Notes to accompany a vegetation map of northwest Mexico

Donald Dilworth Brand

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NOTES TO ACCOMPANY A VEGETATION MAP OF
NORTHWEST MEXICO

DONALD D. BRAND.
PREFACE

The following map and notes are based upon field notes made by the writer during the years 1929-1931, while in northwest Mexico, under the auspices of the University of California Department of Geography. In 1934 and 1935, the Border regions of Baja California, Sonora, and Chihuahua were revisited. Whatever of accuracy and of value there may be in these notes is derived from the instruction in plant geography by Professor William A. Setchell, and in field methods by Professor Carl O. Sauer. All available literature has been checked to verify and amplify the field notes. At the moment, this paper constitutes the most complete summary of the literature and knowledge concerning the vegetation of the area involved. It is hoped to follow this paper, at some time in the future, with a monograph on the climates of northwest Mexico, which will help in the interpretation of areal distributions of associations and formations.
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NOTES TO ACCOMPANY A VEGETATION MAP OF NORTHWEST MEXICO

INTRODUCTION

This paper embodies a preliminary study of the vegetation of northwestern Mexico. Vegetation is here considered to be the plant cover of an area in its general aspects of dominant associations and formations. The region designated as northwestern Mexico comprises the Mexican states of Sonora, Sinaloa, Chihuahua, and Durango. These four states contain about 236,000 square miles, or a trifle less than a third of the republic's total area.

BOTANICAL COLLECTIONS

The flora of northwestern Mexico has been comparatively well studied. The earliest descriptions of plants are to be found in the writings of Tello, Pérez de Ribas, Obregón, and Pfefferkorn, and in the "Rudo Ensayo" and the "Relación de la Nueva Mexico." However, the area was untouched by trained botanists until the expedition of Charles II of Spain, which worked in Mexico under Dr. Martin Sessé from 1788 to 1804. Mocino, Castillo, and Longinos were the members of this expedition who made collections in northwestern Mexico. The chief result of this work was in the information given by Mocino to A. P. de Candolle while the former was a political exile in France. Von Humboldt and Bonpland stimulated scientific study in Mexico, but neither of them ever set foot in the northwest during their visit in 1803-1804.

1. The chief bibliographies and histories of botanical research in Mexico are: Hemsley, W. B. Biologia Centrell-Americana; Botany 4: 117-137, 316-332, London, 1887.
   Leon, Nicholas. Biblioteca Botanica-Mexicana, Mexico, 1895.
   Just's Botanischer Jahrbuch, Leipzig, sporadic numbers on "Pflanzen-geographie der Ausseerneuropaischen Lander."
The modern period of research began with Thomas Coulter, who explored Sonora in the 1830's and was the first collector to send out plant collections from this region. Adolf Wislizenus, in 1846, made the first large collection in Chihuahua, although Josiah Gregg had collected numerous specimens, in the 1830's, which are chiefly in the herbarium of the Missouri Botanical Garden. Charles Wright, 1847-1851, made large collections, in Chihuahua and Sonora, which were studied by Gray. In 1849-50, Berthold Seemann, botanist on H. M. S. Herald, made some collections in Sinaloa and Durango. During the 1850's, various members of the United States-Mexican Boundary Commission, especially Schott, Wright, Thurber, Parry, Bigelow, and Emory, collected extensively along the border. Guillemin-Tarayre collected for the French Scientific Commission in 1865-1866.

The long regime of Díaz was marked by the visits of many noted botanists and naturalists. Among the first, and certainly the greatest field botanist, was Cyrus Pringle, whose Mexican collections are unequalled by those of any other collector. Edward Palmer, who collected mainly from northern Mexico during the period 1870-1910, ranks second only to Pringle. C. V. Hartman and F. D. Lloyd made extensive collections in Sonora and Chihuahua from 1890 to 1893, while accompanying Carl Lumholtz on his archaeological explorations. C. A. Purpus, E. A. Mearns, and T. S. Brandegee gathered many specimens in the northern portions of the region.

E. W. Nelson and E. A. Goldman covered most of northwestern Mexico while engaged in biological investigations. F. V. Coville and J. N. Rose, curators of the United States National Herbarium, collected extensively in northern Mexico. Since the establishment of the Carnegie Desert Laboratory at Tucson, Arizona, in 1908, numerous collecting expeditions have been made into Sonora and adjacent areas by such botanists as Daniel MacDougal, W. A. Cannon, V. M. Spalding, B. E. Livingston, F. E. Clements, and Forrest Shreve. In addition to the plant investigators listed above, there have been several specialists who have visited northwestern Mexico while obtaining specimens and data. Among the best known of these are Trelease for yuccas, agaves, and oaks; Hitchcock for grasses; Britton for cacti; Shaw for pines; Safford for plants of economic significance; and Stahl for cacti and agaves.

**Vegetational Studies**

The vegetation of northwestern Mexico has been but imperfectly studied and described, despite the extensive botanical investigations in the region. The wealth of floristic data has not been synthesized and organized in terms of associations and formations except in a very general manner. Only a few investigators have attempted to describe the entire vegetational landscape, including climatic and edaphic factors involved. These studies have been of small and scattered areas within the region.

In working up this study, use has been made of published floras, botanical monographs, reports of military, naval, and boundary commissions, travelogues, consular reports, descriptions of landscapes incorporated in geologic reconnaissances, and varied scientific reports which include data on vegetation, e.g., reports of archaeologic, zoologic, and ethnologic surveys. The following paragraphs are devoted to a consideration of the principal sources utilized.

The vegetation of northwestern Mexico has been described in eighteen pages by John Harshberger (Phytogeographic Survey of North America, 633-648, 656-658, New York, 1911, which appeared in *Die Vegetation der Erde* series edited by Engler and Drude). A map of North America, on the scale of 1:40,000,000, shows northwestern Mexico divided into five vegetational areas: Chihuahuan Desert, Sonoran Desert, Western Sierra Madre, Rocky Mountain, and Jaliscan. Limits of pine, mangrove, and yucca are indicated. In the symposium *Naturalist's Guide to the Americas* (edited by V. E. Shelford, Baltimore, 1926),
Shreve and Shelford have an article "Descriptive List of Middle American Biota," 77-80, which briefly outlines nine areas for our region: Arid Deciduous Forest (southern Sinaloa), Extreme Desert, Desert, Succulent Desert (all three in Sonora and Chihuahua, but separated by coniferous forests) Dry Grassland (Chihuahua and Durango), Desert Coniferous Forest, Arid Coniferous Forest, Moist Coniferous Forest, and High Mountain Forest (in the Sierra Madre Occidental, progressing from Desert to High Mountain Forest with increase in elevation and decrease in latitude.) This article is illustrated with octavo page map of Mexico and Central America. The symposium also contains an article on "Natural Areas and Regions of Mexico," 574-596, by Nelson and Goldman. These writers recognize an Arid Lower Tropical division in Sinaloa, Covillean Association in much of Durango, Chihuahua, and coastal Sonora, Pinon-Juniper Association flanking the Sierra Madre Occidental above the Covillean Association, and Pine Association over most of the Sierra Madre Occidental. An octavo page vegetation map of Mexico accompanies the above article, but it contains several gross errors. This same map was used to illustrate "The Natural Regions of Mexico," by E. M. Sanders in Geographical Review, 11:212-226, 1921. La Vegetación de Mexico, 1899, by Jose Ramirez, contributes little of value, as it lacks a vegetation map and is composed mainly of translations from foreign botanists such as Grisebach, Hemsley, and Fournier.

Several plant geographies devote small sections to northwestern Mexico. These general works only confuse the subject by adding new terms to an already cluttered terminology, and the maps are on too small a scale to be of much practical value. Among the best of these works are:

Rubel, Eduard. Pflanzengesellschaften der Erde, 1930, with a map by H. Brockmann-Jerosch.
Braun-Blanquet, J. Pflanzensoziologie, 1928.

Monographs on families, genera, and species normally stress the floristic rather than vegetational aspects of the subject. Nevertheless, valuable data on areal distribution and ecology can be gleaned from many of these works. Deserving special mention in Die Pflanzenareale series edited by Diels, Samuelsson, Hannig, and Windler, and published at Jena since 1926. This serial is devoted to articles and maps developing the areal distribution of plants over the earth. The principal monographs consulted are listed below:

Vegetation of Northwest Mexico

Hayek, August. Allgemeine Pflanzengeographie, 1926.
Campbell, D. N. Outline of Plant Geography, 1926.
Hardy, Marcel. The Geography of Plants, 1920.
Schimper, A. F. W. Plant Geography, 1905.
Drude, Oscar. Handbuch der Pflanzengeographie, 1890.

Bailey, L. H. Gentes Herbarium, various numbers.
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Campbell, D. N. Outline of Plant Geography, 1926.
Hardy, Marcel. The Geography of Plants, 1920.
Schimper, A. F. W. Plant Geography, 1905.
Drude, Oscar. Handbuch der Pflanzengeographie, 1890.
Considerable information was derived from articles on the economically valuable plants of Mexico. Among the leading works and authors are:

Cook, O. F. Numerous articles, especially on tropical food-stuffs.
Cordero, y Seguro. *Recesía sobre el cultivo de algunas plantas industriales*, 1884.
Diguet, Leon. Numerous articles, chiefly on cacti.
Dodge, C. *A descriptive catalogue of useful fiber plants of the world*, 1897.
Lloyd, F. E. *Guayule, a Rubber Plant of the Chihuahua Desert*, 1911.
Martínez, Maximino. *Las Plantas Mas Utiles de la Republica Mexicana*, 1928.
Martínez, Maximino. *Plantas Narcoticas de Mexico*, 1925.
Materia Médica Mexicana, 1900, various articles.
Noriega, J. M. *Contribucion al Estudio de la Gobernadora*, 1922.
Noriega, J. M. *Historia de Drogas*, 1902.
Noriega, J. M. *Las Plantas Mexicanas y Algunas Exoticas Productoras de Materiales Colorantes*, 1919.
Ramírez, José. *Sinonimia Vulgar y Cientifica de las Plantas Mexicanas*, 1902.
Record, Samuel. *Timbers of Tropical America*, 1924.
Rose, J. N. *Notes on Useful Plants of Mexico*, 1901.
Safford, W. E. Numerous articles, especially on drugs.

Because of the contiguity of Arizona, New Mexico, and Texas to portions of northwestern Mexico, it was possible to use a number of excellent studies prepared on the American areas. The most important of these studies are:

Bailey, V. *Biological Survey of Texas*, 1908.
Bailey, V. *Life Zones and Crop Zones of New Mexico*, 1913.
Bray, W. L. *Distribution and Adaptation of the Vegetation of Texas*, 1905.
Bray, W. L. *Vegetation of the Sotol Country in Texas*, 1905.
Coulter, J. *Botany of Western Texas*, 1891-1894.
Livingston, B., and Shreve, F. *The Distribution of Vegetation in the United States, as Related to Climatic Conditions*, 1921.
Meinzer, E. O. *Plants as Indicators of Ground Water*, 1927.
Sampson, A. W. *Native American Forage Plants*, 1924.
Shreve, F. *The Vegetation of a Desert Mountain Range as Conditioned by Climatic Factors*, 1915.
Spalding, V. M. *Distribution and Movement of Desert Plants*, 1939.

The data on individual areas in northwestern Mexico were derived mainly from scientific reports and travelogues having vegetational data only incidentally. These data were...
synthesized, co-ordinated, corrected, and interpreted in the light of personal observations which were most extensive in Sinaloa, northern Sonora, and northern Chihuahua. The following list includes most of the works utilized:

Audubon, J. W. Illustrated notes, 1852.
Bell, P. L. Mexican West Coast, 1923.
Hornaday, William. Camp-fires on Desert and Lava, 1908.
Huntington, Ellsworth. The Climatic Factor as Illustrated in Arid America, 1914.
Lumholtz, Carl. New Trails in Mexico, 1912.
Lumholtz, Carl. Unknown Mexico, 1905.
LEGEND

VEGETATION OF NORTHEASTERN MEXICO
LEGEND
VEGETATION
OF
NORTHWESTERN MEXICO

Vegetation Areas
Chihuahuan Desert:
1. Creosote-yucca-mesquite
2. Mesquite-grassland
3. Succulent Desert
Sierra Madre Occidental:
1. Oak-agave-juniper
2. Pine forest
Sonoran Desert:
1. Colorado Delta Association
2. Creosote-palo verde-cacti
3. Sonoran mesquite-grassland
4. Subtropical mimoso-cacti
5. Sinaloa Tropical:
   1. Semi-arid scrub
   2. Humid scrub

Floristic Boundaries

- Northern limit of mangrove
- Southwestern limit of creosote bush

Boundary of vegetation district

Note: The closed boundaries of vegetation districts, indicated in the southern and eastern portions of the map, represent lack of study and not actual limits.
The flora of northwestern Mexico is quite diversified, as would naturally be expected in a region situated on both sides of a tropic (22°N.-33°N.), and extending from a coast line nearly a thousand miles long to the crests of a mountain range which average over 8,000 feet in elevation. High continental-interior and coastal deserts merge into grassy steppes and shrub savannahs, which are succeeded by upland coniferous and lowland tropical forests. With great extremes and ranges of temperature and precipitation are associated a variety of soils which differ markedly in organic content, salinity, and other factors conditioning the physiologic processes and morphology of the native flora.

The Compositae outnumber every other order in genera and species; grow in almost every variety of situation; are often very numerous individually; and especially characterize the dry districts. The Leguminosae, Gramineae, Cactaceae, Euphorbiaceae, Felices, Labiatae, Amaryllidaceae, and Liliaceae are most numerous in species and most prominent in the landscape, with the exception of the Sierra Madre area where the Coniferae are the dominant group in the landscape. Most of the arid climate genera and families (Yuccaceae, Cactaceae, Agave, Fouquieria, Nolina, Dasyliron, etc.) of North America presumably originated in the Chihuahua Desert area, and advanced northward with the withdrawal of the northern glaciation. The species of these genera and families should be considered the native vegetation of northern Mexico. Rosaceae, Fagaceae, Coniferae, etc. of northern forms have invaded the upland portions of the region and maintain themselves to as low as 3,000 feet elevation. This spread of boreal plant forms took place from the southern Rocky Mountain area as the California flora extends into Mexico only in Lower California. Although the prairie vegetation of the Great Plains has entered northern Mexico to some extent, the present direction of movement seems to be of Mexican species northward. Certain Yucca
and cacti are found far north into the Dakotas and Wyoming; and it is a matter of present observation that Acacias and mesquites (Prosopis) are steadily taking over formerly grass-covered areas in Texas. Tropical vegetation has entered northwestern Mexico along the Pacific coastal plain, where it attains to northern Sinaloa. The mangrove (Rhizophora mangle) extends along the strand into southern Sonora. From the above it can be seen that northwestern Mexico constitutes a primary Xerophytic vegetation unit which has been modified and augmented by tropical, northern mountain, and prairie invasions. The identity of this north Mexican vegetation region has been recognized by such phytogeographers as Seeman, Hemsley, and Harshberger.

Vegetation Areas

On the basis of intrusive and native florals, modified by local climatic and edaphic factors, northwestern Mexico falls into four major vegetation areas, each susceptible to subdivision. These major divisions are expressions of latitude, continental position, and elevation in so far as these items condition temperature and precipitation. The Chihuahuan Desert area embraces the most continental interior portions of the elevated tableland that makes up Chihuahua and Durango. The Sonoran Desert area comprises the extra tropical high pressure lowland parts of Sonora and northern Sinaloa, which are somewhat in the rain shadow of Lower California's Peninsular Range. Between these arid areas is the Sierra Madre Occidental area, with a vegetation typical of humid mesothermal highlands. The Sinaloa Tropical area coincides with the northern extension of the Pacific coast tropical forest and is characterized by a deciduous thorn scrub and forest.

Chihuahuan Desert: The Chihuahua Desert area comprises eastern and northern Chihuahua and eastern Durango. This elevated (3,000-7,000 feet) Basin and Range country falls into the arid climates (BWh and BSh of Köppen) due to low precipitation values, as the mean annual temperatures run under 20°C., excepting in the extreme northeastern portion. Xerophytic succulents (cacti, Nolina, Dasylirion, Yucca), microphylls (Prosopis, Larrea, Fouquieria, Acacia) and steppe grasses (Sporobolus, Bouteloua, Aristida, Hilaria, Munroa) form the bulk of the vegetation. In the more humid isolated mountain areas, oaks, junipers, and pines dominate the landscape. Along the river courses are gallery forests made up of cottonwood (Populus sp.), willows (Salix sp.), walnuts (Juglans sp.), hackberry (Celtis sp.), ash (Fraxinus sp.), and sycamore (Platanus sp.), in addition to thickets of Prosopis, Mimosa, Acacia, and other Leguminosae.

1. Creosote-yucca-mesquite: This area falls into three subdivisions or vegetation districts. In northern Chihuahua, from the mesa fronting the Rio Grande west to Laguna Guzmán and the Santa María River and from the Potrillo Hills north of the International Boundary south to Bajío del Ojo Caliente, Laguna Patos and the Conchos basin, is a gravel- and sand-covered plain scantily vegetated with yuccas (mainly Yucca elata), creosote bush (Larrea tridentata), and mesquite (Prosopis juliflora). The creosote bush is the dominant plant of this creosote-yucca-mesquite association. Hundreds of square miles of arid basin land present to view the drab green of creosote bushes widely spaced over the gravelly plains. The yuccas, mesquite, and Koelpinia spinosa are common in the sand dune areas where they often have contributed to the formation of the dunes. Occasional Crotons, chamiso (Atriplex canescens) and Zizyphus flank the dunes. On rocky ridges and the small isolated ranges Agaves, ocotillo (Fouquieria splendens), Nolina, Dasylirion, cacti, Yucca, and mesquite vie with the ubiquitous creosote bush. Gramas (Bouteloua), needle-grasses (Aristida) and tobosa grass (Hilaria mutica)
form the scanty grass vegetation. This district is one of the truest deserts in northern Mexico, the annual precipitation averaging less than 200 mm.

2. Mesquite-grassland: West and south of the above described district is a higher, somewhat less arid region of steppe climate whose vegetation is of a type transitional between desert shrub and mesothermal woodland. Grasses, mesquite, creosote bush, and hojasén (Flourensia sp.) dominate the landscape. Mesquite supplants the creosote bush as the dominant member of the vegetation, and the latter is restricted to high benches, outwash fans, and upper pediment slopes where the soil is coarse textured, permeable, and well drained. The mesquite attains its best growth in the lowland areas of fine textured soils and high water table, but also extends up washes and onto areas quite deficient in water supply. In some of the better watered valleys thickets of arborescent mesquite, frequently associated with screw bean (Prosopis pubescens), Acacias, Koebelínia, chamiso, and Mimosas, occupy the river plains. Hojasén (Flourensia cernua) ranks only after mesquite and creosote, among the shrubs. It usually occurs on lower slopes, mixed with mesquite and creosote. The sequence of the shrub association is quite marked where slopes are well developed. Mesquite normally occupies the middle of the valleys, followed by a mixture of mesquite and hojasén in which hojasén becomes more and more abundant until creosote bush appears as the marked slope begins. The creosote bush increases rapidly, and is nearly pure on the upper slopes and ridges.

Grasses are well developed throughout, and great expanses of grass country are frequent in the western basins between 4,000 and 5,000 feet elevation. The chief grasses are the gramas, various needle grasses, curly mesquite (Hilaria belangeri), tobosa grass (Hilaria mutica), several bunch grasses (Sporobolus), and false buffalo grass (Munroa squarrosa). Black grama, curly mesquite, and false buffalo grass predominate on the upper, well-drained slopes, where their expanse may be broken only by popotillo (Ephedra sp.), a few yuccas, an occasional opuntia or ocotillo, and some mesquite and hojasén. Tobosa grass grows mainly in areas of fine textured soils, and the bunch grasses are found over areas normally subject to annual flooding. Various grasses vegetate the borders of the barren playas, the dominant species being salt grasses (Distichlis spicata, and Eragrostis obtusiflora), and alkali sacaton (Sporobolus airoides). The edges of the flooded areas usually mark the inner limits of the grassy zone, although in some places clumps of sacaton extend well out into the flats.

The banks of the larger streams often carry a considerable tree vegetation consisting of cottonwood, willow, sycamore, walnut, hackberry, ash, and alder. The Fremont cottonwood (Populus fremontii=wislizeni) is the outstanding member of the gallery forest. Walnuts (Juglans rupes-tris, and J. major), desert willow (Chilopsis linearis), and hackberry (Celtis reticulata) also occur singly and in small groves and clumps along the arroyos. Occasional oaks and junipers fringe the upper margins of the western basins, and mark the change to the Sierra Madre Occidental area or to the higher mountain ranges of the district. These desert and steppe ranges have a vertical succession from mesquite-creosote, through juniper, agave, and oak, to pines—in the case of the highest ranges. Oaks are dominant, Quercus emoryi prevailing on the lower slopes and Quercus grisea on the upper slopes. In the steppe lands of the Sonoran Desert area, there is an association quite similar in general to that of the Chihuahua mesquite-grassland, but there are sufficient floristic differences to justify a distinction.

Along the Rio Grande and lower Conchos valley in Chihuahua, the vegetation resembles that of the larger river valleys in the steppe country. There is, however, an increase in the Acacias and Mimosas so typical of the lower Rio Grande. This gallery vegetation is more scrubby than arboreal. It has been mapped as an extension of the mesquite-
grassland district, as mesquite is still dominant, and most of the associated plants are typical. A somewhat similar extension of mesquite-grassland is found along the lower Nazas into the Coahuilan sink.

3. Succulent desert: Southward from the Conchos and the Big Bend of the Rio Grande there is a marked increase in the number of species and individuals of succulent and semi-succulent plants. Cacti, Agaves, Nolinas, Dasylirions, and Yuccas are dominant members of the vegetation, along with various Leguminoseae, creosote bush, and oco­tillo. Along the washes grow mesquite, Acacias, Mimosas, Parkinsonia, hackberries, Lyciums, and Condalias. Creosote bush dominates most of the district, but yields to the succulents on the slopes and ridges. The grass vegetation is poorer than in the creosote-yucca-mesquite association. Both capsular and baccate yuccas are common. Cacti increase in size and numbers southward, and include numerous Echinocacti, Mamillarias (Neolloydia), members of the Cereus group, etc. in addition to the Opuntias found to the north. Agaves, especially lechuguilla, Nolinas (bear grass), and Dasylirions (sotol) have such a development that this district is sometimes referred to as the sotol, or lechuguilla country. Two species of oco­tillo are important items in the landscape. The richness of this district in succulents, prob­ably expresses a close relationship to the cradle of such arid climate plants more than any special suitability of climatic or edaphic factors.

Sierra Madre Occidental: The Sierra Madre Occidental area comprises the western highland margins of the Mexican central plateau or tableland, with elevations between 5,000 and 10,000 feet. The precipitation values run from 500 mm. to over 1,200 mm., with mean annual temperatures under 18°C. The annual rainfall, although concentrated in the summer months, is sufficient to maintain a mixed deciduous-coniferous woodland at the lower elevations and a fairly pure, open coniferous forest higher up. In general, this vegetation area coincides fairly well with the areas of mesothermal savannah climate (Cw of Koeppen). Two associations are dominant in this forest area which extends south for 800 miles, and averages 50 to 100 miles in width.

1. Oak-agave-juniper: Commencing at an elevation of around 5,000 feet in the north, and somewhat higher in the south, the junipers, creosote-bush, popotillo, and other shrubs that dot the basin grasslands are supplanted by Agaves, junipers, and oaks. The Yuccas, Nolinas, Dasylirions, and Opuntias continue upward for another thousand feet in this park landscape of mesothermal climate. Gramas continue to be the dominant grasses. Between 5,000 and 6,000 feet junipers, oaks, and Agaves prevail. From 6,000 to 7,000 feet, there is a pine-oak transition belt, and above 7,000 feet is the pine country. The succession is from juniper through oak to pine, with varying proportions of these trees and their associates. Neither soil nor slope seems to condition the vegetation as much as does mere elevation.

Oaks are dominant in this foothill formation, Quercus emoryi (black live oak) prevailing at the lower elevations, and Quercus grisea (gray live oak) making up nine-tenths of the oak vegetation in the upper elevations mainly above 6,700 feet. On the Pacific coast side Quercus oblongifolia (white live oak) and Quercus Arizonicus (Arizona gray live oak) are dominant. Several other species of oaks, however, are represented in this formation, which varies, in appearance, from chapparal through oak savannah to forest. Junipers (Juniperus pachyphloea and J. Mex­icana) grow on the sunnier slopes and somewhat dry ridges, singly or in quite open groves, commonly interspersed with oaks and Agaves. The Agaves grow singly throughout the association area.

On the Sonoran slopes the lower transition zone from basin grassland to oak-agave-juniper contains relatively few Yuccas, Nolinas, and Dasylirions, while Parkinsonia, Acacia, Prosopis, and Fouquieria are well represented. The
inferior limit of oaks is considerably lower than on the Chi-
huahuan side, as oaks are common at elevations under 3,000
feet. In Sinaloa the transition from tropical to mesothermal
vegetation is marked by the complete absence of Yuccas,
Nolina, Dasylirions, ocotillo, and creosote-bush, and only a
scanty representation of mesquite. These succulents and
shrubs are replaced by a great number of Mimosas, Acacias,
Cassias, Caesalpinias, figs, laurels, and other plants typical
of the Sinaloa tropics. The transition zone in Sinaloa com-
mences around 3,500 feet elevation, which is about the lower
limit of oaks.

2. Creosote-palo verde-cacti: The northwestern por-
tion of Sonora is probably Mexico’s region of least precipi-
tation, many of the annual values averaging under 50 mm.
This district extends from a sand dune and salt flat seacoast
up to about 2,500 feet, but most of it is under 1,500 feet
elevation. Creosote bush, palo verde (Cercidium torreyana,
and Parkinsonia microphylla), Opuntias, mesquite,
Acacias, Franserasias, palo fierro (Olneya tesota), and the
Cereus gigantea dominate the landscape of this truly arid
district: Galleta grass (Hilaria sp.) is distributed, sparsely through-
out. The vegetation is typically Mexican, although it ex-
tends northward into Arizona. There has been influ-
ence across the Gulf from Baja California, and in the south from
the tropical association.

On the coarse gravelly mesas the characteristic plants
are creosote bush, palo verde, palo fierro, saguaro (Cereus—
Carnegia gigantea) cholla (Opuntia sp.), ocotillo, and
Acacias. The creosote bush extends to the coast, where it is
associated with chamiso and galleta grass on the plains
back of the beaches, and with Ephedra in the dune country.
Cacti seldom attain to the coast except in the southern por-
tion where saguaro, pitahaya (Leucaicoereus thurberi)
and other columnar cacti are present. The two cacti named
are commonly associated together and with ocotillo and palo
verde on southern slopes and outwash fans. On many of
the desert plains there are nearly pure stands of cholla cac-
tus, especially northwest of Altar towards the Pinacate
country. The mountains and ridges of the arid district carry
a scanty vegetation of ocotillo, cholla, and columnar cacti,
and some Yucca, Nolina, and Dasylirions in the northeast-
ern portion.
Vegetation of Northwest Mexico

On the flood plains and alluvial areas, there are large trees of Parkinsonia, Quleya, Prosopis, and Acacia, intermingled with columnar cacti, smaller cacti, chamiso, Fran
ersia, and galleta grass. In the arroyos and washes a vegetation of mesquite, cats claw (Acacia sp.), palo verde, palo fierro, creosote bush, hackberry, Ephedra, Condalia, and ocotillo prevails. Along the southern coast there are heavy stands of Pachycereus, and cirio (Idria columnaris). Along the southern foothills are numerous palo blanco trees (Ipomea arborescens), intruders from the tropical area.

3. Sonoran mesquite-grasslands: The northern and eastern basins and plains of Sonora carry a steppe shrub vegetation quite similar to that of the Chihuahuan mesquite-grassland. The distinctive features of the Sonoran district are dominance of grama grasses, numerous cacti, relative unimportance of Yuccas, creosote bush, Flourensia, Ephedra, Condalia, and Koeleria, lesser importance of mesquite as a dominant, and the presence of Parkinsonia and Fran
ersia. The arboreal constituents of the gallery forests are nearly the same in both districts, but there is a stronger development of oaks and Acacias in the Sonoran district. Palms are common in many of the western canyons, the chief genera represented being Washingtonia, Erythea, and Inodes.

4. Subtropical mimosaceae-cacti: Covering the arid coastal and river valley portion of southern Sonora and northern Sinaloa is a spiny shrub and cacti formation dominated by Mimosaceae and columnar cacti. Creosote bush, saguaro, and Fouquieria splendens of the northern districts are virtually lacking, their places being taken by numerous Caesalpinias, Cassias, Mimosas, and palo santo (Guaiacum coulteri). This vegetation is not distributed uniformly, but is arranged in clumps, gathering into a nearly continuous cover in wetter spots. Various Mimosaceae and columnar cacti especially form large stands which extend for miles, as in the deltas of the Yaqui, Mayo, and Fuerte rivers. In the southern river valleys higueras (Ficus sp.), huanacastles (Enterolobium), sabinos (Taxodium sp.), and other tropical trees are increasingly numerous.

Sinaloa Tropical: The Sinaloa tropical district is tropical in temperature values, but varies in moisture supply between savannah and desert conditions. Four associations are prominent in this district, agreeing in distribution with the coastal lagoons, river flood plains, coastal inter-fluvialite uplands, and foothills of the Sierra Madre Occidental. Due to difficulties in mapping on a small scale map these formations have not been differentiated on the vegetation map. Approximately between the Piastla and Quelite rivers there is a change from semi-arid to humid conditions with over 750 mm. of precipitation annually. This change is marked by a taller and more closely spaced vegetation which attains to almost forest proportions in many of the river valleys. This, however, is more of a change in formation than in association.

Along the coast, especially on the mud flats bordering lagoons, there is a dense shrub vegetation. This vegetation consists of mangrove (Rhizophora mangle) in the tidal areas, and seagrape (Coccoloba uvifera), Pisonea sp., mora (Chlorophora tinctoria), numerous Caesalpinias, etc., along the shore. Various palms, especially Cocos nucifera are common near the beach. Dense and nearly continuous scrub forests of this coastal association occur south of Mazatlan, particularly from the mouth of the Rio del Presidio southward. North of Mazatlan the association is more open, lower, and separated by long stretches of sandy beach.

The flood plains of the Sinaloa rivers and adjacent upland slopes have been cleared and cultivated for many centuries, in parts going back even to pre-Spanish days, according to the evidence of archaeologic sites from the Culiacán river southward. The portions not cleared for cultivation have been selectively devegetated in accordance with demands for charcoal, timber, cabinet woods, and dye woods.
Where formerly cleared areas have gone back into the wild; the secondary vegetation has an apparently greater development of scrub than was originally the case. Throughout the district the native associations have been altered considerably, so that now there are large areas carrying an unnaturally large percentage of commercially worthless trees and shrubs. From these preliminary remarks it is evident that the present vegetation of Sinaloa cannot be considered "natural."

Generalizations as to dominant floristic categories, however, can be made with considerable accuracy. The Leguminosae form the dominant order. The *Mimosa*, *Senna* (Caesalpinaceae) and bean (Fabaceae) families have probably more than a quarter of the total tree and shrub species of the area, and contribute possibly three-quarters of the individuals making up the vegetational landscape. Among the leading *Mimosa* genera are *Prosopis* (mesquite), *Mimosa*, *Acacia* (commonly known as husiaches), *Calliandra*, *Enterolobium* (huanacaxtle), *Inga*, and *Pithecolobium* (guamuchil, chino, uña de gato, etc.). The *Senna* family includes such genera as *Cassia* (most of the species known as biches), *Bauhinia*, *Haematoxyllum* (brasil), *Caesalpinia* (ébano, "dividivi," palo colorado, ígwanu, tabachin, etc.), *Parkinsonia* and *Cercidium* (palo verde). The numerous fabaceous genera include *Indigofera* (añil), *Gliricidia*, *Parosela* and *Nissolia*. These legumes, together with various cacti, chiefly columnar, dominate the inter-fluvial areas and extend from hilltop to valley bottom. The "monte" thus formed is a dull green wilderness difficult to penetrate excepting along cut trails.

In addition to the legumes, the river flood plains carry a considerable arboreal vegetation whose leading members represent a number of genera and families. The mulberry family contributes *Chlorophora tinctoria* (the mora, or fusitic of commerce), nearly a dozen species of *Ficus* (higuera, nacapuli, matapalo, sabali, tescalama, etc.), and the *Castilla elastica* (hule). The pine family is represented by the giant bald cypress or sabino, *Taxodium mucronata*. Other important families are *Lignum vitae* (Guaiacum sp., known as palo santo and guayacán), *Rutaceae* (*Casimiroa edulis*, the sapote), *Burseraceae* (*Elaphrium* sp., copal), *Meliaceae* (*Swietenia* sp., caoba), *Euphorbiaceae* (*Euphorbia* sp., *Croton* sp., *Jatropha* sp., *Sapium* sp., etc.), *Rhamnaceae* (*Zizyphus*, *Condalia*, *Karwinskia*, and *Ceanothus*), *Bombacaceae* (*Ceiba* sp., pochote), and *Convolvulaceae* (*Ipomea arborescens*, palo blanco).

The higueras, huanacaxtle, and sabino are often trees over a hundred feet high with an imposing spread of foliage. These trees, together with mora, ébano, brasil, and guamuchil, are the most noteworthy species of the river valleys. Many of the trees and shrubs carry epiphytes and parasites. On the slopes and foothills, palo blanco, *Agaves*, pochote, and cardón (*Pachycoreces*) punctuate the monotony of the spiny "monte" scrub. These species become lost in the higher "monte" developed towards the south by increased precipitation. Towards the Sierra Madre Occidental, the tropical association first loses the higueras, mora, huanacaxtle, and sabino, replacing them with oaks, laurels, wild plums and other plants of the transition to mesotheral climatic conditions. Tropical vegetation, however, advances far into the Sierra Madre along the deep barrancas that carry low elevations for many miles back of the coastal plain.