

THE TRANSITION FROM DESERT TO CHAPARRAL IN BAJA CALIFORNIA

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The desert region of western North America is almost completely surrounded by areas with higher rainfall and with vegetation of greater water requirement. Only on the coasts of Sonora and Baja California does it reach the edge of the continent. Around its periphery the vegetation of the desert merges either abruptly or gradually into that of the adjacent regions. Owing to the position and extent of the desert it borders on dissimilar types of vegetation on the east and west and at different latitudes. There are therefore a number of distinct types of transition, leading respectively to coniferous forest, coniferous woodland, evergreen oak forest, subtropical thorn-forest, chaparral and grassland. The aim of this paper is to describe some of the features of the transition region between desert and chaparral which lies along the northwestern coast of the Mexican territory of Baja California.

In northern Baja California the Juarez and San Pedro Martir mountains form an effective barrier between the desert which occupies the narrow lowland along the Gulf of California and the chaparral and transition which occupy the Pacific coast. The mountain barrier extends for 160 miles south of the International Boundary. Along the Gulf the desert shows little change through this distance, but on the Pacific slopes the two and a half degrees of latitude comprise large areas of true chaparral in the north, and all stages of the transition up to the final disappearance of the vegetational features of the chaparral and of nearly all its characteristic species. South of the southern end of the San Pedro Martir Range, desert extends from the Gulf to the Pacific. On the latter coast the northern limit of desert away from the littoral may be placed about twenty miles north of Rosario at latitude $30^{\circ} 15' N$. The southern limit of chaparral below an altitude of five hundred feet is in the Santo Tomas Valley, about one hundred miles north of the limit of the desert.

At a number of localities in southern California the vegetation of the Colorado Desert merges into chaparral within distances of twenty miles or less. These cases of great change in a short distance are found on the slopes of the San Jacinto Mountains and along the crest of the Cuyamaca Mountains. They are the product of a rugged topography and of the sharp climatic change which it produces. On the coast of Baja California the climatic basis for the transition lies partly in the normal latitudinal change in temperature conditions, but chiefly in the

gradual waxing of the influence which the mountain background exerts on the rainfall on passing north from the edge of the desert.

There are three criteria which serve to distinguish the plant communities of the desert from other types of vegetation: (a) the low stature of the plants, (b) the wide spacing of the plants, and (c) the intermingling of dominant plants of dissimilar forms and types. The stature of desert vegetation may vary from a few inches to fifteen feet. Isolated individuals may reach a height of forty to fifty feet but such plants are widely spaced. The spacing may vary from a few plants per acre to a number which covers eighty per cent of the surface, but the thickest stands usually have a very low stature. The mingling of dissimilar types is greatest in the warmer deserts of the world and in the most favorable desert habitats. In Baja California it is well marked in all but the most unfavorable habitats, in which one or two forms may compose the vegetation. Where such simplicity is found the stature is low and usually the spacing is wide.

The most extended study of chaparral has been made by Cooper,¹ who defines it as "a scrub community, dominated by many species belonging to genera unrelated taxonomically, but of a single constant ecological type, the most important features of which are the root system, extensive in proportion to the size of the plant, the dense rigid branching, and preeminently the leaf, which is small, thick, heavily cutinized, and evergreen." The stature of chaparral frequently varies without great change in its composition. Its height is commonly greater than that of desert shrubbery, but it becomes greatly reduced in dry situations. The density is invariably greater than that of all but the most exceptional stands of desert shrubbery. The average leaf size is greater in chaparral than in desert. In its typical development chaparral is so dense as to form an unbroken cover and to present a canopy of uniform height except where local conditions permit the occurrence of widely spaced broad-sclerophyll trees.

On the western slopes of the Cuyamaca Mountains, in San Diego County, California, the chaparral shows a greater variability of composition and a greater irregularity in height and density than it does from Monterey County to Ventura County. South of the International Boundary there are some stands of chaparral which exhibit great uniformity and make the hills appear as if draped in immense pieces of green velvet. In general, however, the chaparral south of the Boundary shows an increasing tendency toward diversification and openness. Conditions in California indicate that the bodies of chaparral which

¹ Cooper, W. S. The broad-sclerophyll vegetation of California. Carnegie Inst. Wash. Pub. No. 319. 1922.

are most uniform in height, spacing, and composition are the ones found on the most uniform substratum. Even as far north as San Luis Obispo County there are localities in which the slopes are of such great irregularity in pitch, topography, depth of soil, and character of underlying rock that their plant cover is highly diverse. In Baja California a similar diversification may be noted on relatively uniform substrata in the region immediately south of Todos Santos. South of San Vicente there is a steadily increasing diversification in height and spacing, accompanied by the appearance for the first time of a strong intermixture of plants which are not of the chaparral type. At high elevations on the west face of the San Pedro Martir Range there is much true chaparral, but the writer has not visited that region.

As is true of the meeting ground between any two great plant formations, the dominant plants of each formation are found to vary in the distance to which they extend into the other. This indicates that their habitat requirements are not so nearly identical as their close association in the midst of their respective formations would suggest. Also, in all transition regions there are frequent reversals in the progressive change, due to the existence of small areas in which the conditions are unlike those prevailing around them. The trend of change in the vegetation between Rosario and the Boundary is away from the characteristics of the desert and toward those of chaparral. Indeed, the vegetational features of the desert extend farther north than do its characteristic species. This is particularly true with respect to the concurrence of dissimilar types, as many shrubs and bushes which are not of the broad-sclerophyll type are dominants and subdominants in the transition as far north as Ensenada.

The extreme penetration of the chaparral region by desert types is found in the occurrence of *Yucca*, *Ephedra* and four types of cacti north of the International Boundary. With one exception these are represented by species which do not range north from the desert, although their derivation from desert forms is strongly indicated.

The principal features of the transition that may be observed in going north along the Pacific slopes of Baja California are the following: (1) there is a progressive increase in the density of the vegetation. In the vicinity of Rosario there are few situations in which shrubbery forms a close stand, in strong contrast to the compact chaparral of north slopes in the Santo Tomas Valley. (2) There is an increasing uniformity in the height of the dominant plants. In the open vegetation of the desert the lack of uniformity in height is not likely to be noted, but it becomes conspicuous in some of the stages of the transition in which there is a relatively close stand. (3) There is an increasing uniformity in the vegetative character of the dominants.



PLATE XIII. Vegetation of the Desert-Chaparral Transition on the Pacific coast of Baja California, thirty miles north of Rosario; looking east. Conspicuous plants are *Machaeroceus gummosus*, *Euphorbia misera*, *Franseria chenopodiifolia*, *Agave Goldmaniana*, *Echinocereus maritimus*, *Rosa microphylla* and *Atriplex julacea*.

The mingling in the desert of many types of trees, shrubs, bushes, cacti, yuccas, agaves, and other forms becomes more and more local and infrequent through the transition region. (4) There is a gradual loss of deciduous shrubs and an increasing abundance of evergreen shrubs. With several exceptions the shrubs of central Baja California are either deciduous or else retain their leaves after they have withered from drought. The close stands of shrubbery which are found farthest south in the transition are made up largely of deciduous or semi-deciduous types. Only in the northern part of the transition do the evergreen sclerophylls begin to give the vegetation the character of true chaparral.

Meigs² has recently published a map of the climatic and vegetational regions of northern Baja California. The climatic classification follows Köppen's scheme, and the vegetation characterizing each of the subdivisions is very briefly indicated. The southern part of the Desert-Chaparral transition is designated "foggy coastal desert" by Meigs, merging toward the north into "monte," a shrub community occurring in an arid steppe climate. Meigs also describes a series of inland benches extending from the upper course of Rio Guadalupe north to the latitude of Descanso on which the vegetation is predominantly grassland. These areas are north of Ensenada and well beyond the limits of the transition region as here defined, but closer investigation of them will doubtless reveal that they are essentially a part of the transition, due to local soil conditions in conjunction with the steppe type of climate.

In order to convey some indication of the number of perennials found in normal habitats in the transition, and of their relative abundance, the following list is given. It was drawn from an outwash slope near the lower course of Rio San Domingo, about ten miles from the ocean at an altitude of 150 feet in latitude 30° 45' N. and about twenty miles south of the center of the transition. The area on which the list is based was rather heavily covered with perennials, estimated to occupy from eighty to ninety per cent of the ground surface. The level of the vegetation was irregular, on account of the normal height differences among the component species, and the color tone was varied.

Asterisks indicate the relative abundance. The letters D, T, and C indicate respectively whether the range of the plant is chiefly in desert, transition or chaparral. The height, or common range of height, is also given.

****Franseria chenopodifolia	T D	30 inches
***Rosa minutifolia	T	30 "
***Euphorbia misera	D	20- 40 "

² Meigs, Peveril. The Dominican Mission Frontier of Lower California. Univ. of Cal. Press, p. 14. 1935.

*** <i>Viguera laciniata</i>	D	40-50 inches
*** <i>Machaerocereus gummosus</i>	D	48- 72 "
*** <i>Ribes tortuosum</i>	T	40 "
** <i>Viguera deltoidea</i> var.	D	30- 40 "
** <i>Opuntia ciribe</i>	D	20- 30 "
** <i>Simmondsia californica</i>	D T	30 "
** <i>Bergerocactus Emoryi</i>	T	24 "
** <i>Cneoridium dumosum</i>	T	30 "
** <i>Salvia Munzii</i>	T	25 "
** <i>Aesculus Parryi</i>	T	72- 96 "
** <i>Echinocereus maritimus</i>	T	
* <i>Rhus integrifolia</i>	C	96-120 "
* <i>Opuntia prolifera</i>	T	
* <i>Myrtillocactus cochal</i>	D	
* <i>Harfordia macroptera</i>	T	
* <i>Dudleya</i> sp.		
<i>Lycium californicum</i>		40- 50 "
<i>Ferocactus acanthodes</i>	D	
<i>Neomammillaria dioica</i>	T	

From the floristic standpoint the transition region is not merely one in which two distinct floras blend gradually into one another. In the first place the blending is not alike on the part of the two floras, for, as already indicated, the ranges of the desert plants terminate more abruptly than those of the chaparral forms and nearer the outer limit of the vegetation in which they are dominant. Very few characteristic desert species range as far north as the edge of the chaparral at Santo Tomas, but a number of plants identified with the chaparral are found in the desert region for one hundred miles or more south of Rosario. Only two of these, however, are broad-leaved sclerophyll shrubs. In the second place the transition region is characterized by a number of plants which are confined to it or extend only a short way north or south of it. The strongly endemic character of the chaparral indicates its antiquity, and the less pronounced endemism of the transition suggests that there has long been a buffer region between the two very dissimilar vegetations and floras.

Among the dominant plants in the northernmost part of the desert on the Pacific coast of Baja California there are a number which are limited to the desert or occur only in warm situations in the southern part of the transition. These include:

<i>Fouquieria splendens</i>	<i>Cercidium microphyllum</i>
<i>Idria columnaris</i>	<i>Acacia Greggii</i>
<i>Pachycereus Pringlei</i>	<i>Viscainoa geniculata</i>
<i>Opuntia clavellina</i>	<i>Parkinsonia aculeata</i>
<i>Agave Nelsoni</i>	<i>Solanum Hindsianum</i>
<i>Yucca valida</i>	<i>Euphorbia tomentulosa</i>

<i>Echinocereus Engelmannii</i>	<i>Coldenia canescens</i>
<i>Franseria dumosa</i>	<i>Asclepias subulata</i>
<i>Yucca mohavensis</i>	

A smaller number of desert species range north to the central part of the transition and a few of them extend north of Ensenada in close proximity to the ocean, where frosts are rare and light. Among these are:

<i>Myrtillocactus cochal</i>	<i>Euphorbia misera</i>
<i>Opuntia ciribe</i>	<i>Franseria chenopodifolia</i>
<i>Machaerocereus gummosus</i>	<i>Viguera laciniata</i>
<i>Opuntia molesta</i>	<i>Aplopappus venetus</i> var.
<i>Ferocactus acanthodes</i>	<i>oxyphyllus</i>
<i>Echinocereus maritimus</i>	<i>Agave Goldmaniana</i>
	<i>Acalypha californica</i>

Among the chaparral plants which occur in the northern part of the transition but do not range south of the center of it at lower altitudes are the following:

<i>Ceanothus tomentosus</i>	<i>Ceanothus crassifolius</i>
<i>Rhus integrifolia</i>	<i>Quercus dumosa</i>
<i>Rhamnus ilicifolia</i>	<i>Photinia arbutifolia</i>
<i>Artemisia californica</i>	<i>Prunus ilicifolia</i>

A few species are found in the desert east of the Cuyamaca Mountains and also in the southern chaparral and throughout the transition, including:

<i>Simmondsia californica</i>	<i>Encelia californica</i>
<i>Encelia farinosa</i>	<i>Ephedra californica</i>

A few of the plants associated with chaparral in northern Baja California range to the southern limit of the transition and extend into the desert for distances nearly as great as the length of the transition (one hundred miles) or greater. In the following list of notable examples of this group the distances are given to which each of them extends southward from the northern edge of the desert:

<i>Prunus fasciculata</i> 80 miles	<i>Ribes tortuosum</i> 130 miles
<i>Isomeris arborea</i> 145 "	<i>Rhus laurina</i> 150 "
<i>Eriogonum fascicu-</i>	<i>Euphorbia misera</i> 105 "
<i>latum</i> 130 "	<i>Acalypha californica</i> 145 "
<i>Salvia stachyoides</i> 70 "	

Among the species which are confined to the transition region or do not extend more than fifty miles beyond it are:

Aesculus Parryi	Rosa minutifolia
Adolphia californica	Harfordia macroptera
Romneya Coulteri	Atriplex julacea
Ceanothus verrucosus	Eriodictyon sessilifolium
Bergerocactus Emoryi	Salvia Munzii
Arctostaphylos oppositifolia	Ptelea aptera
Eriogonum fastigiatum	Aplopappus berberidis

It will be noted that the species which are endemic in the transition region are preponderantly of northern relationship. *Adolphia californica* (Rhamnaceae) is very closely related to the only other member of the genus, *A. infesta* of Chihuahua and Hidalgo. *Romneya* (Papaveraceae) and *Harfordia* (Polygonaceae) are ditypic genera. *Bergerocactus* is the only one of the transition endemics of desert affinity. It belongs to a monotypic genus with well-marked characters separating it from the Cereae with which it is most closely allied. The other members of the last list belong to genera richly represented in the north and, except in the case of *Salvia*, either absent or poorly represented in the lower latitudes of North America.

These facts further strengthen the evidence that on the Pacific coast the plants of the desert are more sharply confined to their own formation than are the species and genera of the chaparral and other northern types of vegetation. This appears to be due to the fact that the only requirement for the long southward extension of a chaparral plant is the occurrence in the desert region of relatively moist habitats, however restricted in area, while the northward extension of a desert plant requires a well-drained soil, a high percentage of sunshine and freedom from freezing temperatures of more than a few hours' duration. These more exacting requirements are met only in close proximity to the edge of the desert or else in light soils or on steep south slopes near the sea.

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