INTRODUCTION

THE ROCKY MOUNTAIN REGION

EXTENT. In this manual the Rocky Mountain region has been broadly defined as the area lying between the Great Plains and the Pacific Coast states. Montana, Idaho, Wyoming, Colorado, Utah, Nevada, Arizona, New Mexico, extreme western Texas, and the Black Hills of South Dakota are included, as well as the Canadian territory lying north of these states. Mexican species were included only when their range extended into the southwestern states.

CHARACTER. This region, while greatly diversified as to topography and climate, is, on the whole, an arid one. Tree growth is largely restricted to high elevations or to water courses at lower altitudes. The flora varies all the way from subtropical to alpine, and from that found on the humid upper mountains to true desert types. Moisture, temperature, and topography are important factors limiting the distribution of species. The aspect and steepness of the slope are major factors in determining the altitude to which a species will grow, which in itself is important in determining the range of a species. Wherever helpful, the altitudinal range has been given to supplement the distribution maps. In a region extending in latitude from Mexico into Canada, altitude alone is strictly limited in usefulness, and therefore a more important factor is discussed in some detail, i. e., the life zones into which the trees tend to group themselves.

LIFE ZONES. The work of Dr. C. Hart Merriam and others disclosed the fact that both plants and animals tend to group themselves into definite life zones or belts, and that the same or very similar forms of life usually will be found in regions having similar climatic conditions. These zones tend to increase in altitude as they become

more remote from the polar regions, so that typical arctic plants growing near sea level in polar regions might be found at elevations of 10,000 feet in Montana, 12,000 feet in Colorado, and 13,500 feet in Arizona. It has been stated that a change of 300 feet in elevation is approximately the equivalent of 100 miles in latitude. As an example, Dr. Merriam states that nine species of plants growing on the bleak summit of San Francisco Mountain, Arizona, were brought back from Lady Franklin Bay above the arctic circle by Lt. A. W. Greely. As a rule these life zones can be readily identified, and are a very convenient aid in determining the local distributions of species.

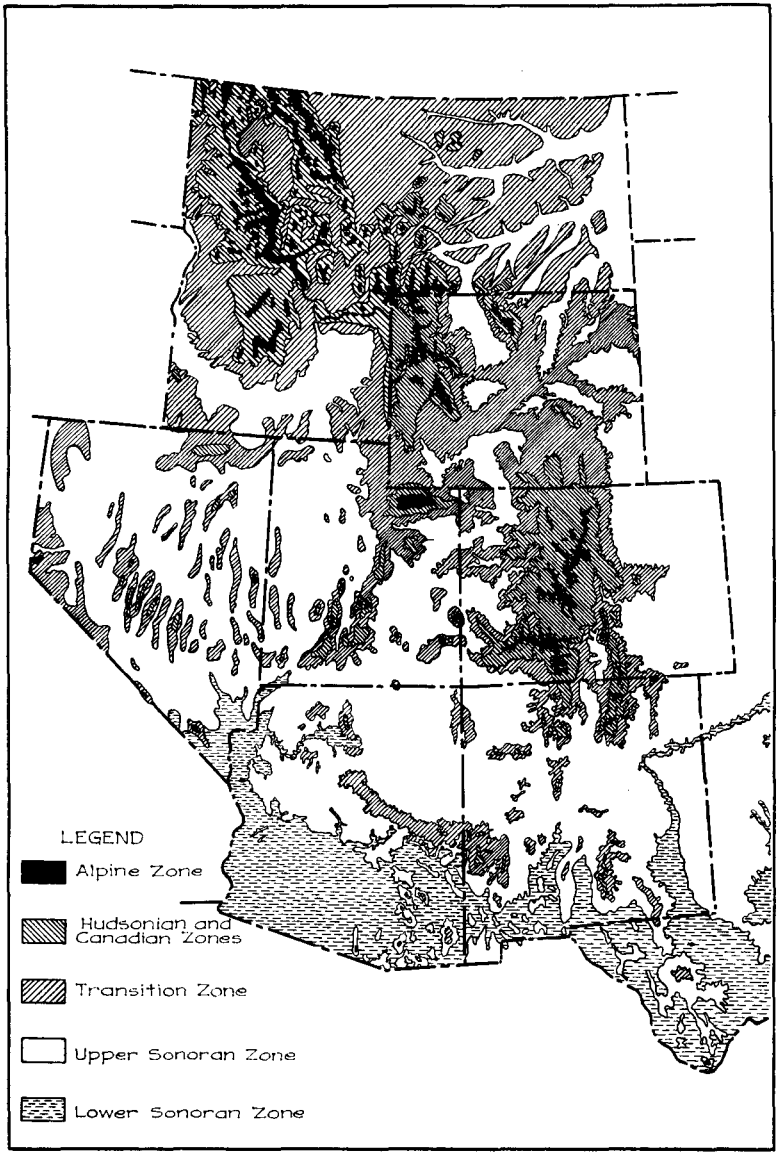
Six life zones or belts are recognized in the Rocky Mountain region; the three higher zones belonging to the Boreal or cooler region, and the three lower to the Austral or subtropical region. Although the tropical region enters this area in the valley of the lower Colorado River in Arizona, it is arid in nature and here classed with the Lower Sonoran. On the whole these zones become progressively warmer and dryer from the Alpine to the Lower Sonoran.

1. *Alpine or Arctic-Alpine Zone*

This area corresponds to the artic barren grounds and lies above timber line. It is a bleak region, covered with snow during the greater part of the year, and one in which the variety of life has been reduced to a minimum. Much of the vegetation consists of mosses, lichens, and dwarf willows, although flowers bloom in profusion during the short summers.

2. *Hudsonian Zone*

In the Rocky Mountains this is a region of dwarfed, stunted conifers located just below timber line and corresponding to the northern part of the great transcontinental coniferous forest. This region, while sharply defined



LIFE ZONES OF THE ROCKY MOUNTAIN REGION

above by the sinuous tongues of timber-line trees, is poorly defined below, and merges almost imperceptibly into the Canadian zone. In reality this is a transitional area between the zones bordering it, and few species are restricted to it. Small, malformed Engelmann spruce and alpine fir characterize the zone, supplemented by foxtail pine in the south and alpine larch, mountain hemlock, and whitebark pine in the north.

3. *Canadian Zone*

This last of the Boreal and humid belts is located on the middle and higher mountain slopes. Sharply defined at its lower edge from the more arid species of the transitional zone, its upper border merges indistinctly into the Hudsonian zone. This is a zone with a rich flora characterized by dense stands of Engelmann spruce, true firs, western white and lodgepole pines, and aspen; while foxtail and limber pines, Douglas-fir, blue spruce, mountain maple, thinleaf alder, mountainash, balsam, poplar, and many other species are characteristic over parts of the region. Often the forests are interrupted by extensive grassland parks.

4. *Transition Zone*

This area, although classed as the upper Austral zone, is actually a neutral or transitional belt between the arid, warmer Sonoran zones and the humid, cool Boreal region, and is largely made up of species from these bordering belts. The zone is a variable one, ranging from the grassy or forested middle mountain slopes in the southern states to the yellow pine foothills and high, grassy or sage plains in the northern states. The forested portions lie largely in the southern and central states. In addition to the very characteristic western yellow pine, which is practically coextensive with the region, common tree species are: Arizona, Apache, Chihuahua, and Mexican white pines, Douglas-fir, western larch, cypress, vari-

ous oaks, narrowleaf cottonwood, water birch, big-toothed maple, southwestern locust, wild plum, chokecherry, hawthorns, serviceberry, mountain mahogany, hophornbeam, and buckthorn. From Wyoming north, this belt for the most part becomes open and treeless and so is less conspicuously characterized than in the south-central regions. Vast plains of gray sage, rabbit brush, and other dry-land species occupy the arid sections, and tree growth is restricted to stream borders. On the moister sites are high grassy plains or, occasionally, yellow pine foothill stands. Where treeless, only the upper border of this belt is clearly defined at that point where the sage gives way to the aspens and conifers of the Canadian zone.

5. *Upper Sonoran Zone*

This arid division of the upper Austral zone is semi-tropical in nature and ranges from the high plains and foothills of the southern states to the low plains and valleys in the north. The zone is typified by the piñon-juniper forests or the broad-leaved cottonwoods along the streams in grassy or barren plains. Ash, elm, plum, sand cherry, black sage, boxelder, saltbrush, walnut, mexican alder, sycamore, Cowania, hackberry, mulberry, and hoptree are also found in this zone.

6. *Lower Sonoran Zone*

This lower or southern desert belt, the arid division of the lower Austral zone, is typically Mexican, extending into the United States over the low plains and along the river valleys of the southwestern states. While uniform both as to climate and species, this is a region of most extreme conditions for plant growth, rainfall being very scanty and the temperature often exceeding 120 degrees Fahrenheit. Few plants reach tree size, and these, growing along stream bottoms, are for the most part unlike those of any of the other zones. Mesquite and creosote

bush characterize this belt, although other small tree forms are found, such as Koeberlinia, Parkinsonia, Acacia, Leucaena, Cercidium, Sophora, Eysenhardtia, desert-willow, Parosela , walnut, soapberry, Wizlizenius poplar, and cactus.

The vertical boundaries of these life zones are highly variable and for a large region can only be given as approximations. These boundaries depend upon various governing factors such as steepness of slope, exposure, wind, moisture, and deforestation, which either allow the species to grow above normal limits, or force them to levels below normal. It must be remembered, too, that on the border of each zone is a belt of varying vertical width (usually between 400-800 feet) in which the species of the two bordering zones mingle. The following table indicates the approximate elevations of the life zones in three sections of the region:

Zone	New Mexico	Central Colorado	Montana
Alpine	12,500–13,300 ft.	11,500–14,400 ft.	9,000–12,000 ft.
Hudsonian ..	11,500–12,500 ft.	10,500–11,500 ft.	8,000– 9,000 ft.
Canadian ...	9,000–11,500 ft.	8,000–10,500 ft.	6,000– 8,000 ft.
Transition ..	7,500– 9,000 ft.	6,000– 8,000 ft.	5,000– 6,000 ft.
Upper Sonoran ..	4,200– 7,500 ft.	3,000– 6,000 ft.	2,000– 5,000 ft.
Lower Sonoran ..	2,800– 4,200 ft.	.....	.....

TREE CHARACTERS

A brief discussion of the structural and silvical characters which are necessary in identifying trees is presented here to aid students without previous botanical training.

DEFINITION OF A TREE. There is no clear-cut line of demarcation between a tree and a shrub, and it is often impossible to place a plant definitely in one group or the other. Frequently a species treelike under favorable environmental conditions will be shrublike over most of its range. In general, height, form and

diameter must be taken into account in determining the classification of a doubtful form. In this manual, Sudworth's definition of a tree as a woody plant having one well-defined stem, a more or less definitely formed crown, and attaining a minimum height of eight feet and a diameter of not less than two inches, has been followed.

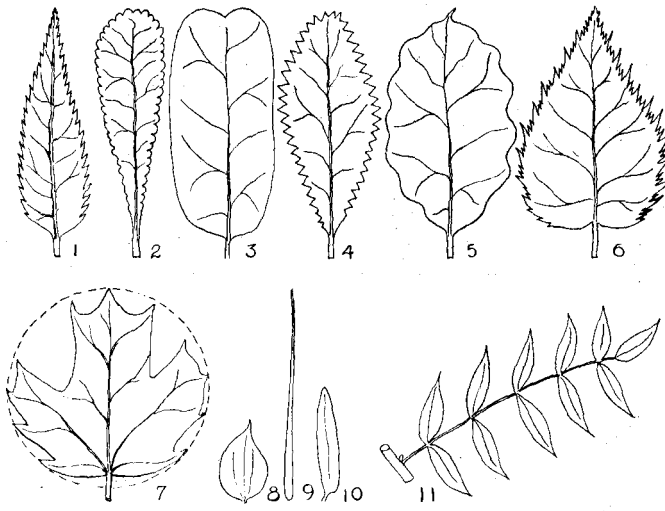
TERMINOLOGY. While appearing cumbersome to the beginner, the use of technical terms in describing characters is often necessary for a concise, accurate description. These technical terms have been avoided wherever their omission did not impair the meaning of the passage, and a glossary explaining all technical terms used has been included. The student should familiarize himself with the more commonly used terms early in his study of the trees.

NAME. Most species of trees have been given one or many common names which usually describe some character of the tree and are easily learned by students. Unfortunately, these common names have many limitations; some are merely local, others apply to two or more entirely different species, and some apply to trees belonging to different genera. Because of this, while common names may be useful and convenient, it is essential that each species of tree have a definite, individual name that can be accepted throughout the world and which cannot be applied to any other species. Botanists and scientists as a whole have agreed that these scientific names should be in Latin, as this is a dead language and not subject to change. Botanists have further agreed that the name of a tree should consist of three parts: a generic name referring the species to the group to which it belongs and which is capitalized; a specific name referring to the single species and beginning with a small letter; and the full or abbreviated name of the authority or person first describing the plant. Thus, the scientific name of western yellow pine is *Pinus ponderosa* Doug. When a variety of a species is recognized, the varietal name follows the spe-

cific name, so in the case of Nogal, a larger variety of the Southwestern little walnut, the scientific name is *Juglans rupestris* var. *major* Torrey. When the names of two authorities are given, one appearing in parentheses, it indicates that the species was first described by the authority indicated in the parentheses, but placed in the wrong genus, and that this error was rectified by the second authority. This is the case with the western hemlock, *Tsuga heterophylla* (Rob.) Sarg. In this work the nomenclature accepted by the United States Forest Service (as amended to Jan. 23, 1940) has been followed, as it was felt that this would be of most service to foresters.

HABIT. This refers to the general appearance of a tree, usually as seen from a distance. The size; appearance and form of the trunk; shape, density and size of crown; the number, size, and direction of growth of the branches, are all factors helpful in distinguishing trees. In the conifers there is typically a trunk that extends to the tip of the tree without dividing (*excurrent*), while most of the hardwoods have the trunk breaking up into several large branches (*deliquescent*). Both the crown and branches may vary greatly in the same species depending upon whether the tree is growing in the open or in a dense stand where it is shaded on the sides by its neighbors.

LEAVES. Since leaves display characteristic patterns, they are probably the most useful organs in identifying trees. Leaves consist of an expanded portion or *blade,* a supporting stalk or *petiole,* and small leaflike or scaly structures (*stipules*) attached in pairs at the base of the petiole. Leaves having no stipules are termed *exstipulate,* and those without petioles are called *sessile.* Those species which are evergreen can be identified by their leaves throughout the year, while species which shed their leaves annually (*deciduous*) must be identified by other characters during the winter months. Leaves may be arranged *alternately* (with one leaf attached to the



LEAF PATTERNS

Leaf Shapes

1–Lanceolate. 2–Oblanceolate. 3–Oblong. 4–Elliptical. 5–Oval. 6–Ovate. 7–Orbicular. 8–Subulate. 9–Acicular. 10–Linear.

Leaf Margins

1–Serrate. 2–Crenate. 3–Entire. 4–Dentate. 5–Sinuate. 6–Doubly serrate. 7–lobed .

Leaf Apices

1–Acuminate. 2–Rounded. 3–Emarginate. 4–Obtuse. 5–Mucronate. 6–Acute.

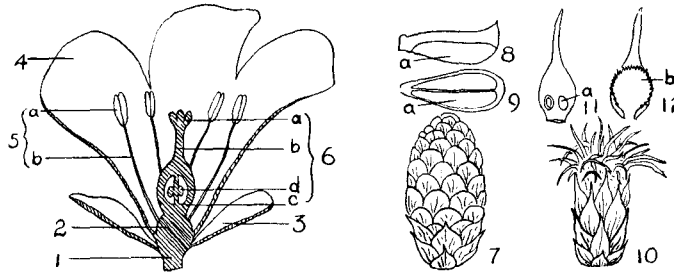
Leaf Bases

1–Obtuse. 2–Cuneate. 3–Rounded. 4–Acute. 5–Rounded. 6–Cordate. 7–Truncate.

Leaf Types

1 to 10–Simple leaves. 11–Pinnately compound leaf.

twig at a certain point), *oppositely* (where two leaves emerge at opposite sides from the same place on a twig), *whorled* (where more than two leaves emerge from one point of the twig), or *fascicled* (where a number of leaves emerge in a cluster or bundle.) They may be *simple* and consist of a single blade or expanded portion, or *compound* and made up of several individual leaflets. If the leaflets in a compound leaf are arranged along each side of a common axis (*petiole* or *rachis*), the leaf is said to be *pinnately compound,* while if the leaflets all arise from



FLOWER STRUCTURE

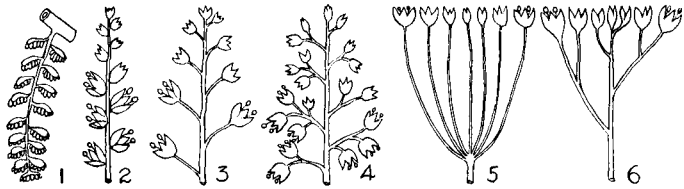
Perfect Flower Flowers of Pine

1–Peduncle. 2–Receptacle. 3–Sepal (Calyx). 4–Petal (Corolla). 5–Stamen; a–Anther, b–Filament. 6–Pistil; a–Stigma, b–Style, c–Ovary, d–Ovule. 7–Staminate conelet. 8 and 9–Stamen, or pollen-bearing scale, showing side and lower surfaces. 10–Pistillate conelet. 11 and 12–Pistillate scale showing inner and outer surfaces respectively; a–Ovule, b–Bract.

the apex of the petiole, the leaf is termed *palmately compound.* Other characters used in identification are the shapes and types of margin, apex, and base (p. xxiii). Texture, color, and the surface, whether smooth or hairy, are also useful characters.

FLOWERS. All trees have flowers, although frequently they are small and inconspicuous. These are the reproductive organs by means of which the species is perpetuated. Floral characters are the most accurate means

of identifying many trees, although they are little used in the field because they bloom for so short a period. Flowers vary greatly in form, structure, and size. A *complete* flower (p. xxiv) is made up usually of leaflike *sepals* (*calyx*), often brightly colored *petals* (*corolla*), *stamens* (the male organs which bear the *pollen* in saclike *anthers*), and a *pistil* (the female organ consisting of a terminal *stigma* which catches the pollen, a *style,* and an *ovary.*) The ovary may consist of one or more compartments (*cells*) and contain one to many *ovules* which later



TYPES OF INFLORESCENSES

1–Ament. 2–Spike. 3–Raceme. 4–Panicle. 5–Umbel. 6–Corymb.

mature into seeds. In Gymnosperms the pistil is replaced by a seed-bearing scale which does not enclose the seed. If the ovary is inserted on top of the other flower parts it is *superior,* while if it appears enclosed within the calyx it is *inferior.* Flowers may be *perfect* (contain both stamens and pistil) or *imperfect* (contain one sex but not the other.) Plants having imperfect flowers are termed either *monoecious* (both sexes present in different flowers on the same plant) or *dioecious* (each sex borne on a different plant.) When the only functioning sex organs in an imperfect flower are stamens the flower is termed *staminate,* while one in which the pistil is the active organ is *pistillate.* Plants which bear some perfect and some imperfect flowers are termed *polygamous.* Flowers may appear singly or in clusters (*inflorescences,* above).

FRUIT. While varying greatly in type and appear-

ance, fruits are very useful in identification. The seeds included in the fruit contain the embryo plant. To the layman these are generally of secondary utility in identification.

TWIGS. The color, stoutness, central pith, or surface coverings and markings may be very useful in identifying trees, especially during the winter months. As buds, stipules, and leaves fall off they leave scars on the twig which are frequently characteristic. Buds are conspicuous on most twigs and helpful in identification. The shape, size, color, number of scales, arrangement, and the presence or absence of a terminal bud are important diagnostic characters.

BARK. The appearance of bark, while varying greatly with age and environment, is often a helpful character in identification. Color and thickness of the bark, whether it is furrowed, scaly, or smooth, and its taste, are commonly helpful features.

WOOD. The characters of the wood of trees form a separate means of identification which is more technical and difficult than the use of external characters. In this manual only the outstanding wood characters are given, such as the weight, color, and arrangement of large pores (whether *ring-porous* in a definite ringlike zone, or *diffuse-porous* and scattered throughout the wood). A statement as to importance and the uses of the woods is also included.

SILVICAL CHARACTERS. The tolerance, sites, associates, reproduction, enemies, roots, life zones, and altitudinal distributions of species are often helpful in identification, and have been included wherever possible.

In identifying trees it must be remembered that characters are variable and often overlap with those of closely related trees. Wherever possible, identification should not be based on a single character, but on as many as are available.