents of the pollen grain is enabled to unite with the contents of an egg cell within the ovule. From this union an embryo plant is formed, and the ovule develops into a seed.

In the spruces and firs the cones are full grown and their seeds are mature at the end of the first season after blooming. But in the pines the cones make but little growth during the first season, but grow rapidly during the second summer and mature their seeds at the close of the second season after blooming.

In the junipers the pistillate scales, which are few in number, become fleshy and grown together as they mature and thus form the berry-like fruits characteristic of these plants.

The pine family in Colorado contains at least thirteen species which grow to the stature of trees, while two more are merely shrubs. These are grouped into five subdivisions or genera which may be distinguished from each other by the characters given in the following key.

Coniferae—PINE FAMILY.

Key to the Genera Found in Colorado

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

1. Needles (leaves) in tufts or bundles of two to five, surrounded at the base by a small sheath of thin scales and placed just above a little scale-like leaf or bract; scales of the mature cones thick, hard and woody.

1. Genus *Pinus*—The Pines.

2. Needles (leaves) single, without a sheath at the base, not seated just above a bract; scales of the mature cones thin, leathery or papery.

A. Needles (leaves) in our species stiff and four-angled, each one jointed to a small, hard, brownish, stem-like base; branchlets from which the leaves have fallen rough with the leaf-bases which remain after the upper part has fallen off; mature cones hanging or pendulous, the scales persistent.

2. Genus *Picea*—The Spruces.

B. Needles (leaves) flat, falling entirely away and leaving small rounded scars on the branchlets, which are quite smooth after the needles have fallen.

a. Needles with narrowed stalk-like base, needle-scars small and elliptical across the branchlets; mature cones hanging or pendulous, feathered with three-pointed, projecting bracts, the scales persistent.

Genus *Pseudotsuga*. The Douglas Firs.

b. Needles not much narrowed at the base, scars quite large, circular in outline; mature cones erect, green, dark purple or blackish, the scales falling separately from the axis.

Genus *Abies*. The Balsam Firs.

II. Foliage leaves awl-shaped or scale-shaped, in the latter case entirely covering the twigs; fruit berry-like, more or less juicy; seeds hard and bony, without a thin wing.

5. Genus *Juniperus*. The Junipers and Cedars.

1. GENUS *Pinus*. THE PINES.

The pines form the most important group among the lumber producing trees. As indicated in the key, they are most easily recognized among the other members of the *Coniferæ* by having their needles in bundles of two to five with a short sheath at the base. This sheath is composed of a number of thin, translucent scales attached to a very short stem. This little stem represents a very short branch which bears the bundle of needles at its apex. This can be easily seen by pulling one of the bundles of needles from a twig of a pine tree when the little stem, together with the sheath, comes off with it. Each of these little branches, moreover, grows in the angle or axil of a small bract or scale-like leaf on the twig, which is the normal place for a branch to stand. The small cones of staminate flowers grow in crowded clusters around the base of the new growth of the season and after they have dried up and fallen away, they leave a bare space on this part of the branch. The pistillate flower cones occur singly or in whorls of two to three around the base of the present season's growth. They are small and inconspicuous at first and are easily overlooked. After the blossoming period, they develop very slowly and have only about doubled in size by the end of the first season. During the second spring, however, they grow rapidly and reach full size by midsummer, although they retain their green color until nearly autumn. Toward the close of autumn the color has changed to a light brown and the cone scales begin to dry and spread apart. The seeds, which are now mature, loosen and begin to drop out, the wind carrying them for many rods from the parent tree. It is possible in some pines to find cones of three different ages upon the same twig: first those just past the flowering stage, second those which are maturing the seeds, and third those which have lost their seeds but still cling to the branch. The cone scales of all the pines are thick, hard and woody and in some species are tipped with a sharp, curved prickle or spine. Two seeds are normally borne at the base of each scale. The wing of the seed is not really a part of the seed, but is derived from the upper part of the scale

to which the seeds are attached. When the seeds reach the ground and become wet with dew or rain, the wings readily separate from them and leave them to germinate quietly as conditions may favor. Five species of pines are native to the foothills and mountains of Colorado.

KEY TO THE SPECIES OF PINUS IN COLORADO

I. Needles, five in a bundle.
  A. Scales of the cones tipped with curved prickles.
    1. *Pinus aristata.*
  B. Scales of the cones without prickles.
    2. *Pinus flexilis.*
II. Needles, two or three in a bundle.
  A. Needles two and three in a bundle, 3 to 6 inches long.
    3. *Pinus ponderosa scopulorum.*
  B. Needles usually two in a bundle, seldom over 2½ inches long.
    a. Needles 1¼ to 2½ inches long; seeds small, winged.
      4. *Pinus contorta murrayana.*
    b. Needles ¾ to 1½ inches long; seeds large, apparently wingless.
      5. *Pinus edulis.*

BRISTLE-CONE PINE, HICKORY PINE, FOXTAIL PINE

Pinus aristata Engelm.

The bristle-cone pine is a tree of the high altitudes in the mountains of Central and Southern Colorado, in Utah, Nevada, and in Southern California and Arizona. It is a small or medium sized tree of rather bushy habit, which seldom reaches a height of fifty feet, and with a short, branched trunk one to three feet in thickness. The bark on young trees is smooth and greyish white, but on old trunks it becomes broken into flat ridges covered with small scales of a dark brownish grey color. The needles are short and are borne in bundles of five. They are crowded along the branchlets in such a manner as to produce an elongated brush-like appearance, from which is derived the common name of "foxtail pine." The cones are about three inches long and each scale is tipped with a slender, curved bristle. The wood, which is soft and light with brownish colored heart wood, is possessed of but little strength and is seldom used except occasionally for mine timbers and fuel.

In Colorado this tree is only occasionally met with. It grows in somewhat open groves of rather limited extent and is of but little importance either as a lumber tree or for planting. Above Manitou, on the slopes of Pikes Peak, are to be found a few small groves of this pine. In the San Juan Forest of Southern Colorado it occurs in sufficiently large areas to be cut for railway ties to a limited extent.

Limber Pine, bundle of needles. **a.** Just unfolding. **b.** Sheath scales ready to fall. **c.** Sheath-scales fallen, x2.

2. LIMBER PINE

Pinus Flexilis James.

The limber pine occurs almost throughout the Rocky Mountain region in the higher elevations, also in Western California on the western slopes of the Sierra Nevada range. In Colorado it commonly grows between the elevations of 7,500 and 11,000 feet. It is the pine which one commonly meets when approaching timber line and is almost sure to be found upon exposed, wind-swept slopes and ridges at 9,000 to 10,000 feet. It derives its name from the long lateral branches which

are so flexible as to enable them to bend readily without breaking. In general it closely resembles the bristle-cone pine, both in its altitudinal range and in habit of growth. It commonly possesses the same bushy form and branching trunk as the foregoing species, although occasional specimens may be found which possess a tall, straight, unbranched trunk. It is much more abundant in this state and reaches a greater size than the bristle-cone pine. The needles of this pine are also borne in bundles of five, but are about one-half longer than those of the bristle-cone pine and instead of remaining on the branchlet for twelve to fifteen years as in that species, in the limber pine they remain only from three to five years. This gives the branches the appearance of being covered with short tufts of needles at the ends of the twigs.

In this pine the sheath of each bundle of needles is composed of long, thin scales which fall away almost before the foliage has reached full size. Thus in looking at the bundles of needles, the sheath is apparently wanting except during the early part of the season, when the new growth is just coming out. The cones are commonly three to five inches in length, although in some parts of the range of this tree, they are much larger than this. The cone scales are broadly oval and are entirely destitute of prickles. This feature readily distinguishes the limber pine from the bristle-cone pine. The seeds are about one-third of an inch in length and ordinarily are wingless.

The bark of young stems and branches is light grey or silvery white. On old trunks it reaches a thickness of one to two inches and is of a blackish brown color. In such cases, it is broken into broad ridges by deep fissures which are often crossed by smaller fissures which separate the ridges into rectangular plates covered by small scales. The wood is rather light, soft, fine grained, with pale yellow sap wood and reddish heart wood. Commercially this tree is of relatively little importance in this state. It is occasionally used in the manufacture of lumber, mine posts, railway ties and for fuel. Occasional specimens may be found which possess straight, unbranched trunks, suitable for posts or for sawn lumber.

3. ROCK PINE, ROCKY MOUNTAIN YELLOW PINE, BULL PINE

Pinus ponderosa scorpulorum Engelm.

This is the Rocky Mountain form of Pinus ponderosa, commonly known as bull pine and western yellow pine, a tree which extends from the western Rocky Mountain region to the Pacific slope and from British Columbia to western Texas and Mexico. It is the common pine of the foothills and lower mountain slopes in Eastern Colorado. In some places, for example along the Divide which extends eastward for many miles between Denver and Colorado Springs, this pine reaches well into the plains region. West of the Continental Divide the yellow pine occurs principally in the southwestern quarter of the State, where it reaches its best development as a lumber tree. Among the mountains, the rock pine commonly leaves off at an altitude of about 8,500 feet, although occasional

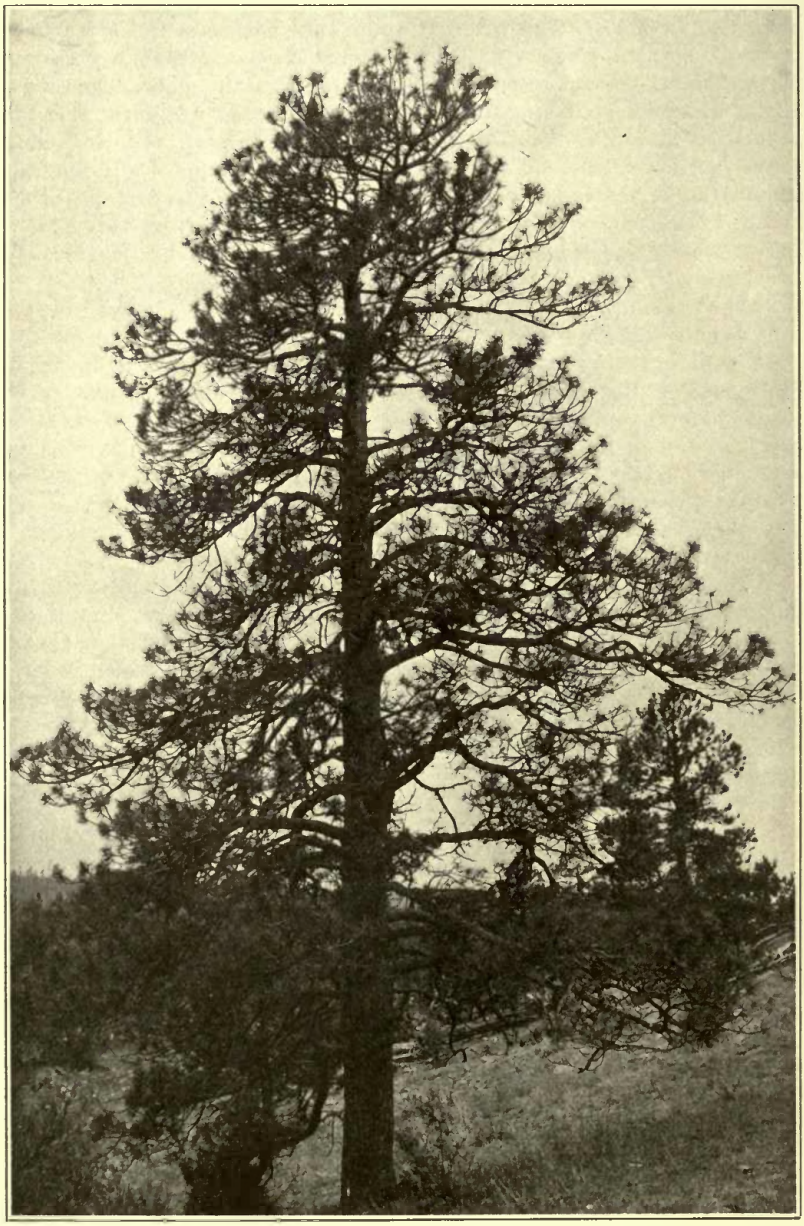


Fig. 5. Yellow Pine. Mature tree, open-grown type, 50 feet tall, trunk 25 inches in diameter.

specimens may be found much higher than this. It is capable of growing in drier situations than most of our other conifers, and is therefore the common type of tree found upon southern and western slopes. Upon dry and rocky ridges this pine grows in low rounded form with short, stocky trunk, but when more favorably situated as to soil and moisture, it reaches a height of 80 to 100 feet and a trunk diameter of two to four feet. In such cases, the trunk loses its lower limbs in early age and forms clear trunks adapted to the better class of lumber. The needles are dark green in color and are borne in bundles of two to three on the same twig. Their length is from three to six inches.

The bark on trees of moderate age is broken into rounded ridges, covered with small brownish or nearly black scales. In this condition, the tree is often known as Black Jack among lumbermen. In trees that have reached two feet in diameter, the bark usually divides into broad plates which extend up and down the trunk and are covered with cinnamon red scales, due to the disappearing of the outermost layers. Under such conditions, the bark acquires a thickness of from one to three inches. The sap wood is nearly white, while the heart wood takes on a light red color. It is heavy and strong, but differs much in quality and is apt to be quite knotty unless sawn from very large clear trunks. The botanical name, ponderosa, refers to the great size and heavy weight of this timber.

The cones in our region are usually 2½ to 3 inches in length and the thick, hard scales are tipped with slender prickles, which become easily broken off after the cones have opened to discharge the seeds. The seeds are about one-quarter inch long with wings about one inch in length. The seeds germinate readily and the seedlings are able to withstand the direct sunlight, making this one of the easiest of our native evergreens to raise from seed. This is our most important native lumber tree in Colorado and produces the best quality of lumber in the matter of strength and durability. While it is still common throughout the eastern foothills of the state, the most extensive forests of this tree were at one time to be found in the southwestern portion of the state in the Mesa Verde region where extensive lumbering operations have been carried on. Much of this cut-over land is now being reforested, however, by a natural growth of this tree.

4. LODGE POLE PINE, WHITE PINE.

Pinus contorta murrayana Engelm.

The lodge pole pine, also improperly called white pine, derives its name from the use which has been made of it by the Indians in the building of their tepees. Its distribution is quite general throughout the Rocky Mountain region from Northern British Columbia to Northern Arizona and New Mexico and westward to the mountains of Oregon and Northern California. In Colorado, north of the San Luis Valley, it is very generally distributed throughout the Rocky Mountains at elevations between 8,500 and 10,000 feet altitude. It usually begins a little lower down than where the Rock Pine leaves off, so that in ascending the

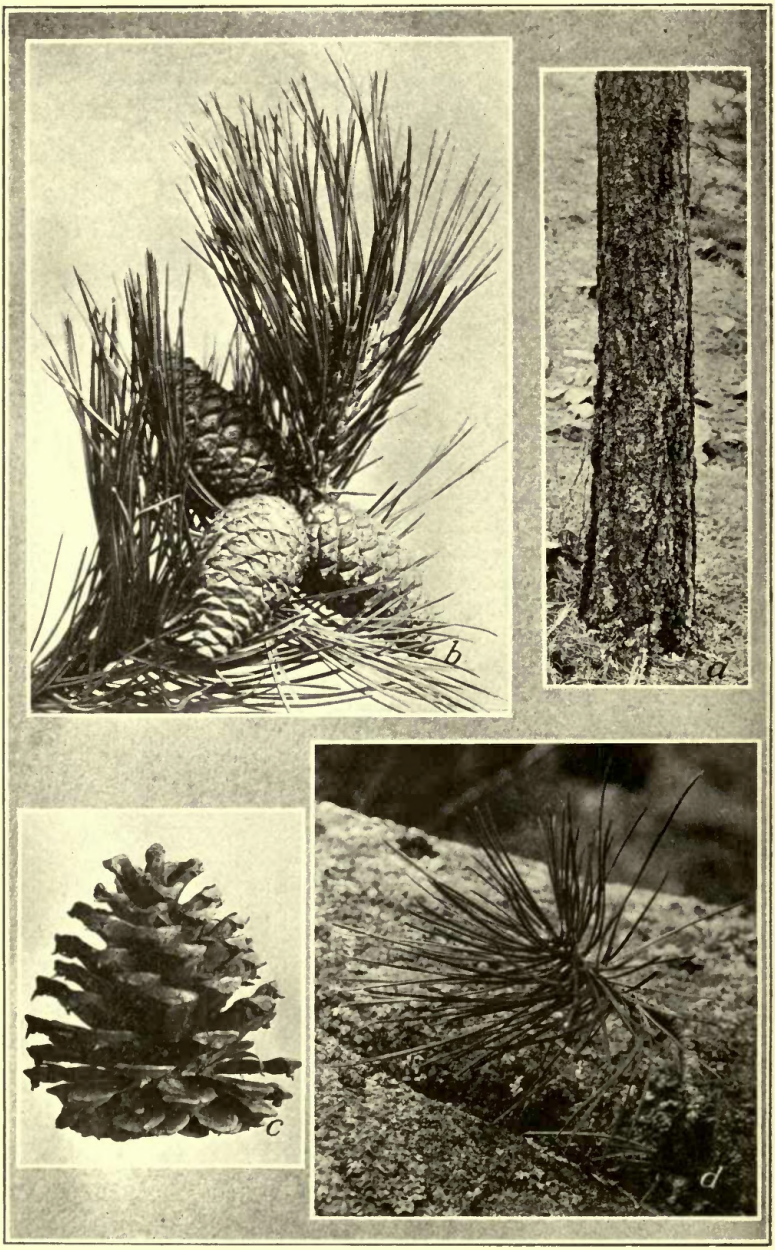


Fig. 6. Yellow Pine. **a.** Immature fourteen-inch trunk, "blackjack" type. **b.** Cones and needles, x½. **c.** Mature, open cone, x½. **d.** Dwarfed specimen, 40 years old, growing from crack in rock.

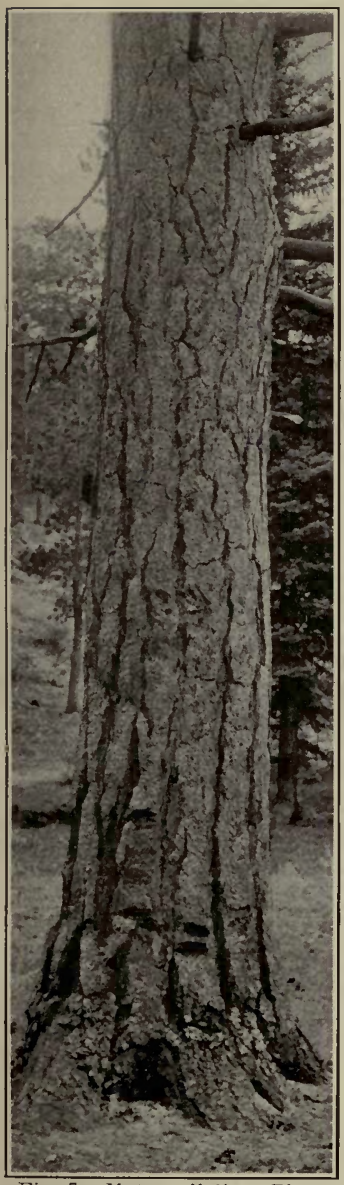


Fig. 7. Mature Yellow Pine, 38-inch trunk.

mountain slopes these two species are often found in mixed growths. At 9,000 to 9,500 feet, however, the lodge pole pine is usually found in nearly pure stands and in such cases forms the densest forests to be found in our mountains. The young growth of lodge pole pine is often so dense that it is almost impossible for a person to crowd his way through.

This tree is less able to stand drought conditions than the Rock Pine and is consequently found in its most vigorous growth on northern and eastern slopes where the moisture conditions are more favorable. It is characterized by tall, slender, straight trunks with the crown of foliage carried mainly at the top. In our region, the lodge pole pine seldom grows to a height of more than 70 or 80 feet with a trunk diameter of from 12 to 20 inches.

The needles are commonly 2 to 2½ inches in length and are borne in bundles of two. They are a lighter green than those of the rock pine, so that forests of this tree present yellowish green masses of foliage. The bark on young specimens is thin and covered with small, greyish scales. As the tree becomes older, these scales disappear, leaving the bark of a light orange or reddish brown color. The bark even on large trees is seldom over a quarter inch in thickness, although on veteran trees of great age, it may become somewhat ridged and from a third to half an inch in thickness at the base. It is always much thinner than that in the rock pine. The wood is light, soft, light yellow or nearly white in color, and lacking in durability. The cones are usually a little shorter than the needles and are borne in clusters of 2 or 3 surrounding the branch. Many of the cones remain closed and attached to the limbs for many years, so that they occasionally become entirely overgrown by the enlarging of the stem. Sometimes these cones are exposed when the trunk is split or sawn, 75 or 100 years after they were produced. These closed cones are usually somewhat curved and

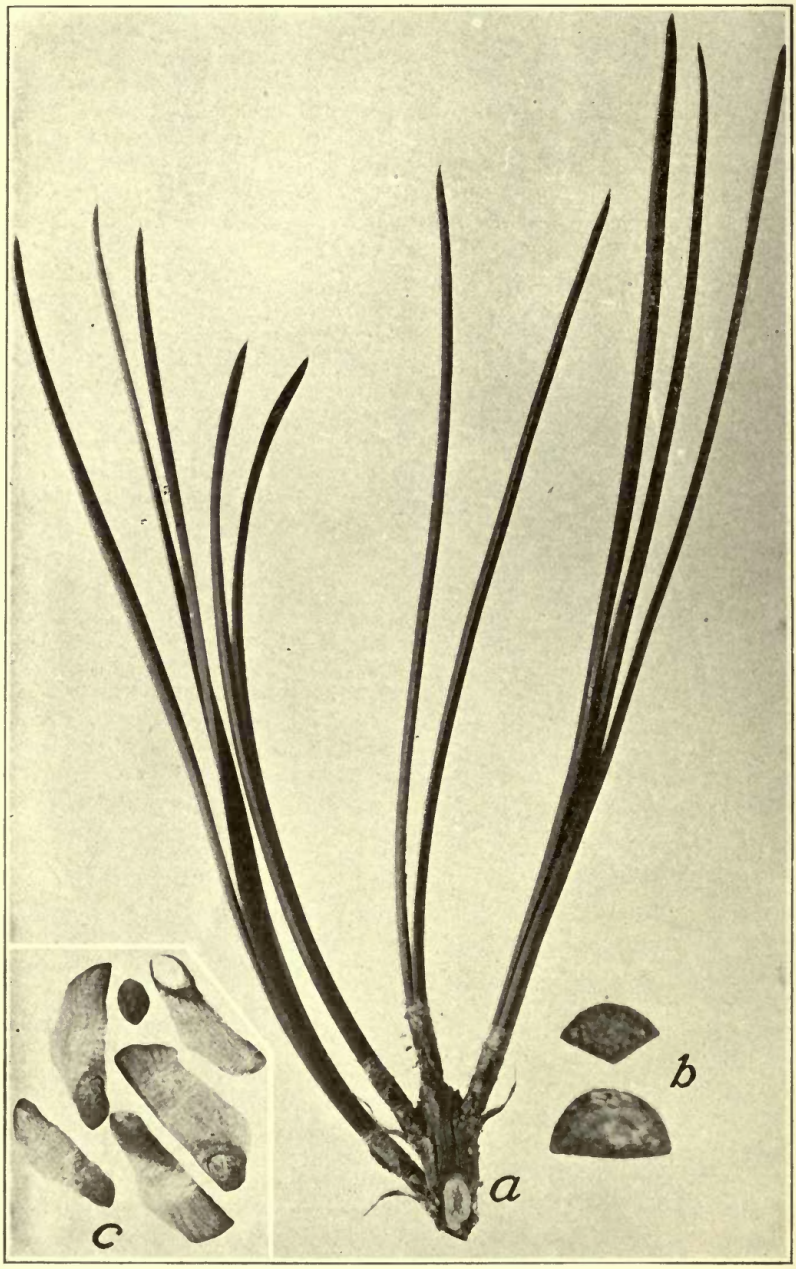


Fig. 8. Yellow Pine. **a.** Bundles of needles, two and three in bundle. **b.** Cross-section of needles, x10. c. Seeds, x1.

are more composed of numerous thick, hard scales each tipped with a slender prickle. A strong heat, such as that produced by a light forest fire, will cause these "tight cones" to open and allow the seeds to fall out. As the seeds may retain their vitality in these cones sometimes for 20 years, a quick forest fire often brings about a generous reseeding of the burned area by causing these closed cones to open.

While the wood of the lodge pole pine is of inferior quality, it is quite extensively used for railway ties, mine timbers, telephone poles, fence posts and to some extent for sawn lumber. Its durability can be greatly increased by treating with some timber preservative and its usefulness extended for all purposes where it is used in contact with the soil.

5. THE PINYON PINE.

Pinus edulis Engelm.

The pinyon pine occurs chiefly at moderate elevations, forming scattered groves or open forests, frequently mixed with Western Red Cedar among the eastern and western foothills of the Rocky Mountains of Colorado, in southwestern Wyoming and western Texas and Arizona. It may be looked for between elevations of 4,000 and 9,000 feet, but is most common at altitudes of about 5,000 to 7,000 feet. It is a tree of small or medium size with compact rounded crown, which extends nearly to the base of the trunk. It rarely exceeds 20 to 30 feet in height, with a trunk diameter of 1 to 2 feet. The needles are in bundles of 2, occasionally 3, and are about 1 inch in length. The trunk usually tapers rapidly upward and is frequently branched. The bark is from a half to three-quarters of an inch in thickness on old trees and is irregularly divided into ridges covered with small, blackish brown scales.

The wood is light, soft, brittle and light brown in color. The cones are nearly spherical in form and about equal in length to the needles. The few scales of which they are composed are without prickles. The seeds are larger than those of any other of our pines. They are usually about half an inch in length or the size of ordinary field beans and are wingless when separated from the scales of the cone. The wood of the pinyon pine is seldom used for lumber on account of the short, knotty trunks. It has been extensively used, however, for fuel and the manufacture of charcoal and to some extent for fence posts. The seeds have been extensively collected by the Indians who made use of them for food, and they are still a common article to be found at confectioners' stands.

2. GENUS *Picea*—THE SPRUCES.

The spruces are mostly tall growing trees with conical or pyramidal crowns and tapering trunks when grown in the open. They are most readily distinguished from the pines by the needles, which are single and possessed of a very short, stalk-like portion at the base. In the case of needles which are one year old, this stalk-like base is brown in color and is apparently jointed to the green upper part of the needle. These

little stalks remain on the branches for several years after the green portion of the needle has fallen off. This gives the branchlets a very rough appearance after the needles have fallen, which readily serves to distinguish the spruces from the firs. In our species, the needles are four-angled in cross section and end in sharp pointed tips. The pistillate flower cones are produced at the ends of small lateral branches. They are usually somewhat larger than in the pines and are dark brownish purple. The staminate flower cones, instead of being crowded together in dense masses around the new growth, are scattered along the branchlets and are usually somewhat larger and looser than those of the pines. The seed-bearing cones of the spruces require but one season in which to mature their seeds. During the blossoming period they point upward, but after being pollinated and fertilized, the cones become pendulous or hanging and remain in this position as long as they are attached to the tree. In some cases, as in the Engelmann spruce, the cones may be borne in such crowded clusters that some of them are forced to point upward. They usually open in late autumn or early winter for the discharge of the seeds. The seeds are much smaller than in any of the pines and each one is furnished with a long thin wing. The spruces occur mostly in moist soil, either along streams and gulches or on the northern and eastern mountain slopes. They furnish some of our most ornamental evergreen trees and are useful in the formation of hedges, wind breaks and shelter belts. There are but two species of spruces native to the mountains of Colorado.

Fig. 9. Lodgepole Pine. Dense growth following a forest fire.

KEY TO THE SPECIES OF PICEA IN COLORADO

I. Needles very stiff and sharp pointed; surface of the twig among the needles of the new growth smooth and free from fine hairs; mature cones 2 to 3 inches long. 1. *Picea parryana.*

II. Needles less rigid and sharply pointed; surface of the twig among the needles of the new growth finely pubescent or hairy; cones 1 to 2 inches long. 2. *Picea Engelmanni.*

BLUE SPRUCE, COLORADO BLUE SPRUCE, SILVER SPRUCE.

Picea parryana (Andree) Sarg.

This is one of the most admired and widely known evergreens in the world and is sometimes called the most beautiful of the evergreens. It is somewhat limited in range, being found in Colorado and Eastern Utah and extending northward into Wyoming. It seldom forms a forest, but commonly grows as scattered individuals in groups or small groves along the streams in the mountains. It is most commonly found between altitudes of 7,000 and 9,000 feet. Mature trees may reach a height of 75 to 100 feet with a trunk 1 to 2 feet in diameter. The young trees are often very symmetrical in form, especially when growing in the open and it is during this period that they are most beautiful and desirable for landscape gardening. The crowns of very old trees frequently become quite ragged and open and the color of the foliage less pleasing than in youth. The needles on different individual trees may vary widely in color from clear, bright green to silvery greenish blue. The new growth is more distinctly bluisn or silvery than in the older foliage, so that this tree is most striking in appearance just after the new foliage has reached its full growth in midsummer. This silvery appearance is due to a fine, powdery substance which is produced on the surface of the needles and which may be largely removed by rubbing them between the fingers. The branches of the blue spruce commonly grow with a slight upward angle, although occasional specimens may be found in which the branches have a drooping or weeping character. The bark on young trees soon becomes rough and broken into

Fig. 10. Lodgepole Pine. A mature tree.

small oblong scales and on old trunks it is divided into lengthwise ridges, a character which enables a person to distinguish this tree from the Engelmann spruce.

The wood is soft, nearly white, weak and of light weight and is only occasionally used for lumber and fuel. The mature cones of the blue spruce are usually about three inches in length and of a pale brownish or whitish tan color. The scales are numerous and each one is somewhat prolonged into a narrowed tip. The blue spruce is extensively planted for ornament. Well grown specimens, especially when twenty-five or thirty years of age, are beautiful trees, but in older age, there is a tendency for the lower branches to die off and leave this part of the tree somewhat ragged. For landscape gardening purposes, the bluest specimens are selected by the nurserymen, as the price which this tree commands is largely in proportion to the blueness of the foliage. Seed of this species has been introduced into Europe and some of the finest

Fig. 11. Lodgepole Pine. **a.** Nine-inch immature trunk. **b.** Terminal portion of branch with cones one, two and three years old.

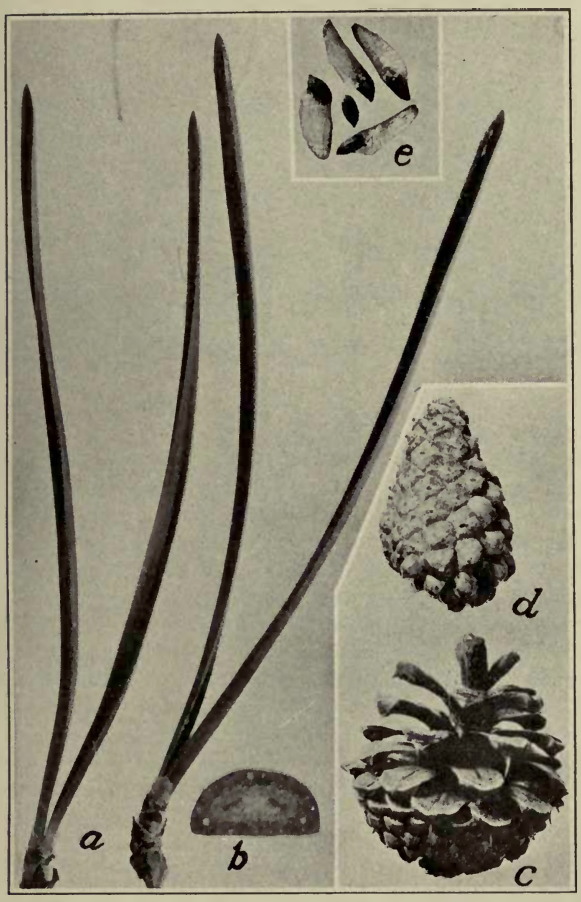


Fig. 12. Lodgepole pine. **a.** Needles, two in each bundle, x2. **b.** Cross-section of needle, x10. **c.** Mature, open cone. **d.** Closed or "tight" cone. **e.** Seeds, x 1.

specimens are now grown in the nurseries of Holland. Koster's blue spruce is a particularly fine form with strongly silvered foliage obtained by selection from among a large number of seedlings. This form of the blue spruce is propagated by grafting upon the seedlings of the ordinary type. The blue spruce is well adapted to the formation of hedges and wind breaks and when used for the former purpose, it makes a practically impassable hedge even for smaller animals on account of the stiff, extremely sharp needles. The blue spruce is at its best only when grown in a moist, fertile soil and in full sunlight. When clothed in the new growth, some of the well developed trees have the appearance of being frosted with pale blue, at which season they are unexcelled in beauty among evergreen trees.

2. THE ENGELMANN SPRUCE.

Picea engelmanni (Parry) Engelm.

This tree has a general range from the mountains of British Columbia southward through the interior mountain ranges of the continent to Northern New Mexico and Arizona. It reaches its greatest size and beauty in the northern part of its range. In Colorado, it is the most abundant of the true spruces and forms extensive forests on the upper

Fig. 13. Lodgepole Pine. Showing a cone imbedded in log over sixty years old.

slopes and along mountain streams between the altitudes of 8,500 to timber line. At the upper limits of tree growth, the Engelmann spruce sometimes forms spreading masses of scrubby growth, scarcely reaching the height of an ordinary man. In form and general appearance, it greatly resembles the blue spruce and in many specimens the foliage possesses the silvered appearance of that tree, especially in early age. In very old trees, the crowns are apt to be somewhat less symmetrical than in the blue spruce, although occasional forms are found which are nearly perfect cones. Many of the so-called perfect trees to be found in the canyons and different parts of the state are of this species. One particularly fine specimen which has usually been mistaken for the blue spruce is to be found in Boulder Canyon. The needles are somewhat shorter as a rule than those of the blue spruce and when grasped in the hand do not present such intolerably sharp points as those of the blue spruce. This is a common method of recognizing the two species in the nursery.

While the surface of young twigs in the blue spruce is always entirely glabrous or free from hairs, the Engelmann spruce has the surface of the young twigs covered with a very fine pubescence or growth of minute hairs. This is one of the characters commonly used by the botanist in recognizing the Engelmann spruce, although in some of the high altitude forms of this tree this character is greatly diminished or nearly wanting. Usually, however, a hand lens will enable a person to see a few hairs at the bases of the needles, especially near the terminal buds.

The Engelmann spruce reaches a much larger size than the blue spruce and under favorable conditions produces clean trunks three or four feet in diameter. The bark on such trunks is dark reddish brown and separates in the form of small rounded scales. In young trees these scales are usually greyish in color externally and often separate from the trunk in ragged patches. The bark seldom if ever becomes ridged or furrowed as it does in the blue spruce and this is one of the most valuable characters by which to distinguish large specimens of these two species.

The cones of the Engelmann spruce are usually about one and one-half inches in length and composed of red-brown scales somewhat broader and more rounded than those of the blue spruce. This is one of our most valuable native lumber trees in Colorado. The wood is light, soft and nearly white in color and while not very strong, it is extensively manufactured into native lumber, mine timbers and is used to some extent for poles, posts and fuel. The bark is sometimes used in the tanning of leather.

While this tree is not often planted for ornament, it is well adapted to such use in this state and well selected specimens are nearly equal in beauty to the blue spruce. It is not adapted, however, to dry situations, for under such circumstances, the foliage is apt to take on a yellowish color, which detracts much from its appearance.

3. GENUS *Pseudotsuga*—DOUGLAS FIR, DOUGLAS SPRUCE.

The name of this genus means "false hemlock," which is taken from the partial resemblance which these trees bear to the hemlocks. They are nearly intermediate, however, between the true spruces and the firs. They are tall, stately evergreens with much the same form as the spruces,

Fig. 14. Pinyon Pine. Aged tree 15 feet tall. Owl Canyon.

but they differ from these trees in the fact that the needles, which are flattened and blunt at the apex, fall entirely from the branchlets and leave small oval scars. In the latter character they resemble the balsam firs, although the leaf scars are usually smaller and are oval in shape across the branchlet. The cones resemble those of the spruces in that they are pendulous or hanging and that they do not break up when mature as in the firs. The Douglas fir cones differ from those of the spruces in the presence of slender, toothed bracts which project from between the scales giving the cones a feathered appearance. This character is so prominent that these trees can be quite easily recognized as far as the details of the cones are visible. Only two species in this genus occur in North America, one of which occurs in Colorado.

Fig. 15. Pinyon Pine. **a.** Needles and open-cone. **b.** Mature closed cone. **c.** Seeds. No. 7.

DOUGLAS SPRUCE, DOUGLAS FIR, RED FIR.

Pseudotsuga mucronata (Raf.) Sudw.

This tree is known by a number of common names throughout its range. It is a common tree in the hills and mountains of the greater portion of the Northwest, from British Columbia and Alberta on the north to Northern Mexico and Texas on the south. When young, it is a tree of conical form with bright green foliage in which condition it resembles the green forms of the blue spruce. In age, the crown becomes quite ragged and open and the branches have a tendency to droop somewhat. It reaches its greatest size in the moist climate near the coast of the Pacific Northwest and in the western foothills of the Cascade Mountains, where it not infrequently reaches a height of 200 feet or more with a trunk sometimes ten to twelve feet in diameter. In that region it grows remarkably straight and with clear trunks suitable for masts and spars of sailing vessels and for tall flagstaffs. In the drier inland regions it is seldom found growing to a height of more than 100 feet and with a diameter of two or three feet.

The needles are usually about one inch in length, flattened and slightly grooved above and with a prominent midrib on the under surface. On lateral branchlets, they have a tendency to spread horizontally in such a way as to form flattened masses of foliage. The needles are narrowed at the base in the form of a short stalk which falls away with the upper part of the needle, a character which readily distinguishes this tree from the spruces.

The bark on the trunks of young trees is smooth and grey in color. In older trees it becomes broken into strong ridges, which in large specimens may reach a thickness of several inches. In the Rocky Mountain form of this tree, the bark on old trees is deeply furrowed and of a light brownish grey color. The sap wood is yellowish in color, with heart wood of a light red or some times reddish yellow. It is variable in density and quality in different trees and to some extent in different parts of the same tree.

In the Pacific Coast range of this tree, two varieties are distinguished by lumbermen: the red fir and the yellow fir, depending somewhat upon the quality of the timber. In the former the wood is coarse grained, dark colored and is not considered as valuable as in the yellow variety.

The cones of the Rocky Mountain form of this tree are usually about two or two and one-half inches in length and are made up of rather large broad scales, each one accompanied by a projecting three-pronged bract. The presence of these cones is one of the easiest characters by which to distinguish this tree from the balsam

Fig. 16. Blue Spruce, 19-inch trunk 60 feet tall.

firs and the true spruces. The Douglas fir is quite extensively planted 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 fertile, moist soil. It appears to be adapted, however, to grow in rather dry alkaline soils, but in such situations the growth is relatively slow. It is quite readily grown from seeds which are of good size, winged and nearly triangular in form.

The Douglas fir is extensively used in this state under the name of spruce and when obtained from the foothills, it is largely used for telephone poles, fence posts mine props and the young trees are gathered in winter for Christmas trees. Most of the lumber sold on the markets under the name of Oregon pine is of this species. It is one of our most valuable structural timbers as the wood is exceedingly strong as compared with its weight, while it possesses a good degree of durability in contact with the soil. In the matter of strength and stiffness, it stands second only to Southern long-leaf pine and is adapted to a great variety of purposes from that of heavy framework to the manufacture of flooring and interior finish.

Fig. 17. Blue Spruce. Twigs showing staminate flower cones, X ⅔.

1. GENUS *Abies*. THE BALSAM FIRS, BALSAMS, FIRS.

The balsam firs are tall-growing, conical trees, often of great symmetry, which resemble in general appearance 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 needles, like those of the spruce and the Douglas fir, are single 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 of frond-like appearance. The needles are flattened, usually grooved on the upper side with a slightly projecting midrib below. Those on the lower branches and on young trees are often slightly notched at the tip, while those on cone-bearing twigs are usually somewhat pointed. The branches arise in whorls from the sides of the main trunk so that when viewed from the side, such trees often appear to have the foliage arranged in circular terraces of great beauty.

The bark on young trunks is smooth, but marked for some time with the needle scars. Numerous resin blisters, containing liquid pitch are

scattered freely over the surface, from which character is derived the common name, balsam, often applied to the trees of this genus. The bark on old trunks usually becomes roughened and more or less broken into longitudinal ridges.

The wood is mostly very soft, light and brittle and is not esteemed by lumbermen. The cones occur only in the topmost parts of the trees and stand erect on the upper side of the branches until mature, in which respect these trees differ from the spruces and the Douglas fir. When mature, the cones break up by the falling away of the scales and leave the central axis of the cone in the form of a spike, which may remain attached to the twig for some time. Complete cones of the firs are consequently never found beneath the trees, unless they have been prematurely removed by some accidental cause.

The seeds are of fair size, nearly triangular in shape, and attached

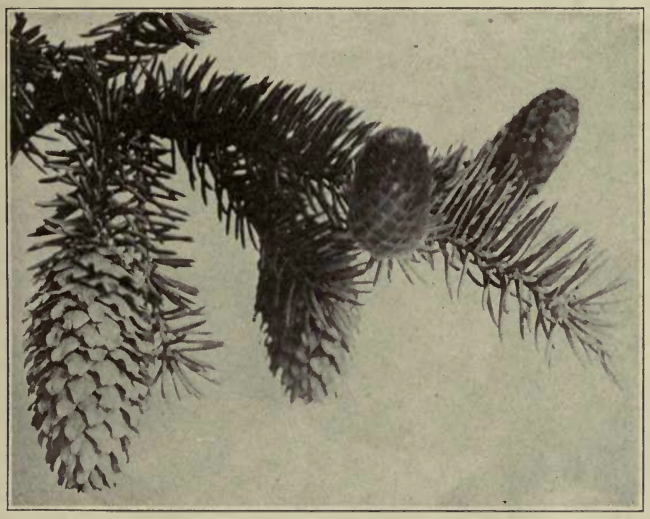


Fig. 18. Blue Spruce. Young pistillate cones pointing upward, and mature cones hanging downward, x½.

to broad, thin wings. They are scattered by the breaking up of the cones.

The balsam fir of the Northeastern states and Canada (Abies balsamea) furnishes the substance known in commerce as Canada Balsam, which is derived from the balsam blisters in the bark of this tree. Two species of balsam firs are found growing in the mountains of Colorado.

KEY TO THE SPECIES OF ABIES IN COLORADO.

I. Needles (leaves) of vigorous lower branches one to one and three-fourths inches 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.*

II. Needles (leaves) of vigorous lower branches one and three-fourths to three inches long. The two resin tubes close to the lower surface. Cones green, yellow or purple.

2. *Abies concolor.*

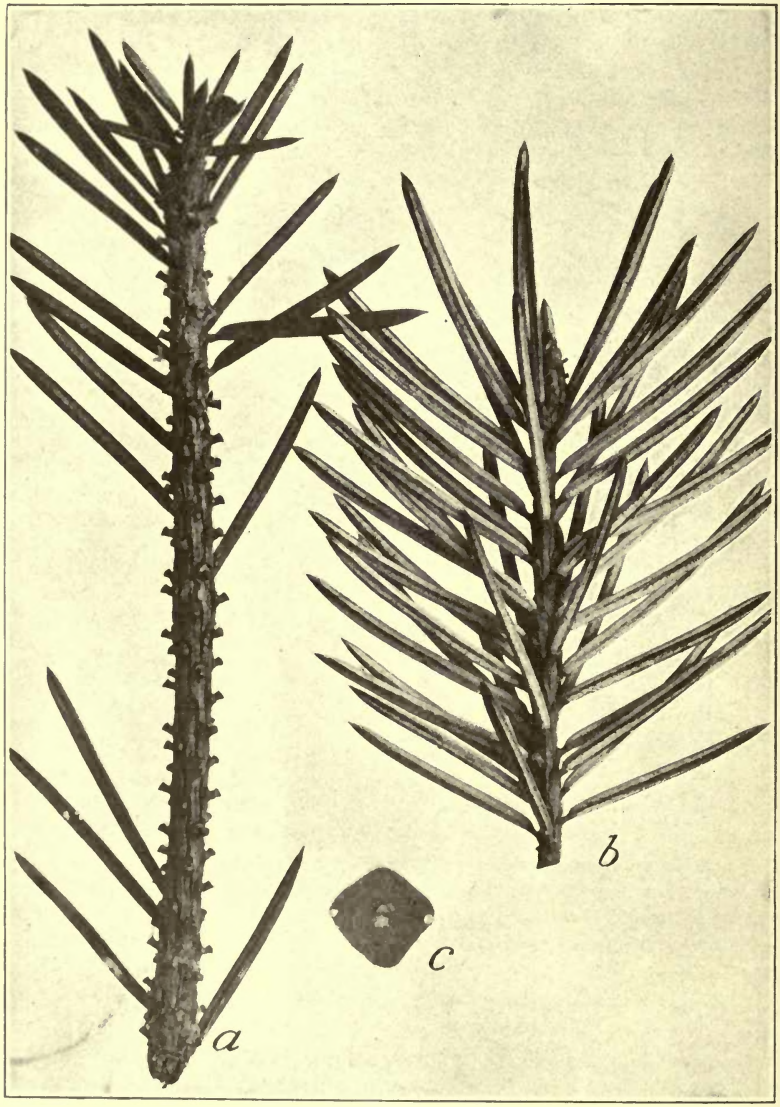


Fig. 19. Blue Spruce. **a.** Stalk-like bases on twig after needles have fallen, x2. **b.** Twig with needles attached, x2. **c.** Cross-section of needle, x10.

1. BALSAM FIR, ALPINE FIR.

Abies lasiocarpa. Nutt.

This tree, which occurs throughout the mountainous parts of western North America, in Colorado frequents the high mountain slopes and summits and appears to some extent along the streams which flow through the mountain parks. While it may occasionally be found as low down as 9,000 feet, it is most common between 10,000 and 11,000 feet and from there in scattered growth to timber-line. It is a common admixture with Engelmann spruce and forms one of the weed trees in Engelmann forests. In Colorado it is a medium sized tree, seldom over 100 feet tall and one to two feet in diameter. In shape, it is narrowly conical and occasional specimens are found which are nearly perfect in form.

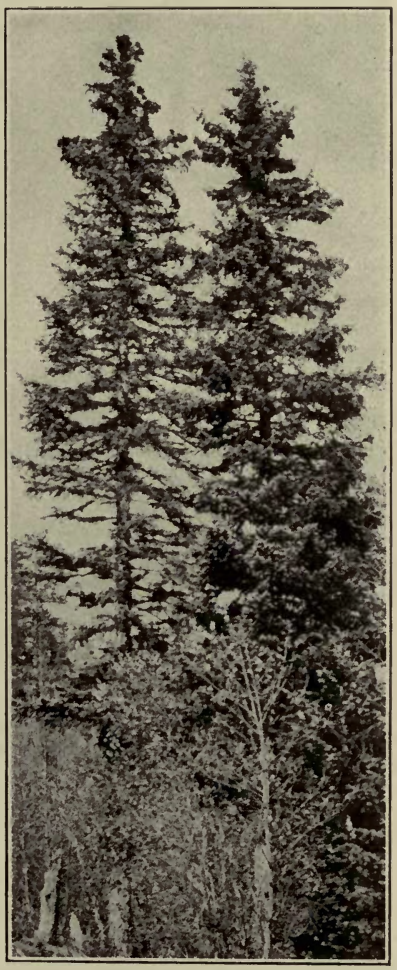


Fig. 20. Engelmann Spruce, growing in the open.

The needles on the lower branches and on young trees are usually blunt or sometimes slightly notched at the tip, while on fruiting branches they are short, pointed and curved upward. They often possess a whitish or silvery bloom much like that of the blue spruce. When cut across, each needle shows two minute ducts or tubes full of resinous juice, situated about midway between the upper and lower surfaces near the margins of the needle. While these tubes can be distinguished with the naked eye, it is necessary to examine them with a hand lens in order to note their position with any degree of accuracy. It is often sufficient to break the leaf across in order to bring them to view.

The trunks of young trees retain the old needle scars for many years on account of the smooth bark. The resin blisters are numerous and appear like slight scattered swellings just under the outer bark and when cut into, the pitch or resinous juice which they contain readily oozes out.

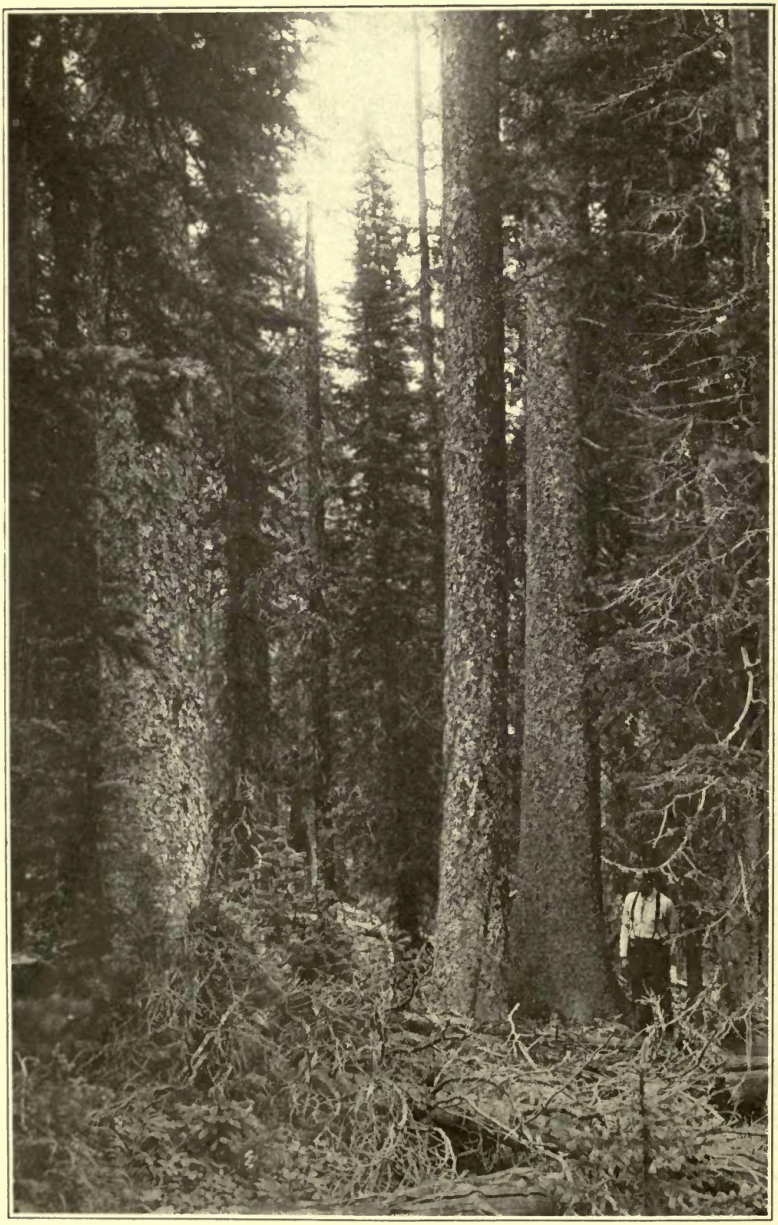


Fig. 21. Engelmann Spruce. Heavy stand of large specimens. Lookout station, college forest.

The wood is nearly white in color and only about three-fourths as heavy as that of yellow pine. It is so soft and brittle as to be of but little use where strength is necessary.

The cones are usually about three or three and one-half inches in length and of a dark purple or nearly black color and are usually more or less coated with balsam. The wood of this tree is considered as of such little value by lumbermen that it is often cut and left on the ground instead of being utilized. At present it is being used for the coarsest, poorest grades of lumber where durability and strength are not important. It is sometimes removed from the Engelmann spruce forests where it occurs, to give room for the more valuable species with which it is growing. The symmetrical form and handsome foliage of this tree would seem to mark it as a desirable ornamental tree and it is sometimes planted for this purpose in the Northern United States and Europe. In the forests of this state, however, it appears to be rather short-lived and is seldom found planted except in tree collections.

2. WHITE FIR, CONCOLOR FIR.

Abies concolor. Lindl.

This is the only true fir to be found within the arid regions of the Great Basin and in Southern New Mexico and Arizona. In this state the concolor fir occurs not farther north than the region of Pike's Peak, at which point it seems to replace the Alpine Fir from the northern parts of the state. When fully grown, it is a much larger tree than the preceding species. Some very good specimens of moderate size are to be seen in North Cheyenne Canyon, near Colorado Springs. Considerable tracts of it are to be found in the San Juan forests of Southern Colorado, where it is lumbered to a moderate extent. During the first year or two, the foliage is similar in color to that of the Silver Spruce, and this, together with its regular whorls of frond-like foliage masses, makes this a very handsome tree.

The needles are usually about one-fourth to one-third longer than those of the Alpine Fir and when examined with a hand lens in cross section, the two resin ducts are found to be very close to the lower surface of the leaf, a character which serves to distinguish this tree in all cases from the Alpine Fir. The trunk of the young tree resembles to some extent that of the preceding species, but the bark soon becomes quite deeply cracked and strongly ridged, so that in trunks of the same diameter, that of the concolor fir is much rougher than that of the Alpine Fir.

The wood is similar in quality to that of the Alpine Fir and is used for much the same purposes where it occurs in abundance. The cones are considerably larger than those of the foregoing species and are often pale green in color until nearly mature, when they take on a light brownish color before breaking up. In some specimens, the cones acquire a purple tint usually lighter in color, however, than that of the Balsam Fir cone.

This tree is planted to some extent for ornamental purposes and when well grown is worthy a place in any grounds. It may be expected to thrive better in the southern portions of the state and at lower altitudes than the preceding species.

5. GENUS *Juniperus.* THE JUNIPERS, RED CEDARS, SAVINS.

The members of this genus are readily distinguished from the other members of the pine family in Colorado, first, by the needles which are either scale-shaped or awl-shaped and are usually borne in pairs on opposite sides of the twigs or in whorls of three; second, by the fruit, which instead of ripening into a dry cone composed of woody or papery scales, forms a berry-like fruit with but few seeds. Also the staminate and pistillate flowers occur on separate individual trees of the same species, instead of being on the same individual tree, as in the other members of the pine family. The staminate flowers are produced in tiny cone-like clusters, composed of ten or a dozen scales, each bearing two to six pollen sacs. These may frequently be found fully developed in autumn, ready to discharge the pollen in early spring. The pistillate cones are likewise formed during the preceding summer and autumn and occur at the tips of very short lateral branchlets. Each consists of two to six scales, standing opposite in pairs and when in bloom, the tips of the two ovules may be distinguished

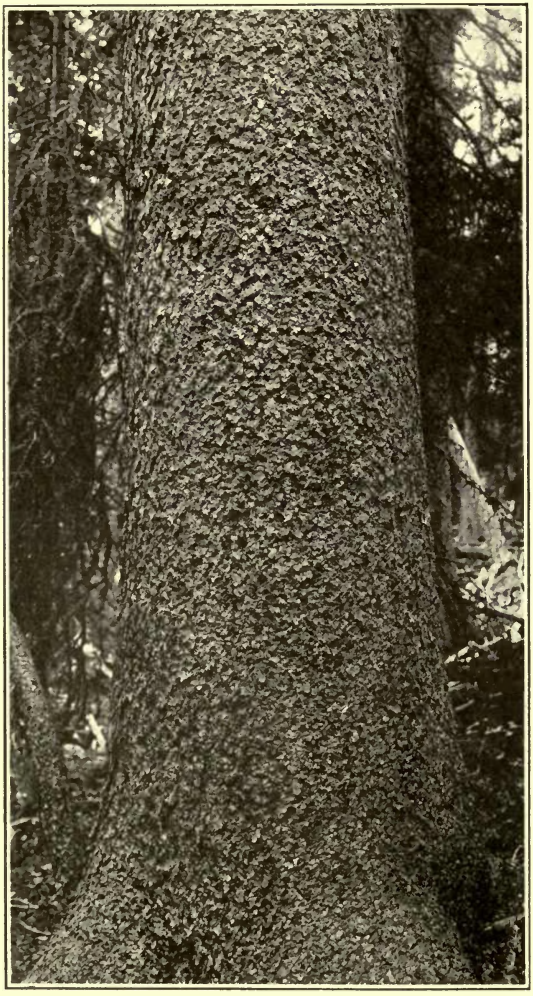


Fig. 22. Engelmann Spruce. 39-inch mature trunk.

at the base of each scale by means of a hand lens. After being pollinated and fertilized, the scales rapidly grow in size and unite to form the so-called juniper berry. Careful examination will reveal the marks upon its surface of the original scales which compose the berry. This berry may require from one to three years to mature the hard-shelled seeds which it contains, depending upon the species. When ripe, the juniper berry is usually more or less juicy and sweet-flavored with a pronounced resinous taste and contains from one to three or more bony-shelled seeds without wings. The berries of certain species of junipers are used in the manufacture of the distilled liquor known as gin, which owes its particular qualities to the presence of the aromatic volatile oils contained in the juniper berries. The hard, thick coat of the juniper seeds enables them to pass unharmed through the digestive apparatus of birds which sometimes feed upon them, and in this way they are widely distributed to new locations. The berries of some red cedars have been largely used by the Indians for food, after being ground and baked into cakes. The large, smooth seeds of one species are not uncommonly used for stringing as beads for various ornamental purposes among primitive peoples.

The wood of the juniper and red cedars is fine, close grained, uniform in texture, not hard but exceedingly durable. The characteristic odor possessed by the red cedar wood is due to a volatile aromatic oil which may be obtained by distillation as a very dark reddish brown oil, possessed of the odor of the wood. This oil is used to some extent in the manufacture of perfumes and for scenting inferior woods of other species. Probably the most extensive use that is made of red cedar wood is in the manufacture of lead pencils. Its fine, soft grain of even texture, the attractive color and the pleasing odor of the wood fits it pre-eminently for this purpose so that no other has been found as a perfect substitute. The wood with its characteristic odor, which is repellant to most insects, also greatly favors its use in the making of chests and boxes used for the storage of garments and furs. Some of the junipers form scrubby spreading plants which are not adapted to the production of lumber, while others form trees of moderate size, the trunks of which are extensively used for fence posts on account of the great durability of the wood. Some botanists separate the junipers into two genera, depending upon the way in which the needles are produced and the fruit borne. All of those which occur in Colorado, however, have been included in one genus. There are only three species commonly found within our border which reach the stature of trees.

On account of the fact that the leaves on seedling or immature specimens of the junipers are so much alike, it is necessary in using the foliage for identifying the species, to make examination of leaves from fully developed or mature plants, those which are at least two feet in height.

Fig. 23. Englemann Spruce. **a.** Twig showing fine hairy covering among the needle bases, x3. **b.** Cross-section of a needle, x10.

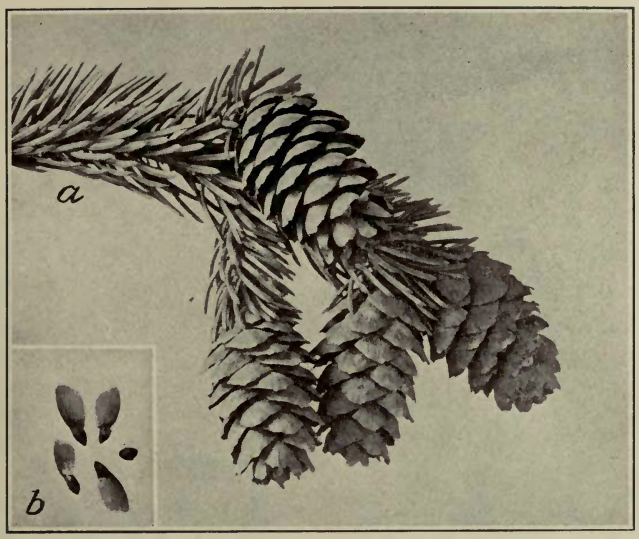


Fig. 24. Engelmann Spruce. **a.** Twig with mature cones, ×⅔. **b.** Seeds, natural size.

KEY TO THE SPECIES OF *Juniperus* IN COLORADO.

I. Leaves on mature branches in whorls of three, awl-shaped, spreading, three-eighths to one-half inch long, deeply grooved or trough-shaped and whitened on the upper surface, convex and green on the lower surface; buds scaly. Low spreading shrub.

1. *Juniperus communis, var. sibirica.*

II. Leaves on mature branches opposite in pairs, scale-like and flattened against the branchlets, to which they are usully grown fast through about half their length; about one-eighth inch long; on young trees and vigorous shoots, slender pointed and somewhat spreading, one-fourth to one-half inch in length; buds naked. Small or medium sized trees (except No. 2).

1. Low-spreading or prostrate shrub.

2. *Juniperus prostrata.*

2. Trees or tree-like, six to fifty feet high.

A. Fruit large, one-fourth to one-third inch long; reddish brown or copper-color with a bluish bloom; cotyledons of the seed, 4-6.

3. *Juniperus Utahensis.*

B. Fruit small, usually less than one-fourth inch long; cotyledons of the seed, 2.

a. Leaves slightly spreading at the tips, yellowish green; fruit mostly one-seeded; seed thin-shelled.

4. *Juniperus monosperma.*

b. Leaves closely flattened against the branchlets, bluish green; fruit, 1-4 seeded; seed thick shelled.

5. *Juniperus scopulorum.*

1. LOW JUNIPER, MOUNTAIN JUNIPER.

Juniperus communis, var. sibirica (Burgsd.) Rydb.

Fig. 25. Douglas Fir. Vigorous young tree.

The low juniper is a spreading shrub usually less than a yard tall, but which sometimes covers several square yards in width. It commonly occurs in rocky places in the foothills and mountains up to 10,000 feet altitude. The stems are slender, branched and covered with a thin, reddish brown bark which separates into thin papery scales upon the older stems.

The needles are single, but produced in whorls of three and point upward and outward from the twigs. They are sharply pointed, rounded below and grooved above and join the stem with an abrupt bend.

The berries are about one-fourth inch in diameter, nearly smooth or with faint marks of the pistil scales and bluish in color. They require three seasons in which to mature and contain from one to three bony seeds.

The principal use to which this juniper is put is for planting in shrubbery borders. It is well adapted to planting against foundation walls, in rockeries and about rustic work, where a low evergreen is desired. The berries are sometimes employed in medicine, and are used extensively to give their characteristic flavor to gin.

The common juniper, of which this is a variety, grows to the stature of a tree in this country only on the limestone hills of southern Illinois, where it sometimes reaches a height of twenty-five feet.

2. SHRUBBY JUNIPER, CREEPING JUNIPER.

Juniperus prostrata (Pers.) Antoine.

This plant, while merely a low spreading shrub seldom more than a yard high, closely resembles the red cedars in everything except stature. It may be infrequently found upon rocky, exposed ridges and dry slopes throughout a large portion of the Northern United States and Canada. It is of uncommon occurrence in Colorado and has been recorded principally from the eastern slopes of the Rocky Mountains in this State. Its stems are slender, much branched and often prostrate, in which case they may strike root. The foliage consists mainly of very small, scale-like leaves in four ranks upon the twigs and is of a yellowish green color. The berries are usually under one-fourth inch in diameter, of a light bluish color, and contain from one to four bony seeds.

This juniper from its scarcity and small size is of little importance except for its possible use as a very low, slow-growing evergreen. Its ability to withstand exposure and drought may fit it for certain rustic effects about cabins and summer homes in the mountains.

3. UTAH JUNIPER, DESERT JUNIPER.

Juniperus Utahensis (Engelm) Rydg.

The Utah juniper occurs quite extensively on dry slopes and table lands of limestone formation, from Western Colorado to Nevada, southeastern California and Arizona, principally at elevations below 8,000 feet. It is a rather low

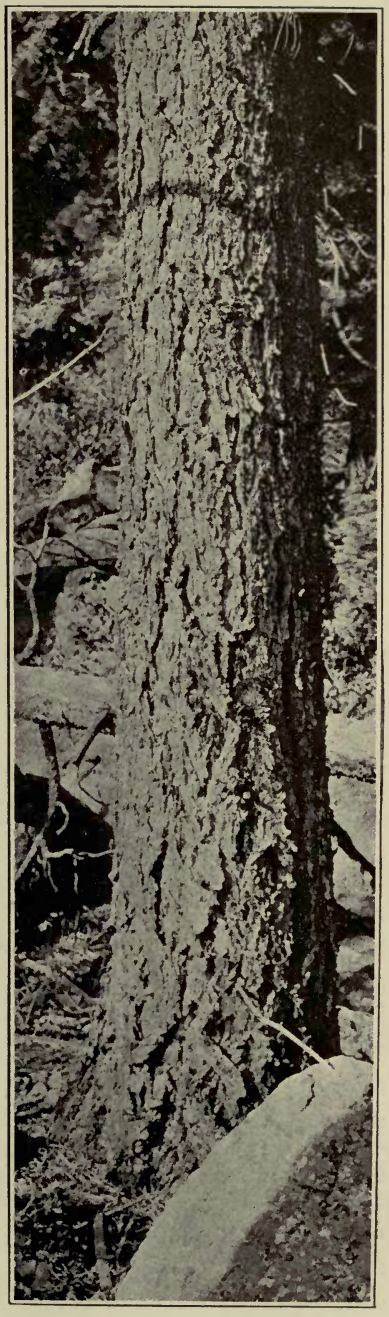


Fig. 26. Douglas Fir. Bark of old trunk.

branching tree of rounded form, and with a short, stocky trunk which is commonly forked at or near the ground. Well developed specimens such as occur in canyons may occasionally reach a height of thirty-five feet, with a crown diameter of nearly equal extent, while on drier exposed situations it is considerably lower, and is frequently broader than tall. The trunk and main branches are very crooked, with but little clear length available for use. The thin, greyish bark separates from the branches in long, fibrous shreds.

The branches are quite stiff, and are covered with short, closely overlapping, scale-like leaves arranged in four, or occasionally in six, ranks, and of a pale yellowish green color.

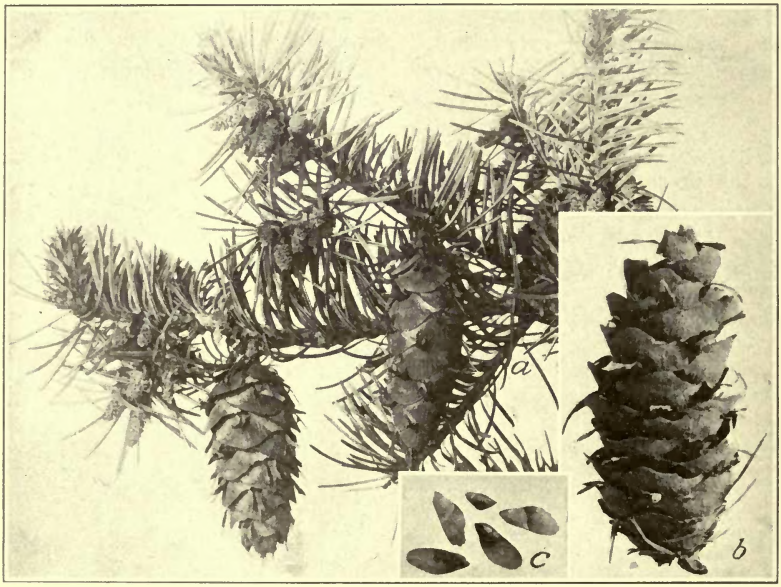


Fig. 27. Douglas Fir. **a.** Staminate and pistillate flower cones and two mature cones, x½. **b.** Mature cone, x⅗. **c.** Seeds, x⅔.

The fruit is somewhat larger than that of the other cedars found in our State, the berries sometimes reaching nearly one-half inch in diameter. In color, they are a reddish or copper brown, covered with a bluish bloom which is easily rubbed off. The berries require two seasons in which to mature, and each contains usually but one seed of good size, imbedded in the dry, fibrous flesh.

This tree is of but little commercial importance in Colorado, but is not uncommonly employed as fuel in its more western and southern range, where it reaches its best development.

4. THE ONE-SEEDED RED CEDAR.

Juniperus monosperma Sarg.

This red cedar has a more southern range than the Rocky Mountain red cedar, from which it is often with difficulty distinguished. In Colorado it occupies the dry foothills and mesas in the southern and western portions of the State, where it occasionally forms the principal tree of the genus. In stature it equals the following species but commonly divides at or near the ground into several trunks of about equal size. The smaller, scale-like leaves are usually less than one-eighth inch in length, while those on vigorous shoots are sometimes one-half inch long. They are thickened on the back, and the tips usually project slightly in the form of a small pointed tooth, a character which helps to distinguish this species. The foliage is yellowish green in color.

The bark on old trunks remains rather thin, but divides into flat, connected ridges which are broken into long shreds of a greyish color. The wood is firm, heavy, with nearly white sapwood and brownish colored heartwood, in which it differs from that of the following species which possesses reddish heartwood.

The fruit of the one-seeded red cedar is commonly less than one-fourth inch in diameter, and in color is reddish brown or copper color, covered with a bluish bloom. The seeds are usually one or sometimes two in number, and are covered with a rather thin brittle shell. They are only about one-half as large as those of the Utah Juniper.

This tree has been extensively used for fencing, wherever it occurs, while the thin, shreddy bark has furnished the Indians with a coarse textile material for the making of rough garments and sleeping mats.

5. ROCKY MOUNTAIN RED CEDAR.

Juniperus Scopulorum Sarg.

This is the common red cedar of the Rocky Mountains, with a range from Alberta and British Columbia to Arizona and Texas. In Colorado, it is found principally along the eastern slopes of the Continental Divide, from the easternmost ranges of foothills to elevations of 8,500 feet. It is one of the tallest of our red cedars in this state, although it rarely exceeds a height of thirty to forty feet.

Young trees usually grow in a pyramidal form, which in old specimens, may widen to a rounded or spreading crown of irregularly open character. It is to be found growing in gulches and canyons, upon the southern exposures, where it endures well the drying effects of the direct sunlight, upon the drier foothill slopes, or it may be seen perched upon the bluffs, along ravines, or clinging to exposed rocky points where most trees are unable to exist. It seems to thrive well either in moist and fertile soils, in apparently barren adobe, or the limestone soils of certain foothill sections, where it is a common accompaniment of the pinyon pine. The trunk of this cedar is commonly single, but in dry situations and in

Fig. 28. Douglas Fir. **a.** Twig showing needle scars. **b.** Cross-section of needle, x10. **c.** Twig with buds and needles, x2.

old specimens, occasionally is found considerably branched, or even divided toward the base. It usually tapers rapidly upward, so that trunks of clear length are not easily found. The bark in old age becomes divided into narrow, flat ridges one-half inch thick, with a light grey color upon the surface and reddish or brownish beneath. The wood is fine-grained, firm, with whitish sapwood and reddish heartwood, which

possesses the characteristic odor of the eastern red cedar. It is very durable in contact with the soil. The foliage of the Rocky Mountain red cedar is usually bluish green in color or silvered, a character which helps to distinguish it from the one-seeded red cedar, which has yellowish green foliage. The scale-like leaves are very small, short, and closely flattened against the twig, while those upon the strong-growing shoots are slender tipped, and often reach one-half inch in length.

The fruit requires two seasons for ripening. Mature berries are usually about one-fourth inch in diameter, bluish or black, covered with a heavy bloom. The seeds are commonly one or two in number, and are covered with a hard, bony shell with several ridges extending lengthwise.

This tree has been so diligently sought out and cut for fence posts, wherever it occurs, that it is now difficult to find specimens of large or medium size. It is one of our most easily transplanted evergreens, when handled in moderate size, and is well adapted to the formation of low hedges in dry situations, as it stands shearing well. Like the other red cedars, it is difficult to grow from seeds, which require careful cleaning and stratifying. Germination requires two seasons, as a rule.

TREE ZONES IN COLORADO.

In passing from the Great Plains to the top of the Continental Divide or to the summit of one of the peaks where snowbanks lie throughout the year in Colorado, an observant person is impressed with the changes that take place in the character of the vegetation at different altitudes. As the climate changes at the different levels, so the plant life also varies, not abruptly, to be sure, but yet in fairly well marked belts or zones. Upon the plains before irrigation was practiced, there were no trees except cottonwoods and willows along streams and draws or occasionally in depressions that caught the surface run off of surrounding slopes. This may be called the Plains Zone.

At the lowest and outermost range of foothills one meets the vanguard of the great forests of evergreen trees that lie higher up. This second or foothill zone lies mainly between the altitudes of 6,000 and 8,000 feet. The most characteristic tree of this zone is the yellow or rock pine, which forms open groves of dwarfed and round topped trees upon the driest ridges and among the rock piles of the outer hills or grows in closer stands of well developed specimens on the gentler and moister slopes higher up. In some portions of the state this zone is quite largely occupied by pinyon pine and red cedar with Douglas fir crowding into gulches and sheltered depressions upon northern and eastern slopes.

Above this zone lies the montaine zone with the lodgepole pine as the characteristic tree. This species often forms a dense, unbroken forest cover, on northern and eastern slopes, mixed at the lower borders with rock pine, especially on southern and western exposures. The Silver Spruces appear in limited numbers along the streams, and in Southern Colorado the Douglas fir and white fir also occupy a prominent place in this zone.

The fourth zone, known as the sub-alpine zone, extends approximately between the altitudes of 10,000 and timberline or the level at which tree

growth ceases. In this state timberline lies commonly at about 11,500 feet elevation, although this varies to quite an extent with the exposure, in some sheltered places the occurrence of stunted timber being found one thousand feet higher up.

The characteristic tree of the sub-alpine zone is the Engelmann spruce which forms great forests of splendid specimens in the more favored situations, with balsam fir as a frequent admixture. As timberline is approached, the limber pine and foxtail pine may be expected to appear upon the exposed slopes or clinging to the crests of wind swept ridges as if to defy the elements.

The growth of trees at timberline often presents a weird sight. Here the struggle of the trees for a bare existence is shown in their stunted,

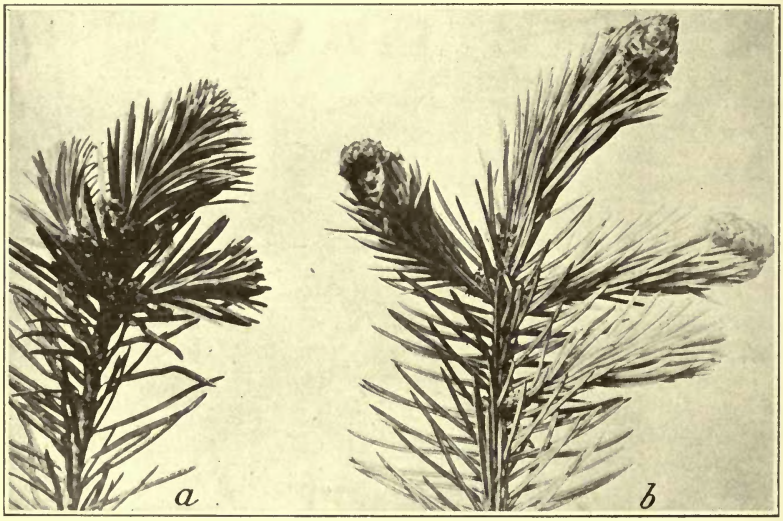


Fig. 29. **a.** Douglas Fir. **b.** Blue Spruce. Showing different behavior of their bud scales in spring.

grotesque forms which frequently hug the very earth as if to escape the wrath of the elements with which they must contend.

The fifth or alpine zone extends from timberline to the summits of the higher mountain peaks and, like the first or plains zone, is treeless but not for the same reason. Thus upon the plains it is a matter principally of soil moisture and when this is supplied by irrigation, many species of trees can be made to thrive. In the alpine zone, however, it is largely the very short growing season, together with high wind velocity and low temperature of the soil, which prohibits the growth of trees.

USES OF OUR EVERGREENS.

Evergreens for Ornamental Planting.—Among the evergreen trees of Colorado are to be found some of the most ornamental trees for landscape gardening purposes. On the home grounds, if rightly placed and properly cared for so as to secure a healthy growth, they are capable of adding much to the foliage effects of summer and of lending a pleasing touch of

green to the winter landscape when other trees are naked. Evergreens are best situated when they are planted along the borders of the grounds or at the sides or rear of buildings, where they may form a background for shrubs and flowering plants and a setting for the buildings themselves. The presence of evergreens in the front lawn where they will obstruct the view from the windows of the dwelling and where they cast a dense shade throughout the year, is decidedly against the best principles of landscape gardening. Specimen trees as a rule should not be freely used except on large grounds where they can be given plenty of room for perfect development and where they will not interfere with the view nor fill up the spaces which should be devoted to open stretches of lawn. They should be placed at a sufficient distance from other trees so that they can spread out naturally and should not be pruned except occasionally to remove any great irregularities that might develop. On extensive grounds, the evergreens appear to best advantage when planted in groups or massed in situations where it is desirable to divide the area or to hide objects from view. If planted in sodded ground, the sod should be removed and the soil deeply spaded and a circle of bare earth four or five feet from the trees should be kept well cultivated during several years.

A great many evergreen trees, as well as other kinds, are lost every year by planting them in small holes cut in the sod where they must compete at once with the grass.

It is usually undesirable to plant evergreens close to the south side of the dwelling, for, on account of the fact that they retain their foliage throughout the winter season, they cut off the sunlight during that portion of the year when it is most desired in the rooms of the home. It is not uncommon to see evergreens planted in the front yard of a small place, directly in front of the windows in such a way that the view from and toward the house is almost entirely cut off when the trees reach any considerable size. A common practice in such cases, in order to restore the view, is for the owner to prune off the lower branches and thus produce an unnatural effect in the trees themselves. As the beauty of an evergreen consists in securing the most natural and characteristic growth of which it is capable, the pruning which is often given such trees approaches mutilation.

While there are many different ideas concerning the planting of private grounds, the most pleasing and restful effects are those which approach as closely as possible the most characteristic growth of the trees and shrubs which are used as seen in the way Nature handles them. For this reason, sheared and clipped evergreens, except when used in the form of hedges, are more suited to the formal treatment in public parks and extensive grounds where this style of treatment harmonizes with the type of architecture usually employed in such places. It is advisable, therefore, to plan well in advance the position of each tree about the home grounds and to take into account the crowding which may result from future growth.

Where privacy and seclusion are sought, evergreens are well suited to such purposes. Thus they are excellently adapted to form a screen to

hide unsightly places or objects, such as ashpits, outbuildings and stock and poultry corrals, and in the latter situations they may often furnish excellent protection from the cold winds of winter.

Evergreens for Wind Breaks.—On account of the perpetual presence of foliage, the evergreens are among our most effective trees for wind breaks. They are especially desirable for planting about the sheds, barns and yards used for stock and when properly situated are capable of adding

Fig. 30. White Fir. **a.** Tree 30 feet tall. **b.** 18-inch trunk.

much to the comfort of the animals during winter. Evergreens may be effectively used for increasing the wind break character of shelter belts in combination with broad leaf trees and are desirable when planted around the windward side of the timber plantation, where they serve to check the sweep of winds which carry away the snow and fallen leaves. When planted along drives or places which must be utilized in winter, they should be set several rods away in order to avoid the formation of snowbanks which may form close along the leaward side.

For the driest situations, the native red cedars may be used, as they are capable of growing with the minimum water supply. The yellow pine

is likewise adapted to such use, but is more difficult to transplant and has a tendency to lose the lower branches after it acquires considerable size. The red cedar is objectionable in some cases on account of a parasitic fungus which it harbors and which works upon the pear and the quince. On this account it is unwise to use the red cedar along orchards where these fruits are grown. The Douglas fir and the blue spruce are desirable for such purposes where a moderate amount of irrigation can be given

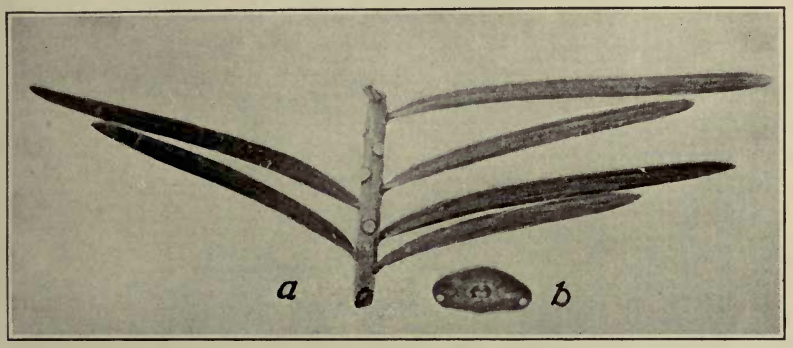


Fig. 31. White Fir. **a.** Twig showing circular needle-scars, x1½. **b.** Cross-section of a needle, x8.

them. They should be planted at least eight or ten feet apart, which will give them room in which to develop. If a denser growth is desired, two rows, with the trees alternating in each row, may be planted, with the rows from eight to twelve feet apart. Where a low hedge or hedge-like effect is desired, much closer planting should be done. Thus little trees may be set one or two feet apart and cut back or sheared each season, which will soon establish a dense and uniform wall of evergreen foliage.

As most of our native evergreens require plenty of sunlight in order to retain their vigor and health, it is nearly useless to try to form good hedges in the shade of large trees. Thorough cultivation is as desirable in securing a vigorous, healthy growth of these trees as in that of other plants, at least until they are well established, which may require a number of years.

FOREST PRODUCTS.

While Colorado is not ordinarily classed with the heavy lumber producing states, still the amount of such material which is annually taken from the mountain forests of this state has a value of several million dollars. The principal timber products are sawn lumber, railway ties, mine props, telephone and telegraph poles, fence posts and fuel. The total production of such material for the year 1911, as shown by the reports of the national forest officers, amounted to 222,808,000 board feet, worth in round numbers, $5,000,000. Of this amount the yellow and lodgepole pine lead, with spruce second, and Douglas fir third.

The two trees which furnish the largest proportion of sawed timber are yellow pine and Engelmann spruce. On account of its straight, slender trunks, lodgepole pine is extensively used for mine props, poles and posts,

while railway ties are made from the largest trees of this species. In the lower foothills region, Douglas fir is extensively used for fence posts, for which purpose its greater durability than some of the other of the native species makes it well fitted. Limber pine and bristle-cone pine are used to some extent for mine timbers, where these species occur in any considerable quantity. Balsam fir, blue spruce and white fir are utilized to a much less degree for the same purpose, the lack of durability of the fir being one of the factors which has much to do with the slight use made of it.

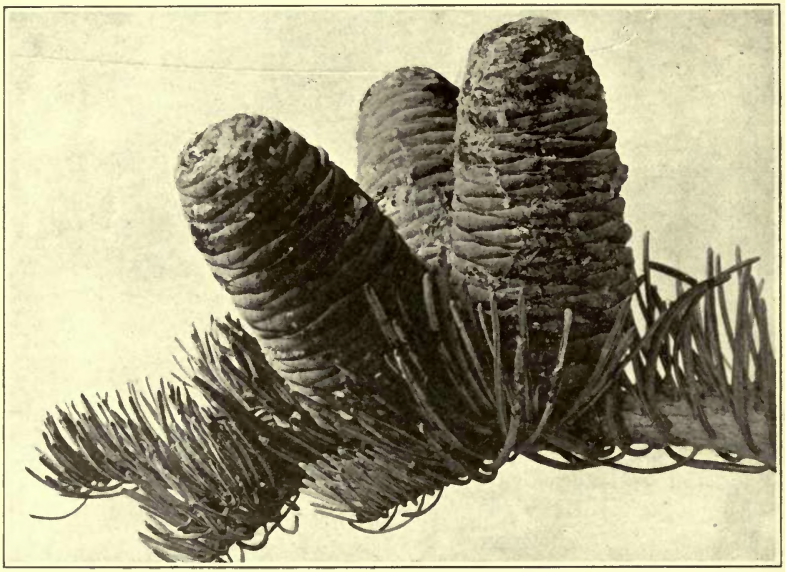


Fig. 32. White Fir. Portion of branch bearing nearly mature cones, x½.

In the production of the so-called pitch pine fence posts, yellow pine is practically the only species concerned. Pitch pine in this connection has reference to the trunks of trees which have in some way become heavily impregnated with the resinous juice from their own wood. Just how this has been brought about is a matter of considerable uncertainty, as it seems to be confined largely to individual trees and is not necessarily a characteristic of the species. It has been commonly observed that any wounds in the bark of trees which do not kill the tree at once, tend to produce a strong flow of the resinous sap, which may be absorbed gradually by the wood itself and thereby greatly increase its durability. Some persons claim to be able to produce pitch pine at will by peeling the live trees and allowing them to stand for one or more seasons. In this way the pitch which is freely produced on the surface, is reabsorbed in a large measure and gives the timber its desired quality. The writer is unable to substantiate such claims through any personal experiments or from sources of reliable information. Such experiments, however, are being conducted

by the Forest Service and this data will be forthcoming doubtless at a near date in the future.

Our native red cedar has a deserved reputation, where it is known, for its great durability in contact with the soil. This durability is confined almost entirely to the heart wood and doubtless varies in considerable degree with the rapidity with which the tree has grown. Fence posts of this tree have been known to last for a period of thirty-five years in actual service, although this should not be considered as the usual length of time. Twenty to twenty-five years for the medium sized posts is probably a safer average length of service to count upon. Red cedar is becoming so scarce at the present time that very high prices are asked for even small, crooked posts. An examination of the native red cedar posts and stakes on the market will show that in many cases from twenty-five to fifty years has been required to produce one inch of diameter growth. This slow rate of growth and the relatively small number of these trees now available, means that in comparatively few years almost no red cedar fence posts of native growth will be obtainable.

PRESERVATIVE TREATMENT OF TIMBERS.

The present and increasing scarcity of our most durable timbers, such as pitch pine and red cedar, is helping to impress the need for some process of making our cheaper but less durable timbers more lasting. A number of preservative treatments have been employed for this purpose for many years in Europe and are being more extensively used every year in this country. One of the easiest and most effective treatments consists in impregnating the wood of the least durable and cheaper species with some antiseptic fluid which will prevent the growth of organisms which produce decay in the wood. For this purpose, the commercial article known as gas tar creosote, which is a by-product in the manufacture of illuminating gas from coal and crude petroleum, has been found especially effective. For small farm operations, involving the treatment of from fifty to two or three hundred posts, the material is most effectively used by placing the butt ends of the seasoned posts into a metal tank or other container deep enough to allow the creosote to reach a point at least six inches above the depth to which the posts will be planted in the ground. The creosote is then heated either by a coil of steam pipes or by a fire underneath to a temperature several degrees above that of boiling water. When allowed to cool down during a period of from six to twelve hours, the creosote is forced into the pores of the wood by atmospheric pressure. Posts treated in this way can be expected to last two or three times as long as the untreated wood and where the treatment has been especially thorough, from four to five times the ordinary length of life of the untreated timber.

One of the tree products which was at one time of considerable importance is tan bark, obtained from the Douglas fir. Since the disappearance of the buffalo, however, from this region and the use of tannin extracts together with the diminishing of the supply of this species in this state, the tan bark industry in Colorado is at a very low ebb.

Fig. 33. Alpine Fir. Perfect form.

FOREST BY-PRODUCTS.

Among the secondary tree products which have been or may be developed from the forests in Colorado, are charcoal, resin, turpentine, essential oils, and seeds. The pinyon pine at one time was extensively employed in the production of charcoal which was largely used in the iron smelters before the introduction of the Bessemer steel process. At the present time the production of charcoal is not an important industry in this state.

Experiments which have been carried on by the Forest Service during the past three years have shown that western yellow pine is capable of producing resin and turpentine of equal quality with that now largely obtained from the long leaf pine of the southeastern states. The experiments in Arizona have shown a total yield of resin from yellow pine about four-fifths as great as that obtained from the southern pines. The lower rate, however, can be ascribed in all probability to the shorter season of production under western climatic conditions. While the season in Colorado during which turpentine production could be worked is considerably shorter than that in Arizona, still it is possible that in time this industry may be developed within our borders.

A note from an Eastern Forestry periodical of the present year states that the volatile oils distilled from the needles of spruce and fir trees are being used to scent petroleum floor oils, which may be objectionable on account of their odor. The abundance of these species in Colorado should make it possible to utilize this by-product which is wasted in our lumbering operations as now carried on.

For many centuries, doubtless, the use of the seeds of certain pines has been made by the Indians of this region for food. This is particularly true of the pinyon or nut pine, the seeds of which are of large size, rich in oil and of excellent flavor. These seeds can be found in almost any confectioner's stand where fruits and nuts are for sale. These

seeds are usually gathered by the Indians in the southern parts of our state, in New Mexico and northern Arizona, where the pinyon pine is abundant.

REARING EVERGREENS FROM SEED.

In most cases this is work which is successfully undertaken only by nurserymen or other persons of experience. However, for those who have time and the necessary patience to wait for several years while the seedlings are growing, this is a cheap way to secure a large amount of stock and is also very interesting work. Seeds of most evergreens can be purchased from the larger seedsmen, but where possible it is desirable to secure them from local growing, native trees which show the best color, form and hardiness. The proper time to collect the seeds is a little while before the cones open. If this is done too early the seeds may be immature and will not germinate, while if left until the cone scales have spread open, a large part of the seeds will have escaped, while those which remain will be somewhat difficult to secure without further loss. The time at which the cones of our native evergreens mature varies somewhat with the altitude and the locality. At lower elevations, seed collecting can begin often as early as the first week in September, while at higher elevations the middle of September is not too late.

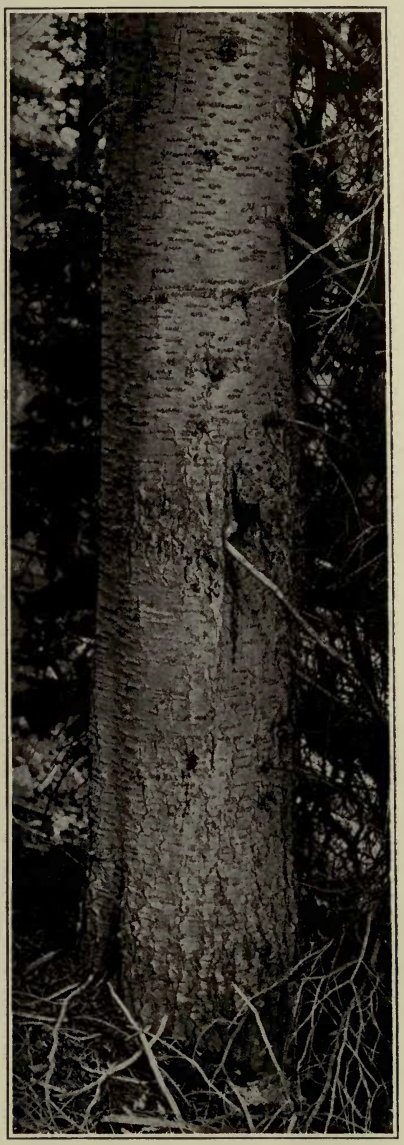


Fig. 34. Alpine Fir, 12-inch trunk.

In order to test the condition of the seeds, some of the cones should be cut open in such a way as to pass through the seeds. If they appear milky and soft, they are too immature, but if the kernel of the seed appears firm, they are ready for harvesting. In harvesting large quantities of seeds, the practice is

often made of gathering the cones at a point where extensive lumbering operations are in progress. This is one of the most economical ways of securing them, as it does not require climbing the trees. As most of the cones are produced near the topmost parts of the trees, especially in the cases of spruces and firs, it is often necessary to climb them in order to reach the crop. A small hook at at the end of a pole is sometimes employed for pulling off the cones from trees which are not too tall and to assist in reaching those in the tops of trees which must be climbed.

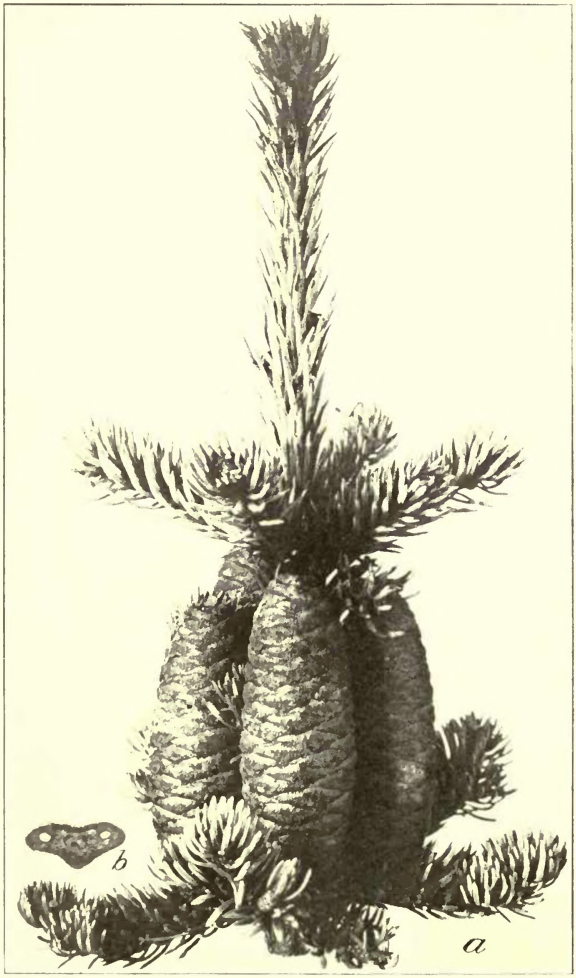


Fig. [illegible] Alpine Fir. **a.** Terminal shoot with cones, x½. **b.** Section of a needle, x10.

Probably the easiest and at the same time most interesting method of seed gathering is that of securing them from squirrel hoards. Most of our native rodents, particularly the squirrels, gather and store large quantities of cones from coniferous trees. These are commonly hoarded in moist places at the roots of fallen trees, beside half decayed logs or stumps or beneath overhanging rocks and similar places. The presence of these hoards is usually indicated by the finding of gnawed cones in quantity. The hoards are sometimes exposed to view and are then easily located, while at other times they are partly or wholly concealed with a covering of leaves, rubbish or humus. The moisture to which the cones are subjected in these caches keeps the scales from opening so that the seeds are retained by the cones until opened by the squirrels. While this method of seed

gathering may seem piratical from the squirrels' standpoint, it is not necessarily so serious a matter for them as might at first appear, due to their habit of storing much larger quantities, as a rule, than they require. Of course, the thorough despoiling of all squirrel hoards in a locality would mean serious deprivation for these animals during the following winter.

After gathering the cones, they should be spread out in a single layer on canvass and exposed to the direct rays of the sun. This will usually cause them to open in a short time, after which the seeds may be threshed

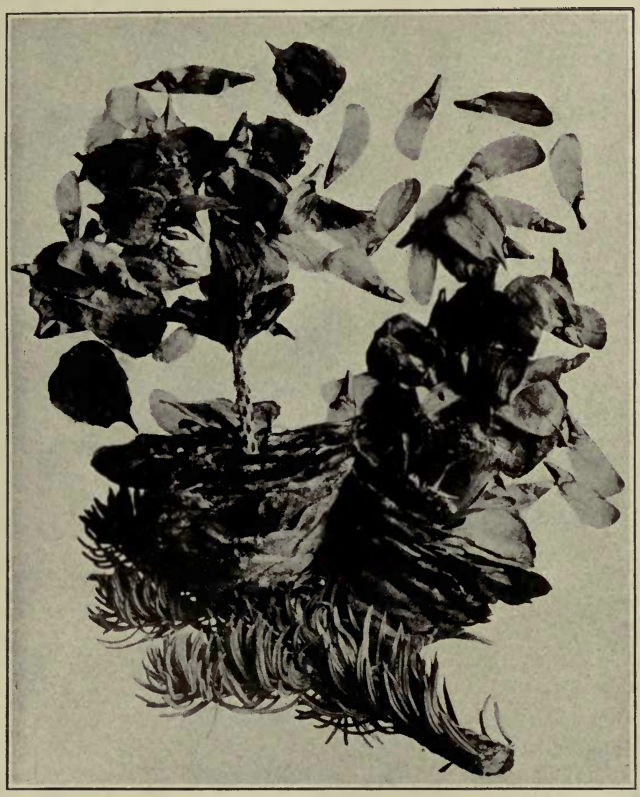


Fig. 36. Alpine Fir. Mature cones breaking up, x½.

out by pounding the cones with a stick or flail. In large operations, as carried on by the Forest Service, the cones after being dried in this manner are passed through a long screen formed by nailing a coarse meshed wire sieve around a rectangular frame, one end of which is slightly elevated. The cones are run into the upper end of this screen and as it is revolved slowly, the seeds are extracted and pass through the meshes

of the screen and on to a canvass beneath. The wings of such seeds as bear them may be easily removed by wetting the seeds for a few minutes and then spreading them out to dry, after which the seeds readily separate from the wings and may be cleaned by winnowing in a breeze or by passing them through a fanning mill.

In the case of lodgepole pine, many of the cones do not open unless heated to a higher temperature than that usually secured by the open air process. In such cases these tight cones may be caused to open by placing them on a wire screen suspended two or three feet above a stove or by placing them in an oven with the door left open. The seeds of juniper and red cedars may be removed from the berries by soaking them in a strong lye made from wood ashes, after which they are rubbed on a fine sieve to remove the pulp. They should then be stratified. This consists in mixing them with moist sand which is to be kept in a box or other receptacle exposed to the frosts of winter. Seeds of the other Conifers may be stored by placing them in cloth or paper bags and hanging them in a cold but fairly dry room or building where they can be protected from the ravages of mice.

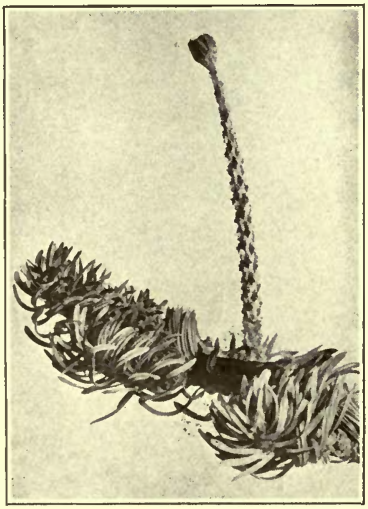


Fig. 37. Alpine Fir. Axis of cone after scales have fallen, x½.

Where only a few dozen or two or three hundred trees are desired, they may be grown in a box of soil about two by three feet and one foot in depth, filled two-thirds its height with sandy loam soil. This may be set in the shade of a building or trees and will make a suitable place for the growing of the seedlings. In larger operations, seed beds should be laid off about four feet wide and from six to twelve feet long. These beds should be surrounded with eight inch boards, placed on edge, in order to protect the seed beds from dry winds and to support the screens which are necessary if the seed beds are placed in direct sunlight. The soil for the seed beds should be a light sandy loam with good drainage but which can be kept from drying out.

The proper time to plant the seeds is in spring as soon as the soil can be worked or about the time that early gardening operations can be carried on. The soil should be levelled off and should be worked into as fine and good a condition as for planting radish or onion seeds. The seeds may be sown in rows about eight or ten inches apart across the seed beds. A very satisfactory way is to press the edge of a board into the soil to the proper depth, depending upon the kind of seeds to be planted, and the seeds are then scattered in the groove thus made, about as thickly

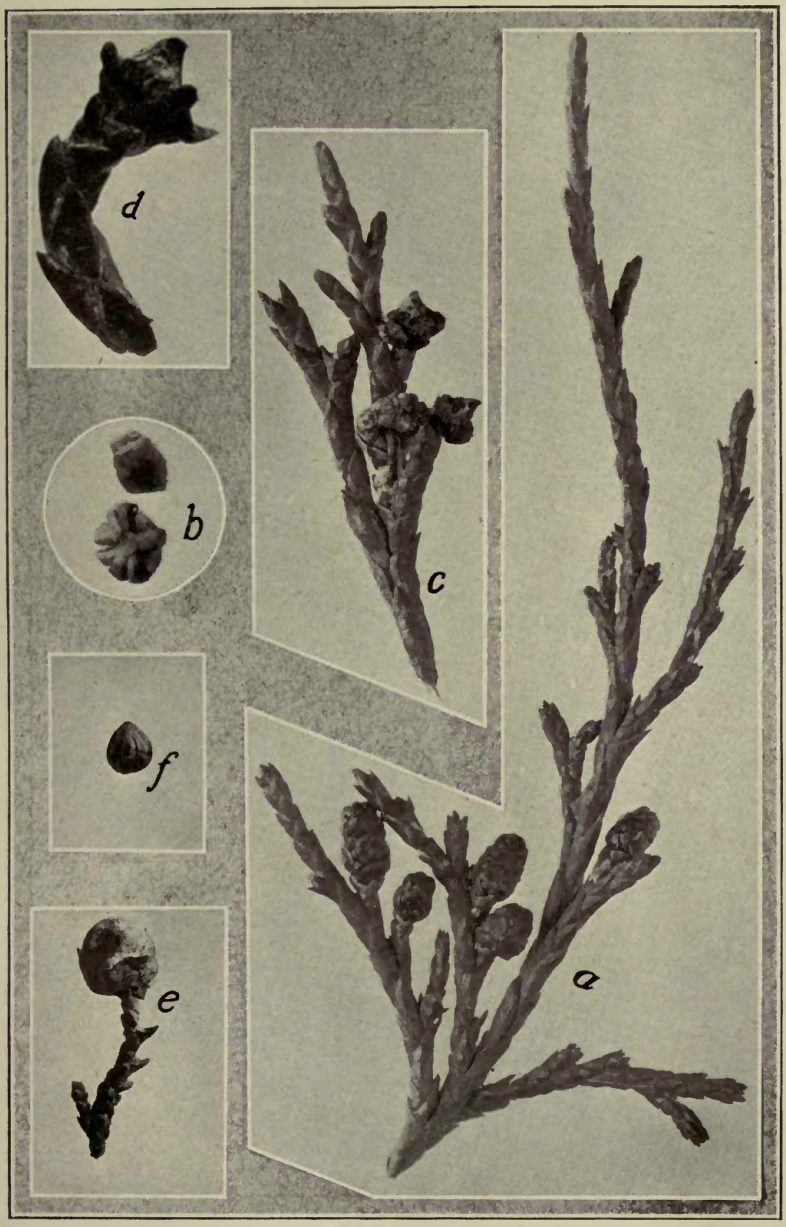


Fig. 38. Flowers and fruit of a Juniper. **a.** Staminate flower cones, x2. **b.** Stamen flowers, x10. **c.** Pistillate flower cones, x2. **d.** Pistillate flower cone showing spreading scales and tips of ovules, x10. **e.** Mature fruit, x2. **f.** A seed, x2.

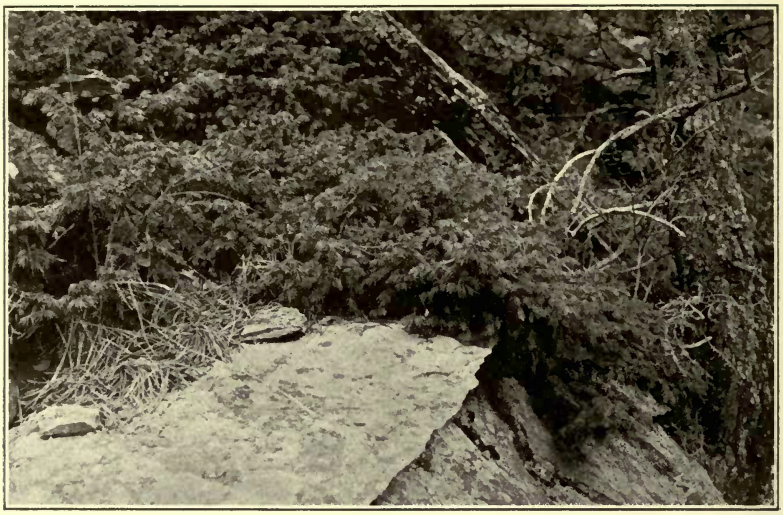


Fig. 39. Low Juniper, showing habit of growth.

Fig. 40. Low Juniper. Twig showing needles and fruit; natural size.

as in the growing of radishes. Fine soil may then be sifted over the seeds and the bed watered with a watering pot, care being taken not to wash the soil nor disturb the seeds. The seeds of limber pine, yellow pine and pinyon pine may be planted from three-fourths to one inch in depth, while for lodgepole pine and Engelmann and blue spruces, one-third to one-half inch in depth is ample.

After the seeds are planted, it is well to sprinkle about 1 or 2 inches of fine chaff over the beds which will help to retain the moisture but will not prevent the young seedlings from pushing up to the light. A very satisfactory way is to cover the seed beds with burlap fastened down with pegs which will allow watering the surface of the beds without danger of disturbing the seeds. The burlap or chaff must be removed as soon as the seeds begin to break the soil. Germination of the Conifers is apt to be rather slow in most cases, at least two weeks being required for the seedlings to appear. In the case of red cedars and junipers, the seeds will often lie dormant in the ground during the first year after planting and will not germinate until the second spring.

Fig. 41. Utah Juniper. **a.** Branch with fruit. **b.** A berry. **c.** Seeds; all natural size.

Most of the Conifers require partial shade during the first year or two. An exception to this is found in our yellow pine, which is one of the few evergreens which can be grown from seed without protection from direct sunlight. Even this species can be more surely grown, however, by some shading during the first season. Suitable screens are made from lath spaced equal to their own width apart and nailed to frames which may be laid over the seed bed. These screens should be removed, however, during very cloudy, damp weather unless the rainfall is heavy, when they may be tilted to one side in such a way as to partially shelter the little seedlings.

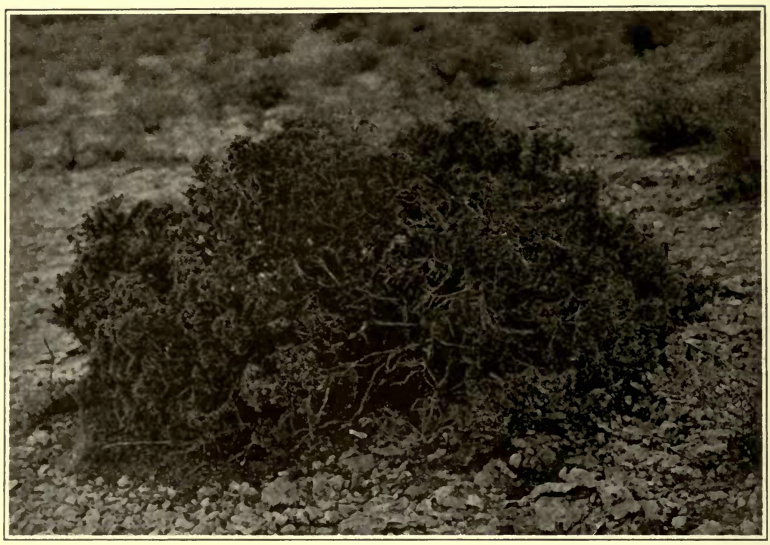


Fig. 42. Trailing Juniper. Six feet across. Owl Canyon.

One of the greatest obstacles in the successful raising of evergreen seedlings is the danger from damping off. This is a disease of the seedlings due to the growth of certain fungi in the soil which causes the roots of the little trees to decay and the seedlings to wilt and die. This trouble usually is most severe during spells of damp, cloudy weather, when the surface of the soil in the seed beds is continually moist. For this reason the practice is sometimes made of covering the surface of the soil with one-fourth to one-half inch of sand and of keeping the seed beds well aired during cloudy, rainy weather. Over-watering of the seed beds may also have a tendency to bring about conditions for the development of this disease and this should be avoided at all times.

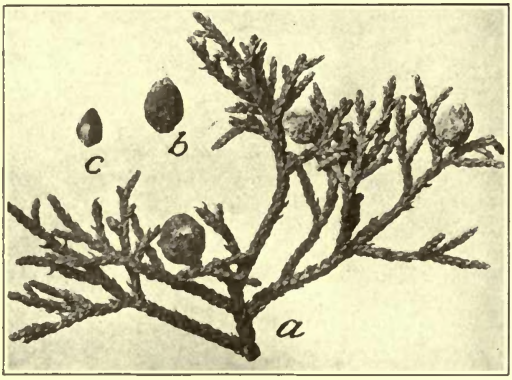


Fig. 43. One-seeded Juniper. Portion of a fruiting branch; natural size.

Upon the approach of winter a mulch of chaff or chopped straw should be scattered among the seedlings, so as to cover them to a depth of three or four inches and the screens may be left on. This will prevent heaving of the little trees by frost. This mulch should be removed in spring as soon as the frost is out of the ground, otherwise the young

trees may be smothered. A good deal of damage is sometimes done in the seed beds by birds and rodents of various kinds. In order to insure the safety of the seedlings at all times, it is well to cover the beds immediately after planting the seed, with a wire netting nailed to a frame, so that none of these intruders can gain access to the beds.

The seedlings should be left in the seed beds usually during at least two years and during this time should be given the best of care as to keeping them free from weeds and sufficiently watered. Cultivation between the rows is as desirable in growing such plants as in the vegetable garden, in order to secure the best results. The seedlings of

Fig. 44. Rocky Mountain Red Cedar. Aged tree 12 feet tall, 8-inch trunk, growing on dry rocky ridge.

most Conifers are very small and at the end of the second season will be not more than two to three inches in height, except in the case of the yellow pine and the Douglas fir. In the spring of the third year, the seedlings should be transplanted to nursery rows, an operation which encourages the development of a more compact root system and enables the little trees to be spaced far enough apart for vigorous development. For this purpose the little trees are usually planted four to six inches apart in rows twelve to eighteen inches apart in the form of beds similar to those in which the seeds were planted, except that they do not require surrounding with boards.

For lodgepole pine, spruces and firs, some shading is desirable during the next two years. This may be secured by using screens similar to those employed on the seed beds raised about one foot above the surface of the ground on poles fastened to stakes. In the absence of screens, suitable shade may be secured by brush laid across the poles supported the same height as the screens. Cultivation and irrigation should be carefully attended to throughout the growing season and the little trees should be given some protection in the form of a mulch during the winter. In most cases, the seedlings will be too small to transplant into permanent quarters before the end of the fourth year and where especially strong stock is desired, they may be kept in nursery rows for five or six years. In the latter case, however, they should be transplanted a second time when four years old in order to secure increased room for development and to still further condense the root system.

Fig. 45. Rocky Mountain Red Cedar. Thrifty tree 12 feet tall.

TRANSPLANTING EVERGREENS.

The transplanting of evergreens, whether grown in the seed bed or taken from the mountains where they have come from natural seeding, is usually attended with more difficulties than with broad leafed trees. This is partly due to the resinous sap of the Conifers which prevents the roots from absorbing moisture when they once become thoroughly dried out. Transplanting should always be done if possible during cloudy or moist weather and particular care should be taken not to expose the roots to the air for more than a few moments at a time. When the seedlings are being dug they should at once be placed with the roots in moist burlap, straw, moss or similar material to prevent their drying out. In transporting them for considerable distances, they may be packed with the roots in moist chaff, moss or grass and enclosed in wooden boxes. They should never be given a chance to become dried out, for

while they may appear to be in a living condition at the end of the journey, they are practically already dead as soon as the roots are once thoroughly dry.

The proper time to transplant evergreens in our climate is during spring, just when the buds are beginning to swell, but before the new growth has put forth. Fall planting, while claimed to be satisfactory in some parts of the country, is not apt to prove successful under our conditions. This is usually due to the dry winds of winter which take the moisture from the young trees before they have an established root system in the soil and while they are still unable to take up soil moisture. In some cases, transplanting which has been done early in autumn and under exceptionally favorable conditions, may succeed, but as a rule is to be considered as a hazardous undertaking.

Fig. 46. Rocky Mountain Red Cedar. Thrifty tree, 6-inch trunk.

USE OF WILD OR FOREST-GROWN SEEDLINGS.

Persons who attempt to transplant our native evergreens from the foothills and mountains to new quarters, usually in lawns, commonly experience a great deal of difficulty in making them succeed. This is largely due to the fact that most persons attempt to transplant as large trees as possible and in so doing only a small part of the root system can be secured without a great deal of labor. The roots of most evergreens are slender and extend to considerable distances without much branching as they grow in the mountains. This is particularly true of yellow pine, which is one of our most difficult trees to successfully transplant from its natural location. The roots in this tree often extend deeply into the crevices of rocks where it is impossible

to dig them out. In all cases, it is best to transplant only the smaller specimens, such as are not more than ten inches or a foot in height.

Only such trees as show a rapid annual growth should be chosen for transplanting. Yellow pines can often be found in rocky situations which are only a foot or two in height, but which are from 25 to 50 years of age. The transplanting of such specimens is almost sure to result in failure. Specimens of blue spruce and Douglas fir which are growing in moist soil of good quality, can usually be transplanted when of larger size than those mentioned. In such cases a ball of earth which shall enclose as much of the root system as possible should be dug up with the tree and tied up with burlap to prevent its being separated from the roots. Trees three or four feet in height may sometimes be successfully moved in this way. Another method occasionally employed is that of digging the trees in winter when the soil is frozen and when it can be moved in a solid mass attached to the roots.

Fig. 17. Rocky Mountain Red Cedar. Fruiting branch, natural size.

In all cases where the expense is not prohibitive, nursery stock is much to be preferred to wild trees. Properly grown nursery trees have had the root system condensed by transplanting and the trees are usually more stocky and vigorous than the wild ones and can be moved with a great deal more certainty of success. The same care should be exercised in transplanting evergreens that is necessary in the successful transplanting of orchard trees and they will respond in the same way to care in the matter of cultivation and proper watering. Excessive watering should be avoided, for most of our native evergreens require a soil of only moderate moisture in which to thrive.

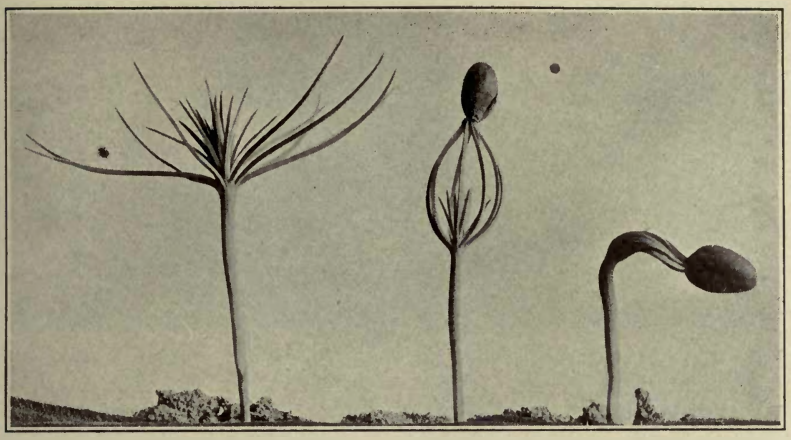


Fig. 48. Three stages in the germination of a pine seed (from right to left). Natural size.

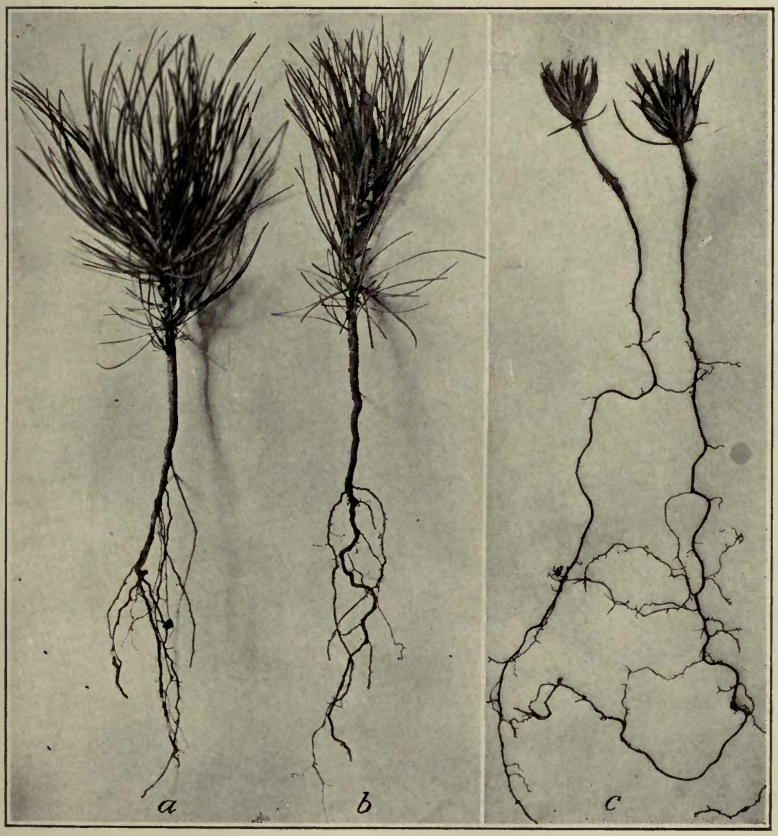


Fig. 49. Seedling Yellow Pines, four years old. **a.** Transplanted at two years of age. **b.** Left in seed bed. **c.** One year old, showing root twelve times as long as stem.

Fig. 50. A cheap but efficient form of seed bed for raising evergreen seedlings. Each bed, 4 by 12 feet, has room for raising 2,000 two-year-old seedlings.

Fig. 51. Evergreens in the front door yard hide a small place.

PRUNING.

It is seldom necessary to prune carefully dug nursery grown evergreens when they are transplanted, unless it is desired to change their shape and the same is true of those taken from the mountains when a ball of earth has been taken with the roots. A partial thinning of the branches of forest grown trees may sometimes be desirable to reduce the loss of moisture from the leaves and compensate in part for the reduced root system. The terminal bud, which gives rise to the leader or main stem, sometimes becomes injured or destroyed, and in such a case two or three of the lower buds may push up equally strong shoots. In this case all but one shoot should be removed and this one may be tied erect to the stub of the original leader so as to eventually take its place.

INSECT PESTS AND DISEASES OF EVERGREEN TREES.

The trees of the pine family are subject to numerous disorders due principally to insects and to parasitic plants. Insects of certain species often cause enormous destruction of living timber and the trees thus killed are apt to be consumed by fires when dry. Probably the most destructive of the insects which attack the evergreen forest trees in Colorado are those known as the pine bark beetles, which belong to the genus Dendroctonus. The most common of these beetles is one which attacks principally the yellow pine, although the lodgepole pine, limber pine and Englemann spruce are also subject to it. This insect deposits its eggs in burrows which it makes in the bark of the host trees in such a way that the larvae which hatch from them are enabled to live upon the inner bark. In this stage of its life history, the insect forms burrows through the living bark, often in such numbers and extent as to entirely girdle the tree and thus cut off the circulation of food material in the vital part of the trunk. Trees which are badly infested usually show signs of the trouble by the dying of the tops, while exudations of resin often appear from the bark where the insects are at work. In case of slight injury, which is sometimes limited to any small part of the trunk, the tree may recover from the attack, but will eventually lose the bark over the affected part of the tree. When the foliage of a tree turns yellowish or brown in color, however, it is an indication that the attack is too severe for the tree to recover. The most effective remedy on a large scale has been found to consist in the cutting and burning of infested trees. Sometimes merely the bark is removed, which exposes the larvae of the insect so that birds can get at them, or the bark is burned and thus all of the insects are destroyed.

During the latter half of summer, the blue spruces often show dead tips to the twigs which, upon close examination, appear in the form of galls or swellings thickly covered with short needles. These dead tips, which are sometimes mistaken for the real cones of the tree, consist of the season's growth which has lengthened but little, while the needles which they bear have become greatly enlarged at the base and each contains a small cavity. Earlier in the season these swollen leaf bases are

inhabited by a species of plant louse, belonging to the genus Chermes, which lives upon the juices of the tree and produces the gall-like enlargements at the ends of the twigs. About midsummer the insects have reached maturity, when they pass to the needles of the Douglas fir which may be in the vicinity and upon which they deposit their eggs. This second generation of the insect passes the remainder of the season upon the Douglas fir. Early in the second summer certain individuals of the insect develop wings and reach the blue spruces, upon which they deposit their eggs. The young lice which hatch from these eggs then attack the needles of the terminal buds and produce a new crop of the abnormal tips. While

Fig. 52. Front yard over-planted with blue spruce. The owner must prune away the lower branches, or have the view shut off.

this insect seldom causes much injury to the blue spruce or to the Douglas fir under forest conditions, it is a rather serious pest upon these trees in parks and upon lawns. It is apt to be most troublesome where the blue spruce and the Douglas fir are growing near together, a condition which favors the insect in its peculiar life history.

Among the diseases due to parasitic plants are certain malformations known as witches' brooms. These appear as dense, matted growths of twigs upon which the needles are usually somewhat stunted. These witches' brooms sometimes appear in the topmost part or at other times are found hanging against the side of the affected tree. A careful ex-

amination of one of these matted growths of twigs will usually reveal the presence of numerous greenish yellow stems growing from the surface of the twigs or of the branch to which they are attached. These little stems belong to one of the small species of mistletoe which infest the different members of the pine family. These are small, leafless plants which produce minute flowers and later give rise to small whitish berries containing seeds covered with a sticky substance. When the berries are mature toward autumn they burst and expel the seeds to a distance of several yards. On account of the sticky covering, the seeds may lodge upon the twigs and branches of nearby trees and start the growth of the plant in a new location during the following spring. In some cases a badly diseased branch may die and fall away, leaving a canker-like wound in the side of the tree trunk. Badly infested trees, however, may be entirely killed by this parasite. While the mistletoe disease of our evergreens is seldom so severe as to warrant any radical measures in its extermination, wherever it attacks trees which are especially desired for their proximity to summer resorts or mountain homes it may be necessary to combat this trouble by cutting off and burning all of the diseased growths as soon as they appear.

Fig. 53. Engelmann Spruce, near timber-line, showing effects of wind.

Our native cedars are subject to certain rust fungi which produce little galls known as cedar apples upon the newer growths. These appear in spring during moist weather in the form of slight enlargements or swellings covered with gelatinous outgrowths from which the spores of the disease are given off. These spores which are microscopic in size readily float in the air. When these spores come in contact with the new foliage of certain plants of the apple family such as the service berry, hawthorn, quince and pear, they are capable of setting up a disease known as the cluster cup fungus. This may be recognized by the formation of swellings of a yellowish or orange color which are produced on the leaves and sometimes upon the fruit of the affected host plant. These swollen, discolored portions contain numerous minute spore producing cavities from which spores are given off, capable of re-infecting the cedars which may be near at hand. For this reason, it is unwise to

plant our native red cedars in close proximity to orchards of pear and quince. This disease has been known to appear in orchards some distance from the wild cedars in the nearby foothills. The apple, however, is seldom attacked by the fungus from the cedar apple disease which occurs upon the cedars native to this state.

FORESTS AND IRRIGATION.

The influence of our forests in Colorado upon the flow of the streams which furnish water for irrigation, while still a matter frequently brought under discussion, is generally conceded to be of the greatest importance.

Fig. 54. Wind-beaten, distorted, grotesque, pitiable "wind timber," on James Peak.

In spring these streams are fed largely from the melting of the snows at the lower levels. Wherever the snow is exposed to the direct rays of the sun and to the milder winds, it is more rapidly melted than where it is protected in ravines and by living trees. For this reason, a wooded mountain side will furnish a slower but more prolonged flow of water into the streams, early in the season, than one which is bare or denuded of forest growth.

Careful studies in the conservation of snow by forests in mountain regions have been made upon the Sierra Nevada range in Nevada during the past four years. The results of extensive measurements show a very positive retarding influence upon the melting of the snows that have ac-

cumulated in the shelter of evergreen forests due to shading and diminished air currents. It has been found that those forests which contain numerous open spaces or glades of small area into which the snow readily finds its way, give the maximum protection to the snow, while the densest forest cover, which tends to keep some of the snow from reaching the ground beneath, falls considerably behind. Much of the benefit due to forest growth upon the higher and more exposed levels was found to be in the catching of the snow which would otherwise be blown off to lower levels where earlier melting occurs.*

Another condition which is brought about by the presence of forests is that due to the deposits of decaying organic matter from the trees themselves. This duff or humus, consisting of the cast-off leaves, shreds of bark, twigs and branches, withered flowers and fallen cones, accumulates very slowly during the years that a forest is growing to maturity. The soil also is completely filled with a network of fine rootlets within a fairly dense stand of timber, so that it is held in place and prevented from washing under the impact of heavy rainfalls. Under such conditions, the forest floor tends to readily absorb water and to allow it to percolate into the underground channels of springs instead of rushing over the surface to the nearest water course.

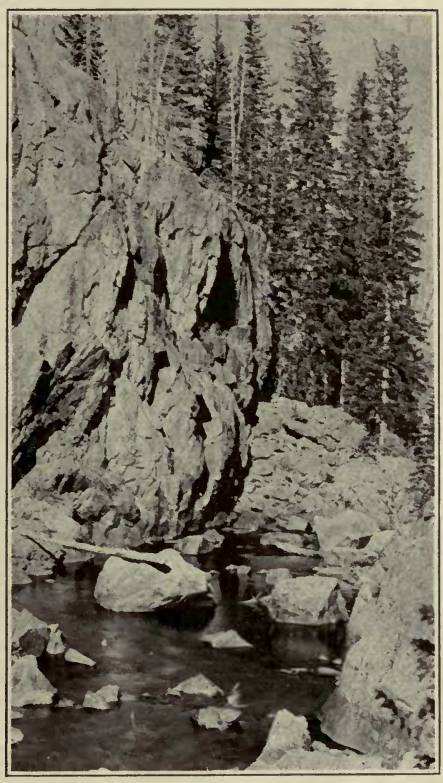


Fig. 55. Water and trees make this spot attractive.

A forested mountain slope, therefore, tends to regulate and prolong the stream flow and favors the better utilization of the water during the entire growing season in the valleys below. While the value of a forest cover upon mountain slopes has been a well established fact in the countries of Europe, where forestry has been carried on for many years, it has been particularly emphasized in our own country during the past

* Recent Studies of Snow in the United States, by J. E. Church, Jr., from the Quarterly Journal of the Royal Meterological Society, Vol XL, No. 169, 1914.

four years. Thus the great forest fires which devastated the mountain forests in Northern Idaho did more than to destroy millions of dollars' worth of timber and hundreds of human lives. A recent news item states that the flow from a burned over watershed, which furnishes the city of Wallace, Idaho, has been very evidently changed since the great fire of 1910. Thus the minimum flow of the stream, which was formerly not less than one thousand miner's inches, has, since the forest fire, fallen to about 250 miner's inches at the minimum flow. The weather records at Wallace show that the precipitation, however, has been about normal for the region during the time since the fire. This change in the regularity of the stream flow which also furnishes water power for the development of electricity, has made it necessary to expend money in the development of steam power to furnish light and for the pumping of water, a matter not heretofore required.

Fig. 56. Tree-clothed mountain slopes offer the chief attraction here. The light-colored foliage in the left foreground belongs to aspens in golden autumn colors.

FORESTS AND SCENERY.

Not the least important office of the evergreen forests in Colorado is the part which they play in making our mountain scenery attractive and beautiful. There are few sights more ugly and depressing than great wastes of jagged, naked mountain sides with no foliage of shrub or tree to soften their rugged barrenness. The mighty cliffs and vast gorges of our mountains are awe-inspiring in themselves, but without the presence of trees clinging in their shelter or of forests sweeping up their very bases, our mountains can hardly be called attractive or beautiful. The loveliness of those mountain parks which have been spared from the devastating effects of forest fires is due in large measure to the tree growths which they harbor. Trees, alone, in their variety of form, texture of leaf, color of foliage and character of bark, can supply the necessary setting of a fine

picture. They constitute the very essence of the soothing, restful quality of every delightful mountain retreat where worn and tired humanity longs to retire. Just how much our state owes to her mountain forests of evergreen trees in attracting and holding the tourists which come within our borders for recreation, cannot be definitely known. Many, doubtless, would pass on to more pleasing scenes were these forests entirely destroyed or their charm removed. Thus for their scenic effects, alone, the state of Colorado may well afford such protection to her mountain forests as shall insure their perpetuation and thrifty growth.

FORESTS AND GAME.

Another important role played by the forests is in the harboring of game and in the clarifying effects which they have upon the streams where fish abound. Streams which have their sources protected by forest cover are seldom or never as turbid with silt and other foreign matter as those which catch the run-off from denuded areas. Such streams are therefore better suited for our gamiest and choicest fish which do not thrive in water charged with impurities of any kind. Then, too, there is a charm which appeals strongly to the true sportsman in following the chase among the wooded hills or luring the finny tribe along tree-bordered streams. If Colorado is famous as a region where human kind may disport itself amid the most healthful and enjoyable surroundings to be found anywhere upon our continent, it is due in no small measure to the beneficent presence of our forests of evergreen trees.

Fig. 57. The gruesome desolation which follows a forest fire. Centuries may elapse before this area becomes reforested.

ILLUSTRATIONS

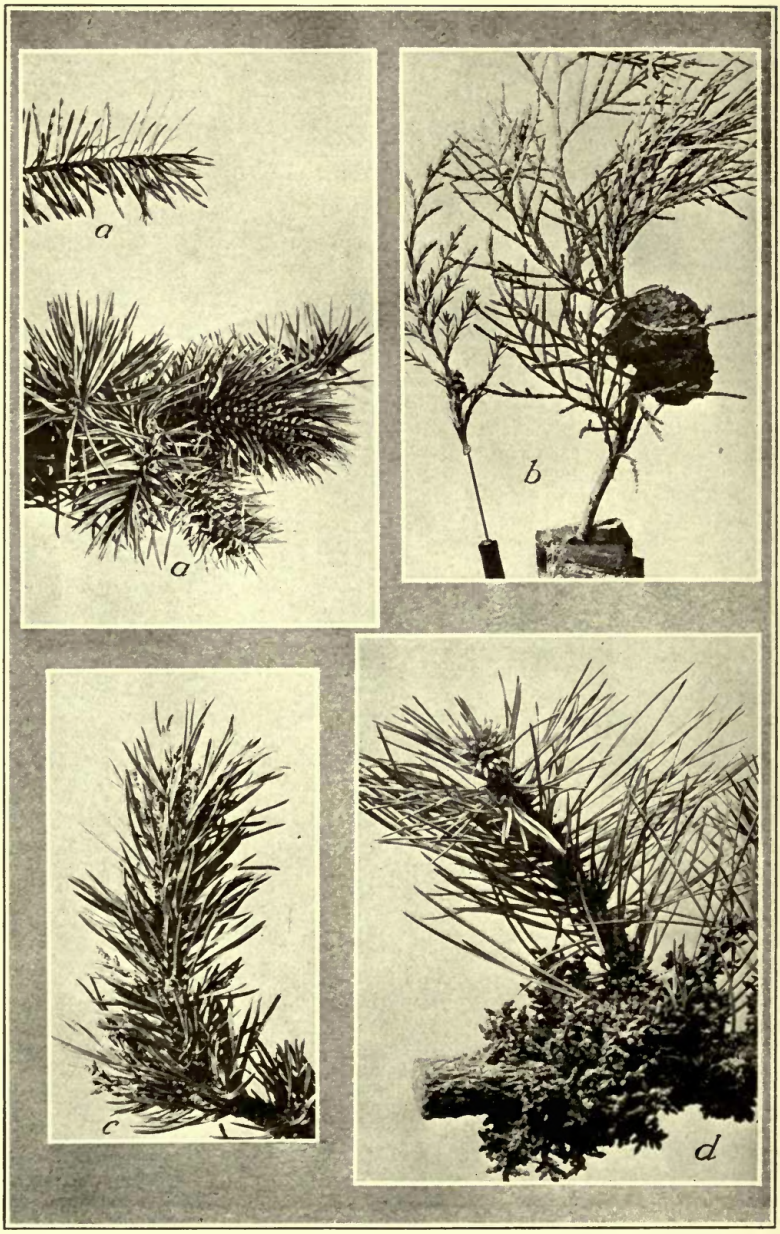


Fig. 58. Common Ailments of Evergreen Trees. **a.** Douglas Fir and Blue Spruce affected by a plant louse, x½. **b.** Red Cedar, showing galls caused by fungous parasite, x½. **c.** Witches broom of Lodgepole Pine caused by a mistletoe, x½. **d.** A mistletoe on Yellow Pine.

Fig. 9. Lodgepole Pine, *Pinus contorta murrayana*. Dense forest of young trees following a forest fire 45 years before. These trees are 40 to 43 years old, and 10 to 20 feet tall. Mountain slope, Estes Park.

Fig. 10. Lodgepole Pine, *Pinus contorta murrayana*. A mature tree on mountain side, near Pingree Park.

Fig. 11. Lodgepole Pine, *Pinus contorta murrayana*.

a. Trunk of immature tree 9 inches in diameter. Pingree Park.

b. Terminal portion of branch with cones and needles. Near the tip are young cones which were in bloom last spring. Farther down are nearly mature cones in their second season. Near the base are cones three years old which have shed their seeds. Taken in August. One-half natural size.

Fig. 12. Lodgepole Pine, *Pinus contorta murrayana*.

a. Needles, two in each bundle, enlarged twice.

b. Cross-section of a needle enlarged ten times.

c. Mature, open cone.

d. Closed or "tight" cone.

e. Seeds, natural size.

Fig. 13. Lodgepole Pine, *Pinus ponderosa scopulorum*. Mature tree, open-grown type, bedded within an eight-inch log over sixty years old.

Fig. 14. Pinyon Pine, *Pinus edulis*. Aged tree 15 feet tall. Owl Canyon.

Fig. 15. Pinyon Pine, *Pinus edulis*.

a. Portion of branch with needles and opening cones. Two seeds are exposed in the upper part of the left-hand cone.

b. Mature closed cone.

c. Seeds. All three-fourths natural size.

Fig. 16. Blue Spruce, *Picea parryana*. Trunk of tree 19 inches in diameter and 60 feet tall. Along Buckhorn Creek.

Fig. 17. Blue Spruce, *Picea parryana*. Twigs showing staminate flower cones. About two-thirds natural size.

Fig. 18. Blue Spruce, *Picea parryana*. Portion of branch showing two young pistillate cones pointing upward, and two mature cones of last season hanging downward. About one-half natural size.

Fig. 19. Blue Spruce, *Picea parryana*.

a. Portion of twig from which the needles have largely fallen, leaving the small stalk-like bases.

b. Portion of twig with needles attached. Enlarged twice.

c. Cross-section of a needle enlarged ten times.

Fig. 20. Engelmann Spruce, *Picea engelmanni*. Two trees growing in the open, height 45 to 50 feet; trunks 11 and 14 inches in diameter. Dense clusters of cones appear in the tops of the crowns. Buckhorn Creek.

Fig. 21. Engelmann Spruce, *Picea engelmanni*. Heavy stand of large specimens. Lookout station, college forest.

Fig. 22. Engelmann Spruce, *Picea engelmanni*. Near view of 39-inch trunk, showing character of bark on mature trees.

Fig. 23. Engelmann Spruce, *Picea engelmanni.*

a. Terminal portion of twig showing fine hairy covering of surface among the needle bases, enlarged three times.

b. Cross-section of a needle, enlarged ten times.

Fig. 24. Engelmann Spruce, *Picca engelmanni.*

a. Twig with mature cones, three-fourths natural size.

b. Seeds, natural size.

Fig. 25. Douglas Fir, *Pseudotsuga mucronata.* Vigorous young tree 40 feet tall and trunk 11 inches in diameter. North Cheyenne Canyon.

Fig. 26. Douglas Fir, *Pseudotsuga mucronata.* Showing rough, coarsely ridged bark of old tree. Estes Park.

Fig. 27. Douglas Fir, *Pseudotsuga mucronata.*

a. Portion of branch bearing staminate flower cones among the needles, and two pistillate flower cones at the tips of twigs. Two mature cones of last season are seen hanging from the lower part. About one-half natural size.

b. Mature cone.

c. Seeds, two-thirds natural size.

Fig. 28. Douglas Fir, *Pseudotsuga mucronata.*

a. Portion of twigs from which the needles have fallen, leaving small oval scars. Enlarged twice.

b. Cross-section of a leaf enlarged ten times.

c. Terminal part of twig showing needles attached. Enlarged twice.

Fig. 29. Douglas Fir (a) and Blue Spruce (b) differ in the behavior of their bud scales in spring. In the first the bud scales remain at the base of the new growth for a time; in the second they are pushed off on the tips of the new growth.

Fig. 30. White Fir, *Abies concolor.*

a. Tree 30 feet tall with trunk 12 inches in diameter.

b. Tree trunk of moderate age, 18 inches in diameter. North Cheyenne Canyon.

Fig. 31. White Fir, *Abies concolor.*

a. Small portion of twig showing needles and circular needle-scars, enlarged one and one-half times.

b. Cross-section of a needle showing two resin tubes close to the lower surface, enlarged eight times.

Fig. 32. White Fir, *Abies concolor.* Portion of branch bearing nearly mature cones, one-half natural size.

Fig. 33. Alpine Fir, *Abies lasiocarpa.* Unusually perfect form of this tree with trunk 9 inches in diameter. Pennock Creek.

Fig. 34. Alpine Fir, *Abics lasiocarpa.* Trunk of vigorous tree 12 inches in diameter.

Fig. 35. Alpine Fir, *Abies lasiocarpa.*

a. Terminal shoot of young tree bearing full grown cones; about one-half natural size.

b. Section of a needle showing two resin tubes midway between upper and lower surfaces of the leaf, enlarged about ten times.

Fig. 36. Alpine Fir, *Abies lasiocarpa.* Two mature cones showing the scales breaking away from the central axis of the cone, thus liberating the seeds. About one-half natural size.

Fig. 37. Alpine Fir, *Abies lasiocarpa.* The spike-like axis of the cone after the scales have fallen. One-half natural size.

Fig. 38. Flowers and fruit of a Juniper (*Juniperus scopulorum*).

a. Small portion of branch bearing staminate flower cones, enlarged twice.

b. Upper and lower views of stamen flowers, enlarged ten times.

c. Portion of branch bearing pistillate flower cones, enlarged twice.

d. Pistillate flower cone showing four spreading scales and the tips of two ovules; enlarged ten times.

e. Mature fruit; enlarged twice.

f. A seed; enlarged twice.

Fig. 39. Low Juniper, *Juniperus communis sibirica.* Showing habit of growth.

Fig. 40. Low Juniper, *Juniperus communis sibirica.* Twig showing needles and fruit; natural size.

Fig. 41. Utah Juniper, *Juniperus utahensis.*

a. Portion of a branch with fruit.

b. A berry.

c. Seeds; all natural size.

Fig. 42. Trailing Juniper, *Juniperus prostrata.* Six feet across. Owl Canyon.

Fig. 43. One-sceded Juniper, *Juniperus monosperma.* Portion of a fruiting branch; natural size.

Fig. 44. Rocky Mountain Red Cedar, *Juniperus scopulorum.* Aged tree 12 feet tall, trunk 8 inches in diameter, growing on dry rocky ridge. Owl Canyon.

Fig. 45. Rocky Mountain Red Cedar, *Juniperus scopulorum.* Showing form of a thrifty tree 12 feet tall. Owl Canyon.

Fig. 46. Rocky Mountain Red Cedar, *Juniperus scopulorum.* Trunk of thrifty tree 6 inches in diameter, showing scaly bark of young trees.

Fig. 47. Rocky Mountain Red Cedar, *Juniperus scopulorum.* Portion of fruiting branch; about natural size.

Fig. 48. Three stages in the germination of a pine seed (from right to left), *Pinus edulis.* Natural size.

Fig. 49. Seedling yellow pines, four years old.

a. Transplanted at two years of age.

b. Left in seed bed. Note difference in vigor.

c. One year old, showing the root twelve times as long as the stem. (*Pinus ponderosa scopulorum*).

Fig. 50. A cheap but efficient form of seed bed for raising evergreen seedlings. Each bed, 4 by 12 feet, has room for raising 2,000 two-year-old seedlings.

Fig. 51. Evergreens are poorly suited to planting in the front door yard of a small place, unless the owner desires to hide. These trees, however, were allowed to grow in natural form.

Fig. 52. Front yard over-planted with blue spruces. The owner must prune away the lower branches, thus injuring the natural beauty of them, or have the view shut off.

Fig. 53. Near timber-line. Engelmann Spruce tree showing effects of wind. Near Dixie Lake.

Fig. 54. At timber-line. Wind-beaten, distorted, grotesque, pitiable "wind timber." (*Picea engelmanni.*) On James Peak.

Fig. 55. The two factors which make this spot attractive are water and trees.

Fig. 56. Tree-clothed mountain slopes offer the chief attraction here. The light-colored foliage in the left foreground belongs to aspens in golden autumn colors. In one of the most noted tourist regions of the state.

Fig. 57. The gruesome desolation which follows a forest fire. Centuries may elapse before this area becomes reforested.

Fig. 58. Some common ailments of evergreen trees.

a. Twigs of Douglas Fir and Blue Spruce affected by a plant louse (*Chermes*). The insect is on the needles in the first, while it causes the cone-like galls to form on the latter. One-half natural size.

b. Twigs of red cedar showing a small and a large gall caused by a fungous parasite (*Gymnosporangium*). Two-thirds natural size.

c. Twigs from witches broom of lodgepole pine caused by a mistletoe. One-half natural size.

d. Portion of branch of yellow pine attacked by mistletoe.

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