

Coastal Vegetation of the Gulf of California

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Abstract

With the uplift of the Sierra Madre Occidental in the late Oligocene-early Miocene, tropical deciduous forest was isolated in northwestern Mexico. Thornscrub and then the Sonoran Desert formed during a drying trend in the middle Miocene. The opening of the Gulf of California at the same time dramatically influenced the vegetation and flora of the region. Today the transition from the New World Tropics to the Northern Temperate Zone is in Sonora with the northernmost tropical deciduous forest in the Sierra San Javier (28°N). Thornscrub is transitional between tropical deciduous forest and temperate oak woodland and desert grassland to the north and Sonoran desertscrub to the northwest. The vegetation in the lowlands around the Gulf of California changes from tropical deciduous forest in Sinaloa and the Cape Region of Baja California Sur to coastal thornscrub in southern Sonora and to desertscrub in the Central Gulf Coast and Lower Colorado River Valley subdivisions of the Sonoran Desert farther north in Sonora and Baja California. Unique iconic species found in each area are the evolutionary legacy of the deep tropical history of the Gulf of California.

Resumen

Con el levantamiento de la Sierra Madre Occidental a finales del Oligoceno y principios del Mioceno, la selva baja caducifolia quedó aislada en el noroeste de México. El matorral espinoso primero y después el Desierto Sonorense se formaron durante una tendencia a la sequía durante el Mioceno medio. La apertura del Golfo de

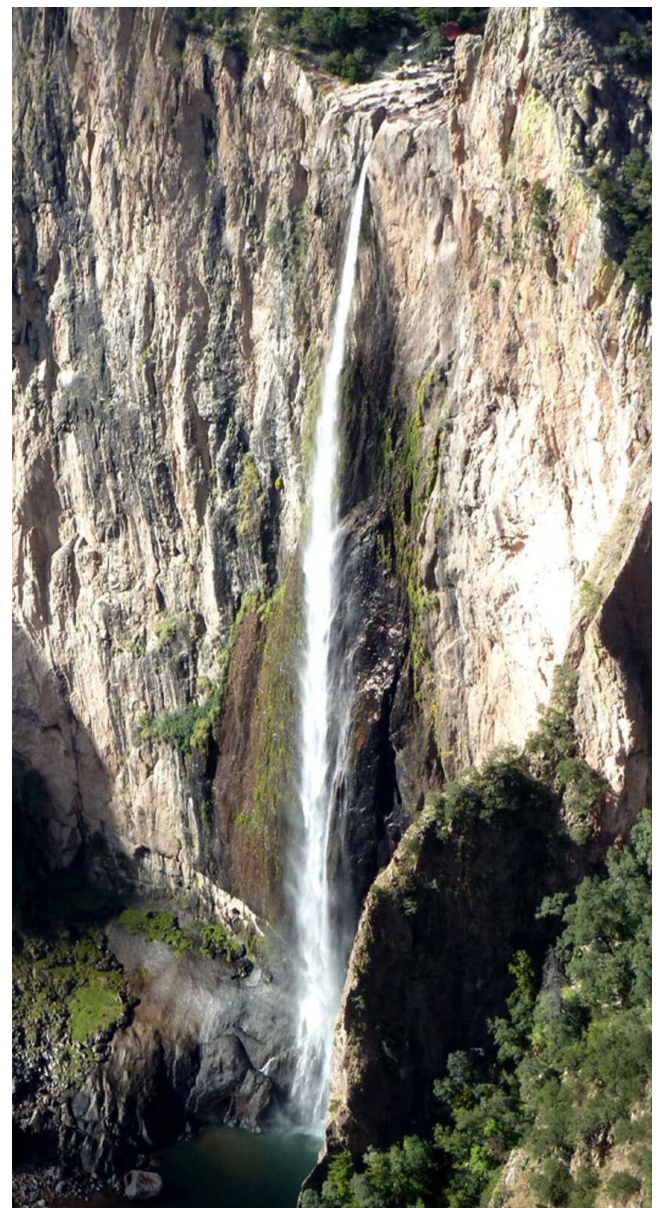


Figure 1. The 305 m (1800 ft) tall rhyolitic cliffs at the Cascada de Basaseáchic in the Barranca de Candameña in Chihuahua are a dramatic legacy of the Oligocene-Miocene formation of the Sierra Madre Occidental. Photo by Reina-Guerrero.

California al mismo tiempo influyó dramáticamente en la vegetación y flora de la región. Actualmente la transición del trópico de América a la zona templada del norte ocurre en Sonora con la selva baja caducifolia alcanzando su límite norte en la Sierra San Javier (28°N). El matorral espinoso es una transición entre la selva baja caducifolia y el encinar templado y el pastizal desértico al norte y el matorral desértico sonorense al noroeste. La vegetación en las tierras bajas alrededor del Golfo de California cambia desde la selva baja caducifolia en Sinaloa y la Región del Cabo en Baja California Sur al matorral espinoso costero en el sur de Sonora y al matorral desértico en las subdivisiones de la Costa Central del Golfo y el Valle del Bajo Río Colorado del Desierto Sonorense más al norte en Sonora y Baja California. Las especies icónicas únicas que se encuentran en cada área son el legado evolutivo de la profunda historia tropical del Golfo de California.

With the extinction of the dinosaurs about 65 million years ago and the rise of the seed plants, tropical forests covered the North American continent from Mexico southward. The dry season in tropical forests was first seen in the fossil record in the middle Eocene (ca. 45 mya = million years ago). Most of the adaptations to extremes in light, heat and aridity in modern plants and animals evolved in response to the tropical dry season, especially the water retention in cacti and other succulents. The volcanism that formed the Sierra Madres Oriental and Occidental in the late Oligocene-middle Miocene (15-30 mya; Axelrod 1979, Van Devender 2001, Figure 1) modernized the physiography, flora, fauna, and climate of North America. By the middle Miocene, this mountain building activity moved southeast to form the Trans-Mexican Volcanic Belt, the southern limits of the Mexican Plateau. The uplifts of these regional cordilleras restricted tropical vegetation to the lowlands along the more southern coasts of the continent and in lower areas on the Mexican Plateau. For the first time, vegetation was segregated into elevational zones along climatic gradients, forming new montane oak woodland and pine-oak forest (Figure 2) in the mountains from tropical species pre-adapted to cold. Tropical deciduous forest west of the Sierra Madre Occidental in northwestern Mexico (Figure 3) was isolated from other tropical areas.

A drying trend in the middle Miocene (10-8 mya) changed tropical deciduous forest in Sonora first to thornscrub (Figure 4) and later to desertscrub (Figure



Figure 2. Pine-oak forest in the Sierra El Tigre, Sonora. Photo by Dale S. Turner.

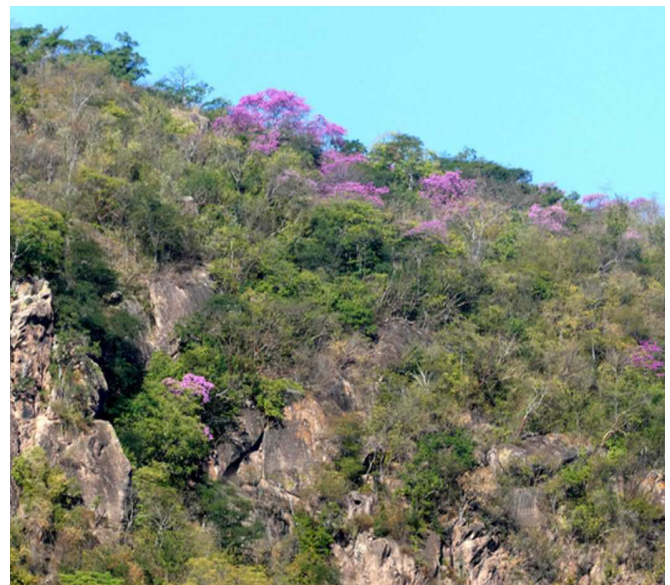


Figure 3. Tropical deciduous forest near Elota, Sinaloa. Note pink amapa flowers in December. Photo by Reina-Guerrero..

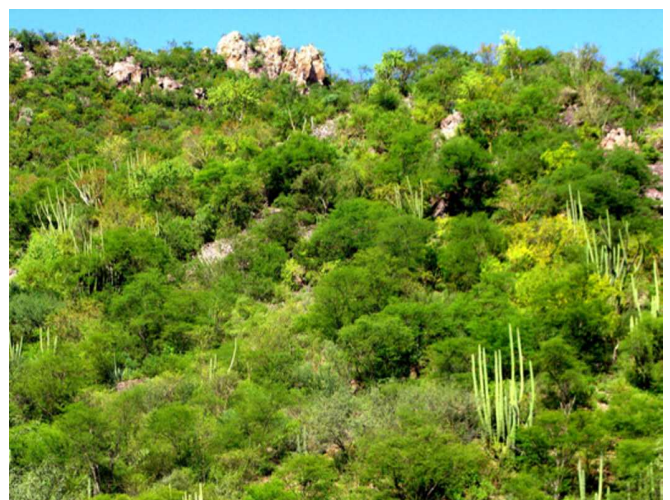


Figure 4. Foothills thornscrub near Sahuaripa, Sonora. Dominants are feather tree or tepeguaje (*Lysiloma watsonii*) and organ pipe cactus. Photo by Van Devender.



Figure 5. Arizona Upland Sonoran desertscrub near Sonoyta, Sonora. Dominants are saguaro, desert ironwood or *palo fierro* (*Olneya tesota*), and *choyas* (*Cylindropuntia fulgida*, *C. thurberi*). Photo by Van Devender.



Figure 6. Gulf of California. View from Isleta El Estanque to Isla Ángel de la Guarda Gulf of California. Photo by Dimmitt.

5) as the Sonoran Desert formed. The proto-Gulf of California formed about 12 mya as land from the Mazatlán, Sinaloa, area separated from the mainland and began to move to the northwest, eventually forming the Baja California Peninsula. The modern Gulf of California was established by the end of the Miocene (5 mya, Figures 6 & 7). The modern Sonoran Desert flora has strong evolutionary roots in the tropical vegetation that preceded it along with the evolution of new species, especially in the splendid isolation of Baja California.

Vegetation around the Gulf of California. Here we present the current spectacular landscapes, vegetation, and iconic plants around the Gulf of California. The New World tropics merge into

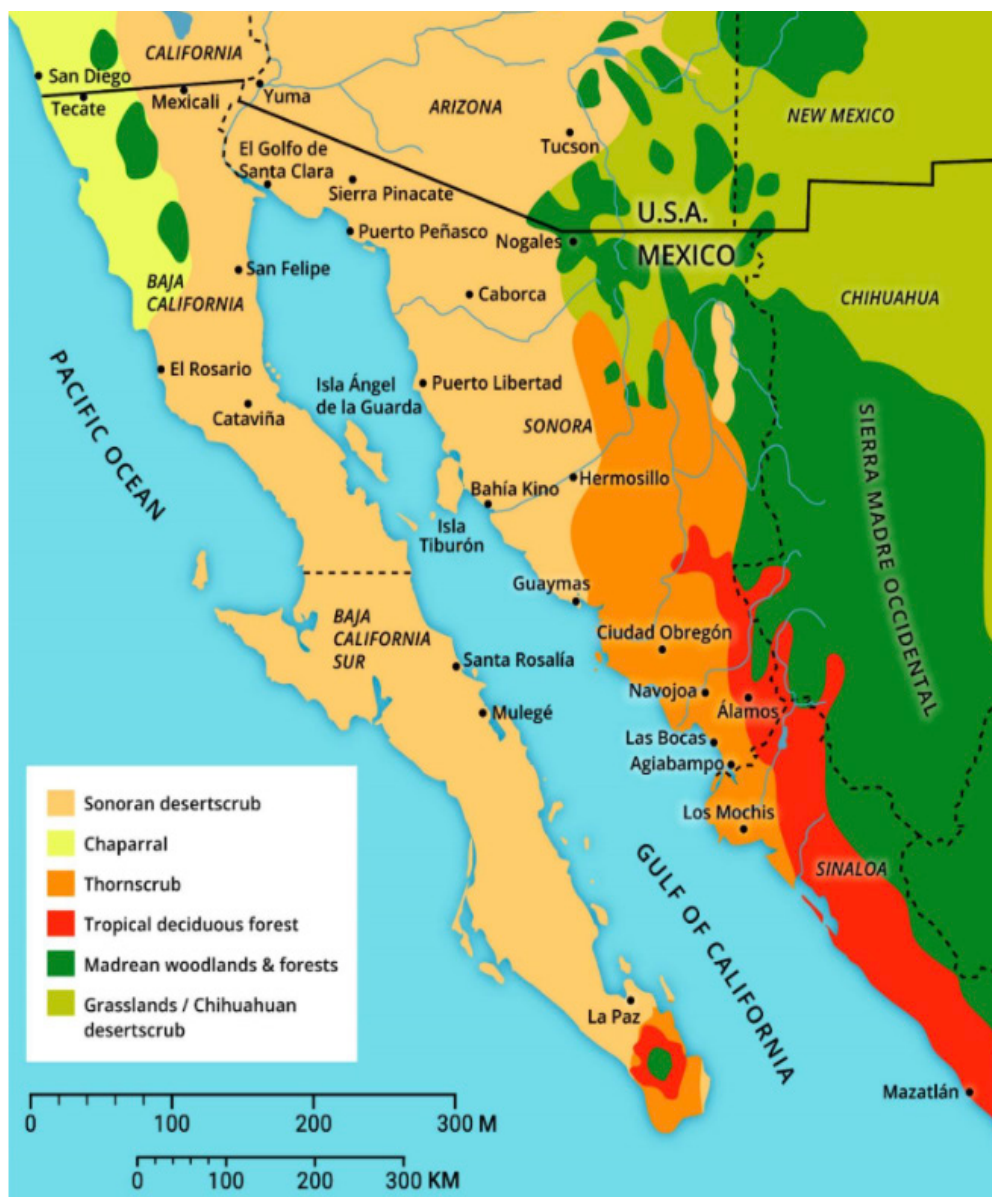


Figure 7. Map of the vegetation around the Gulf of California. Drafted by Marina Maskaykina.

Figure 8A



Figure 8B



Figure 8C



Figure 8. *Etcho*. A. Large individual near Sirebampo, Sonora. B. Stems with fruit near Elota, Sinaloa. C. Mature fruit fallen to ground at Tepoca, Sonora. Photos by Reina-Guerrero and Van Devender.

the northern temperate zone at about 29°N on the western slopes of the Sierra Madre Occidental in east-central Sonora, 680 km to the north-northwest of the Tropic of Cancer (23.4°N, just north of Mazatlán; Van Devender & Reina-Guerrero 2021). In southern Sonora, thornscrub is the transitional vegetation between tropical deciduous forest and Sonoran desertscrub, with coastal thornscrub on the coastal plain along the Gulf of California and foothills thornscrub on inland rocky slopes (Figure 4). Coastal thornscrub transitions into the Sonoran Desert at Guaymas (27.9°N; Van Devender & Reina-Guerrero 2021).

The **Sonoran Desert** with six subdivisions is one of the four major deserts of North America (Shreve 1964, Turner 1994, Figure 19). The Plains of Sonora subdivision is in central Sonora. The Arizona Upland subdivision is present in higher areas to the east in north-central Sonora and southern Arizona. The Central Gulf Coast subdivision is along the coast of the Gulf of California in central Sonora and eastern Baja California. The Lower Colorado River Valley subdivision is in the lowlands around the head of the Gulf of California in northwestern Sonora, southwestern Arizona, southeastern California, and northeastern Baja California. The Vizcaíno and Magdalena Plain subdivisions are on the Baja California Peninsula.

Shreve (1934) gave an overview of the vegetation of northwestern coast of Mexico that was updated in Brown (1994). From Mazatlán (23.2°N) northward, the vegetation along the Gulf of California is **tropical deciduous forest**, although many areas have been converted to agriculture. *Mauro* (*Lysiloma divaricata*)

Figure 9A & B

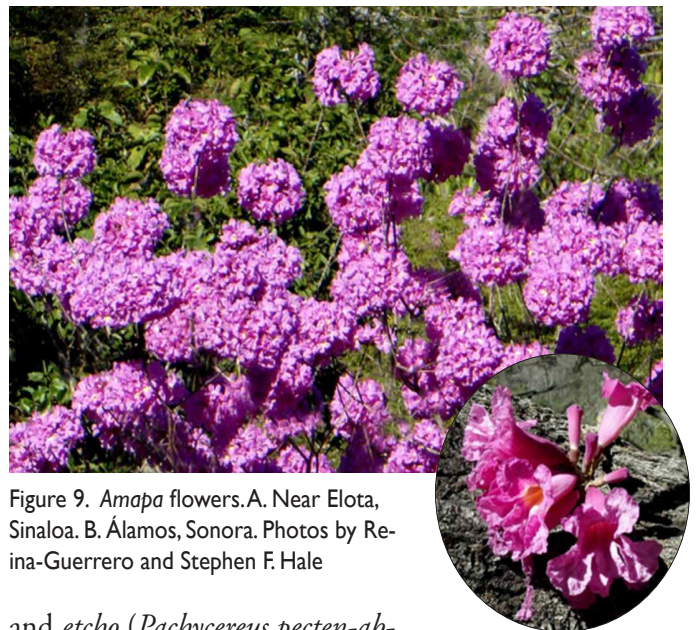


Figure 9. *Amapa* flowers. A. Near Elota, Sinaloa. B. Álamos, Sonora. Photos by Reina-Guerrero and Stephen F. Hale

and *etcho* (*Pachycereus pecten-aboriginum*, Figure 8A) are dominant in tropical deciduous forest in Sinaloa and Sonora (Gentry 1942, Martin et al. 1998). *Mauro* is an 8-10 m tall legume tree that often forms the forest canopy. *Etcho* is a tall columnar cactus with soft, brush-like spines on the fruit (Figure 8B). *Amapa* (*Handroanthus impetiginosus*) is a tree native (Figure 9) to the New World Tropics from South America north to Sonora, Mexico. Its riot of pink flowers (Figure 9B) illuminates the red-gray *mojino* color of dry season tropical deciduous forests in Sinaloa and Sonora from November to March. This and other species of *Handroanthus* are collectively the national tree of Paraguay. The monkey-ear tree or *huanacaxtle* (*Enterolobium cyclocarpum*) at 25 to 35 m tall with a trunk up to 3.5 m in diameter and a broad rounded crown is the largest tropical

Figure 10A



Figure 10B



Figure 10. Monkey-ear tree near Mazatlán, Sinaloa. A. Mature tree. B. Fruit and leaf. Photos by Diego Barrales and Marcela Ruiz-Guerrero.

Figure 11A



Figure 11B



Figure 11. A. Coastal thornscrub near Las Guásimas de Belém, Sonora. Visible dominants are *sinits* (*Lophocereus schottii* var. *tenuis*), etcho, and organ pipe cactus. B. Large organ pipe cactus near Sirebampo, Sonora. Photos by Reina-Guerrero.

tree in Sinaloa (Figure 10). Occurring from South America to Mexico, it is the national tree of Costa Rica where it is abundant in Guanacaste Province.

From Los Mochis (25.8°N) north to Guaymas (27.9°N), a diverse, succulent-rich **coastal thornscrub** covers the coastal plain (Figure 11A). Organ pipe cactus or *pitahaya* (*Stenocereus thurberi*) is a columnar cactus found in Sonora and Baja California north into Arizona (Yetman 2006). In drier areas to the north, it is a shrub that branches from the ground but in tropical deciduous forest and coastal thornscrub it is a tree. El Pitahayal near Las Bocas on the Sonoran coast is a unique succulent scrub dominated by tree-like organ pipe cacti (Van Devender et al. 2024, Figure 11B). *Sinits* (*Lophocereus schottii*) is endemic to Sonoran Desert region in Sonora, adjacent Arizona in Organ Pipe Cactus National Monument, and throughout the Baja California Peninsula. *Lophocereus* s. var. *tenuis* with slender stems and more ribs is found in coastal thornscrub in southern Sonora (Figure 12).

Figure 12A & B



Figure 12. *Sinits* near Sirebampo, Sonora. A. Mature plant. B. Stem cross section with nine ribs. Photos by Reina-Guerrero.

Figure 13A



Figure 13B



Figure 13. Lollipop tree north of Guaymas, Sonora. A. Tree. B. Leaves. Photos by Van Devender.

Figure 14A



Figure 14B



Figure 14. Twisted barrel cactus near Las Guásimas de Belém, Sonora. A. Mature plant with spiraled ribs. B. Stem cross section. Note deep sulci between ribs. Photos by Reina-Guerrero and Van Devender.

The lollipop tree or *jito* (*Forchhammeria watsonii*) is a distinctly shaped tree in coastal thornscrub and southern Plains of Sonora desertscrub in Sonora and Central Gulf Coast desertscrub in Baja California Sur (Figure 13). The twisted barrel cactus or *biznaga* (*Ferocactus herrerae*) is a striking species with deep sulci between often spiraled ribs in tropical deciduous forest in Sinaloa and coastal thornscrub in Sonora (Figure 13). Cudjoe wood (*Bonellia macrocarpa*) is a tropical shrub from Panama north to western Mexi-

co. In Sinaloa and Sonora, *san juanico* (*B. m.* subsp. *pungens*) is in tropical deciduous forest, coastal and foothills thornscrub, and Plains of Sonora desertscrub. The needle-sharp spines on the leaf tips and small orange flowers are distinctive (Figure 15).

Slipper flower or *candelilla* (*Euphorbia lomelii*) is found in coastal thornscrub from northern Sinaloa into southern Sonora and from the tropical Cape Region in Baja California Sur north to the Vizcaíno subdivision in central Baja California. With its ele-

gant orange flowers and fruit, it is a very common cultivated succulent (Figure 16). *Euphorbia antisiphilitica* in the Chihuahuan Desert, *E. ceroderma* in the Sonoran Desert in coastal Sonora and Baja California Sur, and *E. cymosa* in tropical deciduous forest and coastal thornscrub in western Mexico are also succulent-stemmed species called *candelilla*. Leafy cacti

Figure 15A & B



Figure 15. *San juanico* near Álamos, Sonora. A. Leaves. B. Fruit. Photos by Stephen F. Hale

Figure 16A



Figure 16. A. Slipper flower near Bahía de los Ángeles, Baja California. *Torote blanco* in background. B. Slipper flower fruit in Arroyo los Anegados, north of Guaymas, Sonora. Photos by Dimmitt and Van Devender.

Figure 16B



in the genus *Pereskia* are mostly found in tropical Central America and Mexico, with one species in Bolivia. *Jejeri* (*Pereskia porteri*) is found in tropical deciduous forest and coastal thornscrub in Sinaloa, Sonora, and the Cape Region in Baja California Sur (Figure 17).

Figure 17A



Figure 17B



Figure 17. *Jejeri* on Mesa Masiaca, south of Navojoa, Sonora. A. Leaves. B. Spines on stem. Photos by Van Devender.

Figure 18A



Figure 18. Red mangroves. A. Estero Sargento, Sonora. B. Bahía Concepción, Baja California Sur. Photos by Erik F. Enderson and Susan D. Carnahan.

Figure 18B



Manglares are present in coastal estuaries in Sinaloa and Sonora with black, red, and white mangroves (*Avicennia germinans*, *Rhizophora mangle*, and *Laguncularia racemosa*, Figure 18). In Sonora, white mangrove occurs as far north as Punta Sargento (29.0°N) north of Bahía Kino (28.8°N) while black mangrove reaches Puerto Lobos (30.3°N). White mangrove is as far north as Bahía Concepción (26.7°N) in Baja California Sur while red mangroves reach Bahía de los Ángeles (28.8°N) in Baja California (Wiggins 1980).

From Guaymas north to Bahía Kino, **Plains of Sonora desertscrub** is along the coast and inland to central Sonora (Figure 20). *Guayacán* (*Guaiacum coulteri*) is a common shrub or small tree with intense blue-purple flowers in late spring (Figure 21). It is in the same genus as the threatened *lignum vitae* (*G. sanctum*), a tropical tree which has dense, highly prized wood. Tree morning glory or *palo santo* (*Ipomoea arborescens*) is a striking, white-barked tree in tropical deciduous forest, thornscrub, and Plains of Sonora desertscrub in Sinaloa and Sonora that has showy white flowers from November to April when it is leafless (Figure 22). It is one of several species of tree morning glories in western Mexico. Monte Albán (white jungle), the famous pre-Columbian archaeological site in Oaxaca in southern Mexico, was named for the flowers of another tree morning glory (*I. murucoides*).

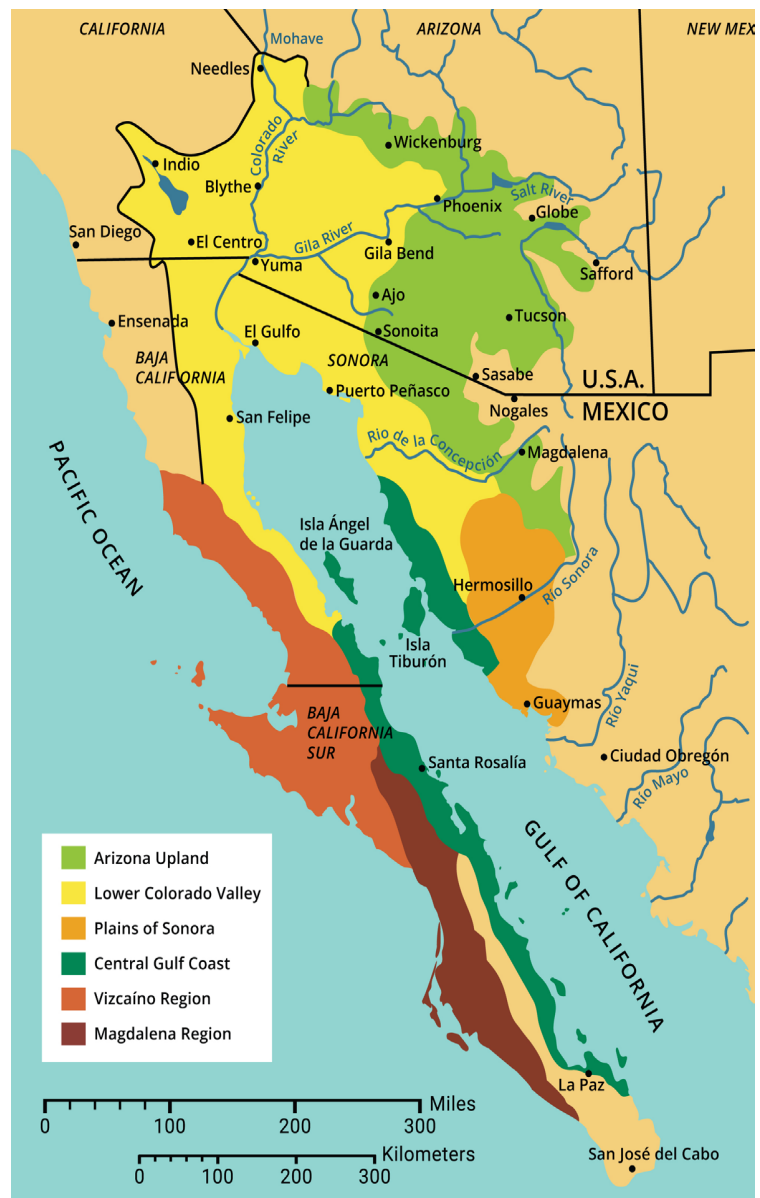


Figure 19. Map of the subdivisions of the Sonoran Desert. Drafted by Marina Maskaykina.



Figure 20. Plains of Sonora desertscrub at Los Anegados, Sonora. Photo by Van Devender.

Figure 21A & B

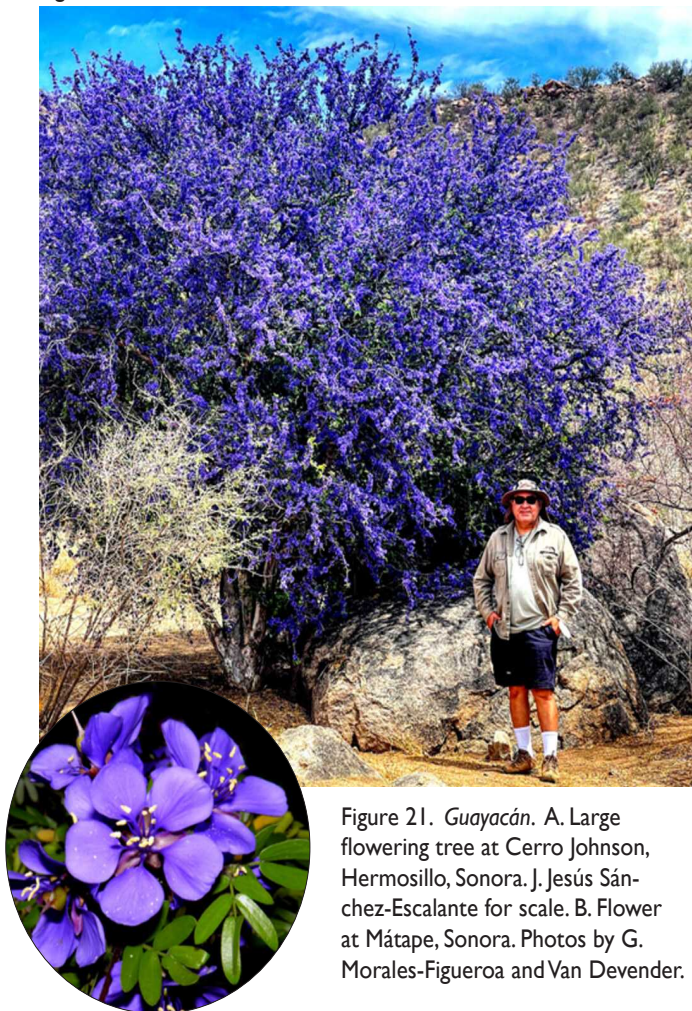


Figure 21. *Guayacán*. A. Large flowering tree at Cerro Johnson, Hermosillo, Sonora. J. Jesús Sánchez-Escalante for scale. B. Flower at Mátape, Sonora. Photos by G. Morales-Figueroa and Van Devender.

Figure 22A & B



Figure 22. *Palo santo*. A. Exceptionally large tree at Mazatán, Sonora. Beatriz E. Loyola-Reina and Reina-Guerro for scale. B. Flowers at Álamos, Sonora. Photos by Van Devender and Stephen F. Hale.

Tree ocotillo or *ocotillo macho* (*Fouquieria macdougalii*) is a common succulent tree in tropical deciduous forest in Sinaloa, and coastal and foothills thornscrub and Plains of Sonora desertscrub in Sonora (Figure 23). Most of the eleven species of *Fouquieria* in the family Fouquieriaceae are small trees. The *ocotillo* (*F. splendens*) with multiple long stems from the base and boojum or *cirio* (*F. columnaris*) with a single swollen trunk and small side branches are the exceptions. *Ocotillo* is one of the most widely distributed desert plants in North America in the Chihuahuan, Mohave, and Sonoran Deserts. Octopus cactus or *sina*

(*Stenocereus alamosensis*) is a red-flowered “galloping” cactus found in tropical deciduous forest in Sinaloa and coastal and foothills thornscrub in southern Sonora. The northernmost stands are in Plains of Sonora desertscrub near Benjamín Hill (30.2°N, Figure 24). Hybrids between organ pipe and *sina* (*S. alamosensis* x *S. thurberi*) are known in tropical deciduous forest in the Masiaca area (26.7°N) in southern Sonora (Yetman & Van Devender 2002). Saguaro (*Carnegiea gigantea*), the iconic dominant species in the Arizona upland subdivision to the east and north in Sonora and Arizona, is also locally common in the Plains of

Figure 23A



Figure 23B



Figure 23. Tree ocotillo. A. Tree near Pueblo de Álamos, Sierra Mazatán, Sonora. B. Flowers on Rancho La India, north of Hermosillo, Sonora. Note corymbose panicle and long slender flower pedicels. Photos by L. Griffin and Reina-Guerrero.

Figure 24A



Figure 24B



Figure 24C



Figure 24. *Sina* near Benjamín Hill, Sonora. A. Plant. B. Fruit. C. Flower. Photos by Van Devender.

Figure 25A



Figure 25B



Figure 25. Saguaro. A. Dense local stand in Plains of Sonora desertscrub near Félix Gómez, Sonora. Nurse trees are velvet mesquite (*Neotoma velutina*). B. Flowers. Photos by Van Devender and Sky Jacobs.

Sonora desertscrub (Figure 25). It is closely related to *Neobuxbaumia*, a genus of about nine species in eastern and southern Mexico. If the two genera are combined in the future, saguaro would become *N. gigantea*!

From Bahía Kino north to Puerto Lobos, **Central Gulf Coast desertscrub** is along the Gulf of California in Sonora (Figure 26). The desertscrub in the Sierra Bacha north of Puerto Libertad is a diverse assemblage of succulents, including the cacti *cardón* or *sahueso* (*Pachycereus pringlei*, Figure 27), organ pipe cactus, saguaro, and *sinita* (*Lophocereus schottii* var. *schottii*). Common succulent shrubs include



Figure 26. Central Gulf Coast desertscrub near Puerto Libertad, Sonora. Dominants are *cardón*, *ocotillo*, organ pipe cactus, and *torote*. Photo by Reina-Guerrero.

Figure 27A



Figure 27. *Cardón*. A. Cardonal dominated by *cardón*, organ pipe cactus, and *sinita* on sand dune near Puerto Arturo, Sonora. B. Large *cardón* with roosting Turkey Vultures (*Cathartes aura*) near Bahía Kino, Sonora. Photos by Reina-Guerrero and Van Devender.

Figure 27B



Figure 28A



Figure 28B



Figure 28. Elephant tree A. Large tree near Puerto Lobos, Sonora. B. Fruit. Cono Rojo, Sierra Pinacate, Sonora. Photos by Reina-Guerrero and Patricia Estes.

elephant trees or *torotes* (*Bursera hindsiana*, *B. microphylla*, Figure 28), euphorbs (*Euphorbia misera*, *E. tomentulosa*), limberbushes or *sangrengados* (*Jatropha cinerea*, *J. cuneata*), and *ocotillo*. Although the massive *cardón* is more common in Vizcaíno desertscrub in Baja California, they are larger in the *cardonales* near Bahía Kino (Figure 27). *Pachycereus pringlei* is one of the largest species in the genus and with a record of 19.2 m probably the tallest cactus of all. The common name is from the European Spanish *cardo* referring to thistles (*Cirsium* spp.), then applied to prickly poppies (*Argemone* spp.) in the New World. The ending ‘*ón*’ just means ‘a big one’. In San Luis Potosí in central Mexico, *cardón* is the cane cholla (*Cylindropuntia imbricata*). In Baja California where most of the indigenous peoples and their plant common names died out early, *cardón* was mysteriously reassigned to a giant cactus!

Elephant tree or *torote* (*Bursera microphylla*) is a succulent shrub or tree (Figure 28) found from coastal thornscrub in southern Sonora north through the Sonoran Desert as far north as the Phoenix area in Arizona. It is widespread on the Baja California Peninsula, extending on the coast of the Gulf of California north into southern California. The sap exuding from the stem is burned as the incense *copal* in indigenous ceremonies and used medicinally in Sonora.

On the Baja California Peninsula, Central Gulf Coast desertscrub extends in a narrow band from south of San Felipe (31.0°N) along the eastern coast of the Gulf of California as far as the La Paz area



Figure 29. Palo blanco on Santa Marta road to the Sierra San Francisco, Baja California Sur. Photo by Dimmitt.



Figure 30. View of Lower Colorado River Valley desertscrub from the Tinajas Altas Mountains, Arizona. Photo by Van Devender.



Figure 31. Lower Colorado River Valley desert scrub on Ives Sand Dunes and Lava Flow west of the Sierra Blanca, Sonora. White bursage, creosotebush, and big galleta grass are dominants. Photo by Van Devender.

(24.2°N) in Baja California Sur. *Palo blanco* (*Lysiloma candida*) is a handsome tree with white bark (Figure 29) that is nearly endemic to the southern part of this area in the Cape Region except for a disjunct population in the Sierra El Aguaje north of Guaymas, Sonora (Wiggins 1980).

The hyper-arid **Lower Colorado River Valley desert scrub** extends from Puerto Lobos to San Luis Colorado (32.6°N) in northwestern Sonora and to southwestern Arizona and from San Felipe (31.0°N) (32.6°N) in northeastern Baja California north to Mexicali and southeastern California. Creosotebush or *gobernadora* (*Larrea divaricata* subsp. *tridentata*), white bursage (*Ambrosia dumosa*), and big galleta grass (*Hilaria rigida*) are important dominants (Figure 30 & 31). Creosotebush is one of the most widespread and dominant shrubs in the deserts of North America. Unlike many other important desert plants that evolved in earlier tropical vegetation or *in situ* as the Sonoran Desert developed, the genus *Larrea* with four species, including *L. divaricata*, evolved in South America. The weakly differentiated *L. d.* subsp. *tridentata* (widely used as the species *L. tridentata* in the United States, Figure 32) evolved in Perú before it immigrated north sometime in the Pleistocene and conquered the North American deserts. The most unusual creosotebush in North America is the willow-like *L. d.* var. *arenaria* endemic to the Algo-

Figure 32A



Figure 32B



Figure 32. Creosotebush. A. Plant in fruit in the Tinajas Altas Mountains, Arizona. B. Flowers in the Tucson Mountains, Arizona. Photos by Van Devender.

dones Dunes in southeastern California just west of Yuma, Arizona.

The El Pinacate y Gran Desierto de Altar Biosphere Reserve is in the Lower Colorado River Valley. The spectacular concentration of basalt peaks and craters in the Sierra Pinacate forms a surreal landscape (Figure 33) inland from Puerto Peñasco. South of El Golfo de Santa Clara (31.7°N), Sonora, the massive sand dunes of the Gran Desierto Sand Sea reach the coast (Figure 34). In wet winters, the dunes can be covered with wildflowers (Figure 35), including desert sand verbena (*Abronia villosa*, Figure 36), dune evening primrose (*Oenothera deltoides*, Figure 37A), Ajo lily (*Hesperocallis undulata*, Figure 37B), and others.



Figure 33. View of Lower Colorado River Valley desert scrub from Pinacate Peak, Sonora, west to the Gulf of California. Photo by Dimmitt.



Figure 35. Wildflowers on the Mohawk Sand Dunes, Arizona. Dominants are desert sand verbena, white bursage, and creosotebush. Photo by M. J. Hage.

Figure 37A



Figure 37B



Figure 37. Dune wildflowers north-northeast of Puerto Peñasco, Sonora. A. Dune evening primrose. B. Ajo lily. Photos by Charles Hedgcock and Chris Roll.



Figure 34. Gran Desierto sand dunes southeast of El Golfo de Santa Clara, Sonora. Photo by Van Devender.



Figure 36. Desert sand verbena on the Mohawk Sand Dunes, Arizona. Photo by Dimmitt.



Figure 38. Vizcaíno Sonoran desert scrub in Montevideo Canyon near Bahía de los Ángeles, Baja California. Dominants are Baja elephant tree and boojum. Photo by Dimmitt.

Figure 39A



Figure 39B



Figure 39C



Figure 39. Boojum. A. With cardones at Yubay, Baja California. B. Robert Humphrey measured this individual to be 24.8 m (81.5 ft) tall in Montevideo Canyon near Bahía de los Ángeles, Baja California in 1981. C. With cardones at Punta Cirio, Sonora. Photos by Dimmitt and Van Devender.

Figure 40A

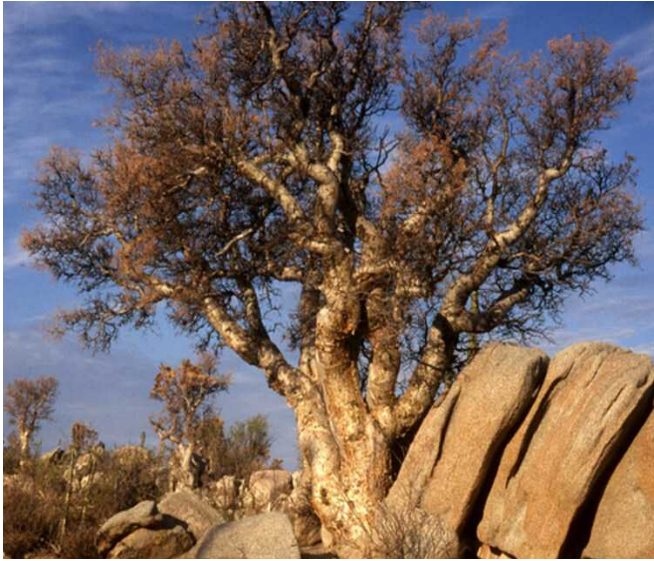


Figure 40B



Figure 40. Baja elephant tree. A. Stand at Cataviña, Baja California. B. Wind-pruned prostrate individual on coast of the Pacific Ocean at Punta Eugenia, Baja California Sur. Photos by Dimmitt.

On the Baja California Peninsula, the transition from the New World tropics to the north temperate zone goes from tropical deciduous forest and thornscrub (Figure 44) in the Cape Region up through the Sonoran Desert with its unique Baja California flavor to typical Californian Mediterranean chaparral in the Tecate area on the California border.

The **Vizcaíno subdivision** of the Sonoran Desert is inland on the Baja California Peninsula from El Rosa-

rio (30.1°N) south to west of Santa Rosalia (27.3°N, Figure 38). Important species are boojum (Figure 39), Baja elephant tree or *torote blanco* (*Pachycormus discolor*, Figure 40), *cardón* (Figure 27), *palo adán* (*E. diguetii*, Figure 41), *pitaya agria* (*Stenocereus gummosus*, Figure 42), and *sinita*. Boojum is mostly in Vizcaíno desertscrub in central Baja California, with outlier populations in the Sierra San Francisco and Volcán Tres Virgenes in Baja California Sur and in the Sierra

Figure 41A



Figure 41B



Figure 41. *Palo adán*. A. Detail of trunk near Bahía de los Ángeles, Baja California. B. Flowers at San Carlos, Sonora. Note compact panicle and short flower pedicels. Photos by Dimmitt and Douglas Danforth.

Figure 42A



Figure 42B



Figure 42C



Figure 42. *Pitahaya agria*. A. Plant at Cataviña, Baja California. Photo by Robert A. Villa. B. Stem with spines. C. Flower. Photos by Dimmitt.

Bacha south of Puerto Libertad in Sonora (Figure 39C). The only other *Fouquieria* with swollen stems like boojum is *F. purpusii* from Oaxaca and Puebla in southern Mexico.

Pachycormus discolor is the only species in the genus *Pachycormus*, which is endemic to the Baja California Peninsula (Wiggins 1980, Figure 40). This succulent tree in the Anacardiaceae is convergent with elephant trees in the genus *Bursera* (Burseraceae). *Palo adán* is a common succulent shrub *ocotillo* (Figure 41) from the Vizcaíno subdivision south to the tropical Cape Region with mainland populations in Plains of Sonora desertscrub in the Guaymas area and in coastal thornscrub near Las Bocas in southern Sonora. *Pitaya agria* is a “galloping cactus” with white flowers in summer (Figure 42). Except for populations north of Bahía Kino and on Isla Tiburón in Sonora, it is restricted to the Baja California Peninsula from Ensenada (31.9°N) south along the Pacific coast to El Rosario, and then through the Vizcaíno subdivision to the Cape Region. All the dominant Vizcaíno plants approach the coast of the Gulf of California near Bahía de los Ángeles (Figure 43).



Figure 43. Aerial view from above Bahía de los Ángeles to Isla Ángel de la Guarda, Baja California. Vizcaíno Sonoran desertscrub approaches Central Gulf Coast desertscrub in the area. Photo by Dimmitt.

The **Magdalena Plain subdivision** of the Sonoran Desert is inland from west of Mulegé (26.8°N), Baja California Sur south to the La Paz area. In southernmost Baja California Sur, **thornscrub** occurs in the Cabo Pulmo (23.4°N) area north of San José del Cabo (Figure 44). **Tropical deciduous forest** surrounds the base of the Sierra La Laguna (23.6°N), below oak woodland that has affinities to the mainland Sierra Madre Occidental in Sonora and Chihuahua.

The vegetation on both sides of the Gulf of California is a south to north, tropical to (temperate) Sonoran Desert transition. Both transects reflect the deep historical development of modern communities from tropical deciduous forests in the middle Miocene and the evolution of new species in the Sonoran Desert Region, especially on the Baja California Peninsula. The formation of the Gulf of California profoundly



Figure 44. Thornscrub in the Cape Region in southern Baja California Sur. Photo by Dimmitt.

influenced the biogeography of the Sonoran Desert. So many stunning places to visit and unique species to learn (Figure 45)!



Figure 45. Sunset on the Gulf of California near Puerto Libertad, Sonora. Photo by Reina-Guerrero.

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