

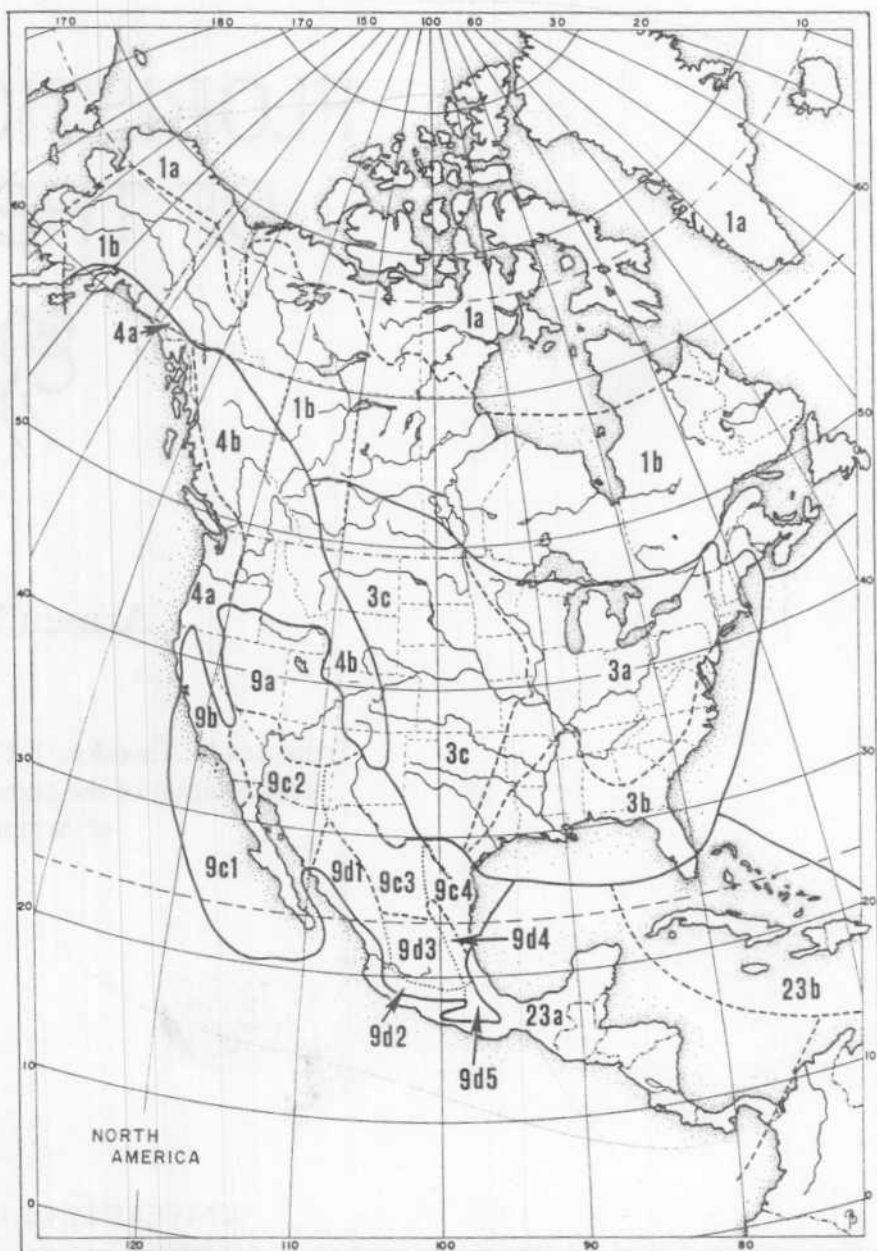
# FLORISTIC REGIONS OF THE WORLD



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Map 4. FLORISTIC REGIONS AND PROVINCES OF NORTH AMERICA

Like the Rocky Mountain Province, the Great Basin Province is marked by prominent altitudinal zonation of the vegetation. The shrub-dominated community of the lowlands gives way at successively higher elevations to open woodland or chaparral brushland, then open or patchy forest and, at the highest elevations in some of the mountains, to alpine tundra.

Water relations are of critical importance throughout the province. A north slope may be forested or wooded, whereas an adjoining south slope is more open. Cold air drainage and restricted insolation in the canyons cause local reversals of zonation, with the trees extending to lower elevations in the canyons than on the ridges. One may climb through a spruce-fir forest in a north-facing hollow and come out on the summit to find it covered with sagebrush.

**2. Californian Province** (Engler 1882,<sup>85</sup> Harshberger 1911; Howell 1957, p.p.; Munz 1959; Thorne 1963; p.p.; Gleason and Cronquist 1964; Stebbins and Major 1965, p.p.; Ornduff 1974, p.p.; Raven 1977, p.p.; Raven and Axelrod 1978, p.p.).

The Californian Province occupies a major part of the state of California and a small part of northwestern Baja California Norte (Mexico). Many phytogeographers also include a part of southwestern Oregon, but this area is transitional to the Vancouverian Province, in which it is here included.

The long Central Valley of California forms the heartland of the California Province. This is surrounded on all sides by mountains of varying height. The more northerly of these mountains (Sierra Nevada, southern Cascade Mountains, mountains of the Klamath area, and the western part of the North Coast Ranges of California) are here assigned to the Vancouverian Province, in the Rocky Mountain Region. The inner North Coast Ranges, the South Coast Ranges, the Transverse Ranges in southern California, and the western foothills and lower slopes of the Sierra Nevada and Cascade Mountains all belong to the California Province. The lower limit of the ponderosa pine forests in the Cascade Mountains and Sierra Nevada (about 1,200 m in the southern Sierra Nevada) may be the most useful boundary line in that area, but many characteristically Californian species extend well up into the ponderosa pine zone, and some go even higher. The higher parts of the mountains of southern California and northern Baja California carry attenuated versions of the Sierran forests, surrounded and considerably infiltrated by Californian and/or Sonoran elements.

We limit the Californian Province more narrowly (in accordance with Gleason and Cronquist 1964) than do some authors, such as Raven and Axelrod (1978), so that it conforms essentially to the area in which the vegetation and flora are shaped by a Mediterranean climate. Following such a concept, we consider the Californian Province to be basically Madrean, with some influence and infiltration from the Vancouverian Province and,

to a lesser extent, from the Rocky Mountain Province and other parts of the Boreal Subkingdom.

The present flora of the Californian Province is largely descended from the Madro-Tertiary flora that evolved in the southwestern United States and northern Mexico under the influence of gradually increasing aridity. Sclerophyllous shrubs and small trees formed an important element in the vegetation of California at least as long ago as the Miocene epoch. These Miocene and Pliocene sclerophylls are thought to have been vegetatively active for much of the year, however, instead of being dormant in the summer like most of the modern species. The present Mediterranean climate, with prolonged summer drought, appears to have developed only during the past million or so years, at least partly in relation to the rise of the Sierra Nevada. Intense speciation, mainly from preexisting Madrean elements, occurred during this climatic change.

Raven and Axelrod (1978) calculated that the Californian Province harbors 4,452 native species of vascular plants, of which 2,125 (47.7%) are endemic. They defined the province more broadly than we, including not only the Klamath area and all of the North Coast Ranges, but also the southern Cascade Mountains and the Sierra Nevada. The number of native species in the province as here defined must be less than 4,000, but the percentage of endemics is, if anything, higher than Raven and Axelrod calculated for the larger, more heterogeneous area. Thus we may say that roughly half of the native species in the province are nearly or quite endemic to it.

In addition to the many endemic species, a considerable number of genera and a few small families are endemic to the Californian Province or have their principal center of diversity there. Among the more notable of these are: *Limnanthaceae* (10 species, 9 in California); subtribe *Madiinae* of the tribe *Heliantheae* in the *Asteraceae* (nearly 100 species in all, the vast majority endemic); tribe *Gileae* in the *Polemoniaceae* (about 170 species in all, 100 in the province, 60 or more endemic); *Mimulus* (100 or more species in all, about 75 in the province, many endemic); *Caulanthus* (15 species in all, 11 in the province, 7 endemic); *Streptanthus* (30+ species in all, 20+ in the province, all endemic); *Arctostaphylos* (40+ species, nearly all in the province, many endemic); *Dudleya* (about 50 in all, more than half in the province, most of these endemic); *Lotus* subg. *Hosackia* (about 40 in all, about 30 in the province, many endemic); *Clarkia* (33 in all, 29 in the province, many endemic); *Ceanothus* (50+ in all, 44 in the province, 37 endemic); *Cryptantha* subg. *Krynitzkia* (50+ species, about 25 in the province, some endemic); *Collinsia* (18 species, 14 in the province, most endemic); *Downingia* (14 in all, 10 in the province, 5 endemic); *Brodiaea* (15 species, all in the province, 13 endemic); *Triteleia* (14 in all, 13 in the province, 12 endemic). *Eriogonum* and *Astragalus*, which have major centers in the Great Basin

explanation for the pattern. The varying degrees of relationship between the members of a given pair suggest repeated rather than concurrent dispersal events. The past existence of climatically suitable stepping stones seems highly unlikely, especially in view of the fact that the Mediterranean climate of both California and Chile appears to be geologically rather recent. A postulated Californian-Chilean landbridge in the past is purely fanciful and without geological foundation.

In most cases the Californian distribution appears to be primary and the Chilean one secondary. *Limonium californicum*, a California salt-marsh endemic, provides a contrary example. It is homostylic and self-compatible, in contrast to *L. guaicura* of Chile, which is heterostylic and self-incompatible.

Some examples of species that occur in both California and Chile are *Carpobrotus chilensis*, *Cardionema ramosissima*, *Paronychia franciscana*, *Lepidium nitidum*, *Lotus subpinnatus*, *Trifolium depauperatum*, *T. macraci*, *T. microdon*, *Sanicula crassicaulis*, *S. graveolens*, *Microcala quadrangularis*, *Pectocarya ferocula*, *P. pusilla* (perhaps only recently introduced in Chile), *Plagiobothrys myosotoides*, *P. scouleri*, *Orthocarpus attenuatus*, *Amblyopappus pusillus*, *Madia sativa*, and *Psilocarphus brevissimus*. Some species-pairs, with the Californian species listed first, are *Chorizanthe coriacea* and *C. chilensis*; *Helianthemum scoparium* and *H. spartioides*; *Acaena californica* and *A. trifida*; *Clarkia davyi* and *C. tenella*; *Collomia grandiflora* and *C. cavanillesii*; *C. linearis* and *C. biflora*; *Linanthus pygmaeus* and *L. pusillus*; *Pectocarya peninsularis* and *P. dimorpha*; *Plagiobothrys greenii* and *P. gracilis*; *Downingia humilis* and *D. pusilla*; *Legenere limosa* and *L. valdiviana*; *Lasthenia glaberrima* and *L. kunthii*; *Psilocarphus tenellus* and *P. berterii*; and *Poa douglasii* and *P. commungii*.

There is a degree of altitudinal zonation in the Californian Province. Most of the floor of the Central Valley and other lowlands was originally a treeless grassland, but some oaks extend out into the valley floor, especially toward the north. Climbing from the valley floor, one at first encounters scattered oaks in a sea of grass. This very open oak woodland merges upwards, in relatively favorable sites, with an oak woodland or oak-pine woodland, in which the trees are less widely spaced. In the Coast Ranges, especially northward, the oak woodland merges upward with a mixed broad sclerophyll forest. In drier, less favorable sites in the foothills and lower mountains, one finds chaparral instead of oak woodland. All of these zones are also represented in southern California, to the south of the Great Valley and its surrounding mountains.

It has been widely believed that Central Valley was originally (in terms of human time) a great prairie dominated by perennial bunchgrasses. *Stipa pulchra* was the most abundant single species. *Stipa cernua* and species of *Aristida*, *Elymus*, *Festuca*, *Koeleria*, *Melica*, and *Poa* were also common. The interstices between the bunchgrasses contained some annual grasses and a wide variety of annual and perennial herbs in other families. The annual

*D. elegans*, *D. insignis*, *D. ornatissima*, *D. pulchella*, *D. pusilla*, *D. yina*, *Legenere limosa*, *Evax caulescens*, *Psilocarphus brevissimus*, *Orcuttia californica*, *O. pilosa*, and *O. tenuis*. Some of the more characteristic species from around the margins are *Trifolium barbigerum*, *T. cyathiferum*, *T. depauperatum*, *T. fucatum*, *Limnanthes douglasii*, *Plagiobothrys acanthocarpus*, *P. distantiflorus*, *Pogogyne zizyphoroides*, *Orthocarpus campestris*, *Blennosperma nanum*, *Lasthenia burkei*, *L. chrysantha*, *L. fremontii*, *L. glaberrima*, *L. platycarpha*, *Layia chrysanthemoides*, *Machaerocarpus californicus*, *Juncus uncialis*, and *Alopecurus howellii*. Only a few foreign species have been able to invade the vernal pool habitat.

The Central Valley is largely surrounded by oak woodland. There are about 15 species of *Quercus* in the province, and several of them are common and widespread. The most common trees in most of the oak woodland are *Quercus lobata* (valley oak), *Q. douglasii* (blue oak), and *Pinus sabiniana* (digger pine). Blue oak and digger pine often grow together, but they do not usually grow with valley oak. Both of these oaks are deciduous. Several evergreen oaks, most notably *Q. agrifolia* (coast live oak), and *Q. wislizenii* (interior live oak) are also common in the oak woodland, and *Q. agrifolia* is an integral part of the broad sclerophyll forest in the Coast Ranges as well. *Quercus engelmannii* (a semi-evergreen species) is common in southern California. Favorable sites in the oak woodland (often called the foothill woodland) often harbor a few other deciduous trees, such as *Aesculus californica* and (toward the south only) *Juglans californica*.

A mixed broad sclerophyll forest occupies the more mesic sites in the Coast Ranges, and occurs also in a few places in the foothills of the Sierra Nevada, where the Californian Province abuts on the ponderosa pine forests of the Sierran district of the Vancouverian Province. The most important dominant species are *Quercus agrifolia*, *Q. chrysolepis*, *Arbutus menziesii*, *Lithocarpus densiflora*, and *Umbellularia californica*. *Pinus coulteri* often grows with *Quercus chrysolepis* in these otherwise hardwood forests. All of these dominant species except the pine sprout freely after fire. Fires are not so frequent here as in the chaparral community, but they still play an important role.

In the North Coast Ranges of California and in the Klamath area in southern Oregon, the broad sclerophyll forest passes into the mainly coniferous forest of the Vancouverian Province. Douglas fir may grow intermingled with the broad sclerophyll trees. In some places the broad sclerophyll forest abuts on the coast redwood forest (Vancouverian Province), occurring above the fog belt in which the redwood grows. Some elements of the broad sclerophyll forest, such as madrone, extend north irregularly in relatively dry habitats all the way to Puget Sound.

Chaparral covers many of the hills and lower mountains of California, occupying sites too dry for the oak woodland. The community is adapted to drought and fire, passing through repeated cycles of burning and regrowth. It is a rare stand that escapes fire for more than fifty years.

The drier and more exposed sites in the chaparral community are com-



monly dominated by *Adenostoma fasciculatum* (chamise), an evergreen shrub with small, narrow leaves—that is, a narrow sclerophyll. Ephemeral annuals and short-lived perennial herbs germinate after fire in the chamise chaparral and form a vigorous herbaceous carpet that persists for a few years until the shrub cover becomes too dense. The seeds of some of these species may lie dormant in the ground for years until the return of conditions favorable to them. A similar herbaceous growth occurs after fire in the other chaparral communities.

Progressively more mesic sites in the chaparral community are typically dominated by species of *Ceanothus*, *Arctostaphylos*, and shrubby oaks. These are all broad sclerophylls. Many but not all of the species sprout after fire. The taxonomy of both *Ceanothus* and *Arctostaphylos* is complex, and interspecific hybrids are frequent. The explosive speciation of the past million years has not yet produced clear breaks between some of the taxa.

The most mesic (but still rather dry) sites in the chaparral community are characterized by small oaks, notably *Quercus dumosa* (scrub oak) and a shrubby phase of *Q. wislizenii*. A wide variety of other shrubs occur with the oaks. *Toxicodendron diversilobum* (poison oak, a member of the Anacardiaceae), an allergenic shrub or vine that is widely distributed in California, Oregon, and Washington, is a prominent member of this as well as several other communities.

The Coast Ranges and the foothills of the Sierra Nevada contain scattered outcrops of serpentine, most of them smaller than the massive blocks in the Klamath area to the north (discussed under the Vancouverian Province). An important ecological feature of serpentine is the virtual absence of available calcium. As elsewhere in dry climates, serpentine tends to be more sparsely vegetated than other substrates, and it carries a specialized flora. Some species of *Allium* grow indiscriminately on serpentine or in other barren habitats where the competition is minimal, but many species in a wide range of the other genera grow preferentially on serpentine or are restricted to it. Some species are limited to a single outcrop and may have a total range less than 100 m long. Others grow on two or more outcrops that are not necessarily adjacent, and some seem to find a large proportion of the serpentine exposures over a wider range. Among the many Californian species associated with serpentine are *Quercus durata*, *Arenaria howellii*, *Chorizanthe brewerii*, *C. uniaristata*, *Eriogonum argillosum*, *E. covilleum*, *Arabis mcdonaldiana*, *Streptanthus barbiger*, *S. breweri*, *S. batrachopus*, *S. howellii*, *S. insignis*, *S. polygaloides*, *Thelypodium flavescens*, *Astragalus breweri*, *Lupinus spectabilis*, *Linum adenophyllum*, *L. bicarpellatum*, *L. californicum*, *L. clevelandii*, *Lomatium howellii*, *Phacelia greenei*, *Cryptantha mariposae*, *Castilleja neglecta*, *Cordylanthus nidularius*, *Mimulus brachiatus*, *Haplopappus ophitidis*, *Layia discoidea*, *Madia hallii*, *Senecio clevelandii*, *S. greenei*, *Calochortus umbellatus*, *Fritillaria falcata*, *F. glauca*, and *F. purdyi*.

Several rather small species of closed-cone conifers (*Pinus* and *Cupressus*)

form distinctive local communities in inhospitable (but not especially dry) habitats here and there in the Californian Province, especially along the coast. They are all fire-trees, in which the cones tend to persist on the tree for a number of years, opening after fire. Some of them occur on serpentine or on other soils deficient in one or more nutrients. All are thought to be relicts from a more mesic Tertiary coniferous forest. Their ranges may well have expanded—and contracted also—in association with Pleistocene reversals in climate.

The closed-cone pines include *Pinus attenuata*, *P. muricata*, *P. radiata* (Monterey pine, now widely planted in Mediterranean climates), *P. remorata*, *P. torreyana*, and *P. contorta* var. *contorta*. *Pinus contorta* is also widespread as a fire-tree in the Rocky Mountain Region, in more slender and erect varieties known as lodgepole pine. The other species are nearly or quite endemic to the Californian Province.

The taxonomy of *Cupressus* is complex, and some taxa treated as species by some authors are reduced to infraspecific rank by others. In one view the genus contains about 25 species, all in the Northern Hemisphere. Ten of these are native to California, and most of the 10 are nearly or quite endemic to the Californian Province. These are *Cupressus abramsiana*, *C. bakeri*, *C. forbesii*, *C. goveniana*, *C. macnabiana*, *C. macrocarpa*, *C. nevadensis*, *C. pygmaea*, *C. sargentii*, and *C. stephensonii*. All of these species have restricted distributions (most of them discontinuous), and some have very narrow limits indeed. The famous and picturesque Monterey cypress (*C. macrocarpa*) is known from two groves along the windswept coast of Monterey County, and the Gowen cypress (*C. goveniana*) is also known from only two groves, likewise in Monterey County, but a few kilometers inland.

**3. Sonoran Province** (Thorne 1963; Gleason and Cronquist 1964; Chaparal-Provinz and Sonora-Provinz, Engler 1899, 1903, 1924).<sup>86</sup> The Sonoran Province occupies much of northern Mexico and a considerable fringe of southwestern United States, as far north as southern Nevada and a tiny corner of southwestern Utah. The portion in the United States is continuous from southeastern California to southern Texas, but the portion in Mexico is partly divided into segments by the Gulf of California, the Sierra Madre Occidental, and the Sierra Madre Oriental. These two Sierra Madres form parts of the Mexican Highlands Province.

The province has four well-marked subprovinces. From west to east these are Baja California (excluding the northwest corner), the Sonoran Desert, the Chihuahuan Desert, and the Tamaulipan Thorn-scrub. A low-lying portion of the Sonoran Desert near the Colorado River in southeastern California is often called the Colorado Desert. The Mohave Desert forms a distinctive northwestern district of the Sonoran Desert. The district is here broadly interpreted to include Death Valley and some desert mountain ranges that border on the Great Basin Province, as well as the Mohave Desert proper.



No one species or genus characterizes the Sonoran Province as a whole, but two genera collectively may almost do so. *Larrea* is dominant in much of the Sonoran (including Mohave) and Chihuahuan deserts, and is also common in a large part of Baja California, but not in the Tamaulipan Thorn-scrub. *Prosopis* is a dominant element in the Tamaulipan Thorn-scrub and is also common in the Chihuahuan Desert and parts of Baja California and the more southern parts of the Sonoran Desert, but it is not significant in the Mohave district.

Both *Larrea* and *Prosopis* also have a wider range. *Larrea* has 1 species (*L. tridentata*, creosote bush) in North America, and 4 in deserts of South America. The North American species is mainly confined to the Sonoran Province, but has outlying stations (even local communities) in the drier parts of the Mexican Highlands Province. *Prosopis* has about 40 species, in warm, dry parts of the Old World as well as of the New. In North America it encroaches into the southern part of the North American Prairies Province, and it occurs irregularly southward into South America, as well as being common in the West Indies. It is a prominent element in the thorn-scrub vegetation of Paraguay and northern Argentina.

Both *Larrea* and *Prosopis*, as represented in North America, have their antecedents in South America. The time of migration is debatable, but it may well have been relatively recent. The North American *Larrea tridentata* is so closely related to *L. divaricata* of Argentina that the two have often been regarded as conspecific. The North American *Prosopis reptans* var. *cinerascens* is paralleled by *P. reptans* var. *reptans* in northern Argentina, and the common Sonoran species *P. glandulosa* was long confused with the very closely related *P. juliflora* of the Caribbean Region and *P. chilensis* of subtropical South America.

Cacti are an important part of the vegetation in the Sonoran Province, much more so than in the Californian and Great Basin provinces to the north. Baja California alone has some 90 native cacti, about 60 of them endemic. *Carnegiea gigantea* (saguaro), the largest of all cacti, occurs mainly in southern Arizona and northern Sonora. Several species in other genera, found mainly in Mexico, get nearly as large. *Opuntia*, with jointed stems, is well represented throughout the province. Species with flattened stem segments are called prickly pear, and species with terete segments are called cholla. Some of the chollas disjoint very easily when brushed against, and are known as jumping cholla.

*Cercidium* (palo verde) is also a common and conspicuous plant in most of the Sonoran Province, although it scarcely reaches the Mohave Desert. The several species are robust, spiny shrubs or small trees with notably green twigs (whence the common name). They are leafless for most of the year, and the leaves when present are relatively small and insignificant. *Cercidium* is widespread in dry places in the American tropics and is a common member of the desert flora in northern Argentina.

The taxonomically isolated genus *Fouquieria* has its home in the Sonoran and Mexican Highlands provinces. One of the species, *F. splendens* (the ocotillo), is fairly widespread in the Sonoran Province (excluding the Mohave and Tamaulipan areas), but the others have more limited ranges. The famous *Fouquieria* (*Idria*) *columnaris*, the boojum tree, occurs mainly in the southern part of Baja California Norte, with a few outlying stations across the Gulf of California in Sonora.

The Asteraceae are by far the largest family in the Sonoran Province, as they are in many other parts of the world outside the moist tropics. They do not dominate the landscape, however, as do the legumes, cacti, and *Larrea*. One species, *Ambrosia dumosa*, is codominant with *Larrea* in the Mohave Desert, but it is smaller and less conspicuous than the *Larrea*.

Monocotyledons make up less than 15% of the Sonoran flora, in contrast to nearly 25% for the world as a whole. The large genus *Carex*, which has so many species throughout the Boreal Subkingdom, has only a handful here. The grasses are somewhat better represented, and there is a considerable amount of desert grassland or oak woodland in the more nearly mesic, upland parts of the province. *Agave*, *Yucca* and other firm-leaved succulents of the family Agavaceae are well developed in the less extreme habitats, as they are also in the Mexican Highlands Province. Bulbous plants, so common among the monocotyledons, are in general not well adapted to the conditions of the Sonoran Province.

As in all dryland regions, the nature of the parent rock has a profound and continuing influence on the soils in the Sonoran Province. Limestone, sandstone, shale, and the various sorts of crystalline rocks provide different substrates with different (though not mutually exclusive) floras.

Gypsum provides one of the most notable special habitats in the Chihuahuan subprovince and adjacent parts of the Tamaulipan subprovince and the Sierra Madre Oriental (Mexican Highlands Province). It also occurs here and there in other parts of the Mexican Highlands, in addition to the Sierra Madre Oriental. Some species are wholly confined to gypseous habitats, some are more common there than elsewhere, some are indifferent, and many are excluded. Among the gypsophilous species of the Chihuahuan subprovince and nearby areas are *Notholaena bryopoda*, *Anulocaulis eriosolenus*, *A. gypsogenus*, *A. leisolenus*, *A. reflexus*, *Selinocarpus purpusianus*, *Atriplex reptans*, *Drymaria elata*, *D. lyropetala*, *Nerisyrenia castillonii*, *N. gracilis*, *N. incana*, *N. linearifolia*, *Frankenia gypsophila*, *F. jamesii*, *F. johnstonii*, *Fouquieria shrevei*, *Astragalus gypsodes*, *Dalea filiciformis*, *Petalonyx crenatus*, *Nama canescens*, *N. carnosum*, *N. purpusii*, *N. stevensii*, *N. stewartii*, *Phacelia gypsogenia*, *Aster gypsophilus*, *Dicranocarpus parviflorus*, *Flaveria anomala*, *F. oppositifolia*, *Gaillardia gypsophila*, *G. multiceps*, *G. powellii*, *G. henricksonii*, *Haploesthes greggii*, *Haplopappus johnstonii*, "*Machaeranthera*" *gypsophila*, "*Machaeranthera*" *re-*

*stiformis*, *Sartwellia flaveriae*, *S. mexicana*, *S. puberula*, *Strotheria gypsophila*, *Thelesperma ramosius*, *T. scabridulum*, *Muhlenbergia bryopoda*, and *Sporobolus nealleyi*.

The floras of Baja California (exclusive of the essentially Californian north-west corner), the Sonoran Desert, and the Chihuahuan Desert are all about the same size, in the range of 2,500–3,000 native species. No figures are available for the Tamaulipan Thorn-scrub, but it may be comparable. Most of the species are of course common to two or more of the subprovinces, so that the total flora may be in the range of 5,000–6,000 species. Endemism for the province as a whole has not been carefully calculated, but it is probably more than 25%.

The floras of Baja California and the Chihuahuan Desert are now fairly well understood. The percentage of endemism in these two is strikingly different, in the range of 20–25% for the former, and 8–10% for the latter. The relatively high endemism in Baja California may reflect the presence of the Gulf of California as a physical barrier to migration, and also the fact that more than half of the peninsula is frost-free. In contrast, all of the Chihuahuan Desert and most of the Sonoran (including the Mohave) Desert and the Tamaulipan Thorn-scrub are subject to some frost. The elevation of the Chihuahuan Desert gradually increases southward into Mexico, so that the southern part is not so much warmer than the northern part as might otherwise be expected.

Baja California is not completely cut off from the rest of the Sonoran Province. The Sonoran Desert flora is continuous around the head of the Gulf of California and extends south for more than 300 km in a fringe along the northeastern side of the peninsula. This strip is largely dominated by *Larrea* and is here only arbitrarily included in the Baja Californian subprovince.

*Larrea* is also a significant element in most of the rest of Baja California, but other genera are more prominent. Cacti, many of them arborescent, are common and conspicuous throughout. Sarcocaulous shrubs or small trees are often dominant, and coarse succulents such as *Agave* and *Yucca* are common. Dominance at a particular site may be shared by species of a dozen or more genera, including *Opuntia*, *Pachycereus*, *Atriplex*, *Fouquieria*, *Jatropha*, *Pedilanthus*, *Cercidium*, *Bursera*, *Larrea*, and *Yucca*. Low annuals in the Asteraceae and other families make a brief show at the end of the rainy season in a good year. The flora may be highly diversified, but much of the ground is bare, especially after the annuals wither and die.

Southward the flora of Baja California takes on a progressively more tropical aspect. Cacti are abundant to the southern tip of the peninsula; species of *Ferocactus*, *Lemaireocereus*, *Mammillaria*, and *Pachycereus* are prominent elements. Common woody plants include species of *Acacia*, *Pithecel-*

*lobium*, *Bursera*, *Cyrtocarpa*, *Sapindus*, *Erythea*, and other genera. Some of these reach tree size, but the community is always open, never forming a dense forest.

Although *Larrea* is the most pervasive element in the Sonoran and Chihuahuan subprovinces, it is of course not always the only dominant. Woody species of *Yucca* stand up above the *Larrea* in parts of both of these areas. The largest of these species, *Yucca brevifolia*, forms grotesque elfin "forests" along the western and northern borders of the Mohave Desert, where it also overlaps into the sagebrush zone of the Great Basin Province. Other sorts of large shrubs or even arborescent cacti rise above the *Larrea* in other parts of these deserts, except the Mohave.

Chaparral and oak woodlands resembling those of California occur in some of the uplands of the Sonoran and Chihuahuan subprovinces, especially in bands encircling the isolated mountain ranges of central to southeastern Arizona and southwestern New Mexico. The resemblance is mainly in broad aspect and in some of the dominant genera (*Quercus*, *Arctostaphylos*, *Ceanothus*), however. Many of the other genera and most of the species are different, although *Quercus turbinella*, *Arctostaphylos pungens*, and *Ceanothus greggii* are common members of the Arizona-New Mexico chaparral that do extend west to California. Vegetative activity of the plants is of course attuned to the seasonal distribution of rainfall.

Above the chaparral and oak woodland in these mountains there may be a zone of junipers and pinyon pine, which in turn gives way to a more characteristic coniferous forest. The highest peaks extend above timberline and have a more or less alpine vegetation. Toward the northern part of these subprovinces many of the species in the upper vegetational zones are the same as those of comparable habitats in the Rocky Mountains and Great Basin. There are, for example, many Rocky Mountain species in the mountains of trans-Pecos Texas.

The Tamaulipan subprovince is not so dry as the other parts of the Sonoran Province. The principal vegetation is more nearly a thorn-scrub than a truly desert type. Species of *Acacia*, *Prosopis* (especially *P. glandulosa*) and *Cercidium* are among the most important dominants. Others include *Aloysia gratissima*, *Castela texana*, *Celtis pallida*, *Karwinskia humboldtiana*, *Ziziphus obtusifolia*, and so on.

Fairly large parts of the Tamaulipan Thorn-scrub might be considered a mesquite-grassland, with *Prosopis glandulosa* and/or *P. reptans* var. *cinerascens* as the dominant woody plants. The common grasses include some species that are widespread in the North American Prairies Province, such as *Bouteloua hirsuta*, and others that have more limited ranges and reach their best development in and near the Tamaulipan Thorn-scrub, such as *Aristida roemeriana*, *Trichachne hitchcockii*, and *Tridens texanus*.

As in all desert regions, the vegetation in most of the Sonoran Province is sparse, with much open ground between individual plants. A large part of the area is dominated by widely spaced shrubs not more than 1.5 m tall. Such open habitats are also well suited to annual plants, and in a good year these are abundant, diversified, and conspicuous for a short time at the end of the rainy season.

Whittaker (1975:156) points out that "in the warm semideserts there is no such convergence of dominant form as in the cool semideserts and other biomes; evolution here has produced [a] divergence of plant forms." This generalization applies best to the less extreme desert habitats, which are too dry for real trees and too dry to permit a continuous crown cover or ground cover, but not so dry as to impose rigid limitations on non-tree forms of growth. It is well illustrated in parts of Baja California, where microphyllous desert shrubs, pachycaulous arborescent shrubs, cacti of all sizes (including tree-cacti) and plants of diverse other specialized forms (but not ordinary trees) grow intermingled. Some of the less extreme parts of the Sonoran and Chihuahuan deserts present more or less similar mixtures. Still, one can drive through mile after mile of the Mohave Desert and some other parts of the Sonoran Desert and see little but two small-leaved evergreen shrubs, one (*Larrea tridentata*) sclerophyllous, the other (*Ambrosia dumosa*) with soft leaves. Large stretches of the Chihuahuan Desert are even more monotonous, dominated by *Larrea* alone.

**4. Province of the Mexican Highlands** (Provinz des mexikanischen Hochlandes, Engler 1899, 1903, 1924; Mexican Highlands, Good 1947, 1974; Aztekische Provinz, Engler 1882; Kingdom of the Mexican Mountains, Schouw 1823). The topographic, ecologic, and floristic diversity of central Mexico is so great that no scheme of classification can do it justice. Alexander von Humboldt said that the vegetative cover of the area might well be considered a microcosm of that of the whole world. Doing our best, we here define the Mexican Highlands Province to include the major mountain systems of Mexico, from the southern slopes of the Sierra Madre del Sur on the south, to the northern ends of the Sierra Madre Occidental and Sierra Madre Oriental on the north. The Altiplano of central Mexico, south of the Chihuahuan Desert and north of the Trans-Mexican Volcanic Belt, is also included. The Balsas Depression, lying between the Sierra Madre del Sur and the volcanic belt, is excluded and is considered to form a peninsula of the Central American Province, joining with the rest of that province at the west. The mountains of Chiapas have many species in common with or closely related to those of the Mexican Highlands Province, but these mountains are wholly surrounded by tropical vegetation and are here considered to be northern enclaves in the Central American Province.

Province, also have considerable numbers of species in the California Province. The presence of about 10 species of the widespread genus *Cupressus* may also be noted.

Endemic species include: *Ophioglossum californicum*, species of *Cheilanthes* (including *C. californica*), *Pinus coulteri*, *P. muricata*, *P. radiata*, *P. sabiniana*, *P. torreyana*, *Pseudotsuga macrocarpa*, species of *Cupressus* (including *C. macrocarpa*), *Eschscholzia lemmonii*, *Meconella californica*, *Papaver californicum*, *Romneya coulteri*, *Quercus agrifolia*, *Q. douglasii*, *Q. lobata*, *Q. tomentella*, *Aphanisma blitoides*, *Atriplex californica*, *Chorizanthe* spp., many species of *Eriogonum*, *Hollisteria lanata*, *Paeonia californica*, *Crossosoma californicum*, many species of *Arctostaphylos*, *Lavatera assurgentiflora*, *Dirca occidentalis*, species of *Dudleya*, *Jepsonia parryi*, *Adenostoma sparsifolium*, *Chamaebatia australis*, *Lyonothamnus floribundus*, many species of *Astragalus*, *Lupinus* spp., *Pickeringia montana*, *Clarkia delicata*, *C. rubicunda* and several others, *Heterogaura heterandra*, *Cneoridium dumosum*, *Adolphia californica*, *Ceanothus arboreus* and some other species of this genus, *Mentzelia* spp., *Gilia* spp., *Leptodactylon californicum*, *Phacelia* spp., *Amsinckia douglasiana*, *Cryptantha* spp., *Castilleja* spp., *Galvezia speciosa*, *Mimulus* spp., all three species of *Acanthomintha*, *Lepechinia* spp., *Monardella* spp., *Pogogyne abramsii*, *P. nudiuscula*, *Pycnanthemum californicum*, *Salvia* spp., *Satureja chandleri*, *Stachys* spp., *Downingia cuspidata*, *Githopsis* spp., *Nemacladus* spp. *Erigeron sanctarum*, species of *Haplopappus*, *Perezia microcephala*, *Layia* spp., *Senecio lyonii*, *Calochortus catalinae*, *C. clavatus*, *C. pulchellus*, *C. umbellatus* and few other species of this genus, *Chlorogalum pomeridianum*, *Fritillaria biflora* and several other species of this genus, *Allium* spp., *Bloomeria crocea*, *B. clevelandii*, species of *Brodiaea*, *Muilla maritima*, *Triteleia clementina*, *T. versicolor*, *Nolina interrata*, *Smilax californica*, *Discantheum californicum*, *Orcuttia californica*, *Poa douglasii*, *P. napensis*, and *P. tenerrima*.

A phytogeographical relationship between the western United States and temperate or warm-temperate South America has attracted attention and comment from many botanists (cf. Raven 1963). There are more than a hundred examples of the occurrence of the same or closely related species in these two areas, but not elsewhere. The common feature in the large majority of these disjunctions is that the Californian Province provides part or all of the North American area, and central and/or northern Chile provides part or all of the South American area. These taxa with disjunct distribution all have small disseminules. Nearly all of them are self-compatible (many self-pollinated), or at least one member of the pair is so. Most of them are plants of open habitats, in which establishment can be relatively easy once the seed arrives. Many of them are annual. It is doubtless significant that no similar pattern of distribution exists among vertebrates.

Long-distance dispersal, by birds or whatever method, is the obvious



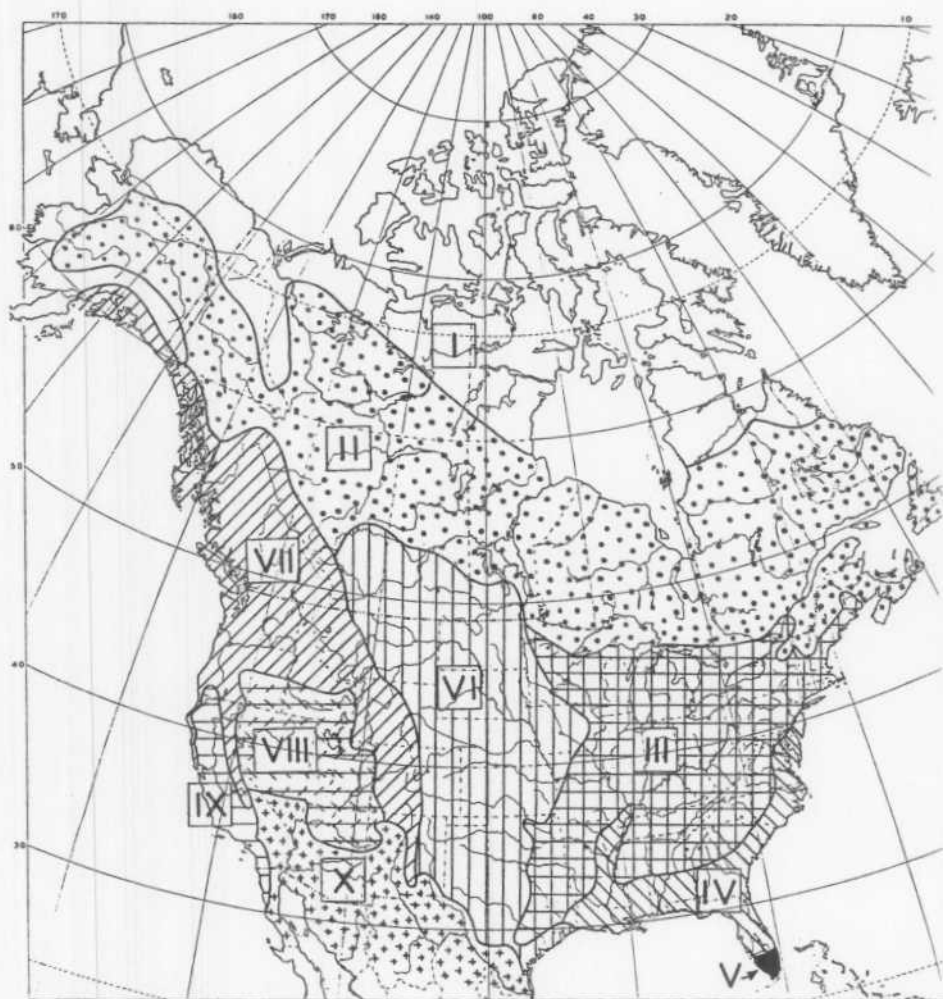


Fig. 15.1. The floristic provinces of the continental United States and Canada. I, Tund. Province; II, Northern Conifer Province; III, Eastern Deciduous Forest Province; IV, Coastal Plain Province; V, West Indian Province; VI, Grassland Province; VII, Cordilleran Forest Province; VIII, Great Basin Province; IX, Californian Province; X, Sonoran Province.

For this map the lines between the provinces have been drawn boldly, so as to show the general outlines rather than the ultimate details. The actual boundaries are in general not sharp; instead they overlap and interfinger extensively, and small enclaves of one province may be wholly surrounded by another.