Baja California Desert

Category: Desert Biomes.
Geographic Location: North America.
Summary: The only desert in the world surrounded by two seas, this geologically isolated peninsula sets the stage for a myriad of remarkable plants and animals exemplifying adaptations to an isolated and arid environment.

The Baja California Desert is the peninsular arm of the mainland Sonoran Desert, and although closely related to each other, they contain dramatically different evolutionary histories. While the mainland Sonoran Desert biota evolved connected to both northern temperate biomes and southern tropical forests, the evolution of the Baja California peninsula took a different trajectory due to its long history of isolation. The Baja California Desert is a paradigm of the importance of geography and time, the two axes along which life develops its variations in shaping the natural world.

Distributed through the major part of the second-longest peninsula in the world at 800 miles (1,300 kilometers), the Baja California Desert is a peninsular desert. This fundamental fact implies two straightforward but decisive ecological consequences: isolation, and the climatic influence of the surrounding seas. Also to consider are four more geographical attributes: location at mid-latitudes (23 degrees 30 minutes N to 30 degrees N); almost north-south orientation; very narrow width of 31 miles (50 kilometers) on average; and an intermittent mountain range along its length. With these few, but determinant, attributes one can outline the basis for an understanding of the ecological singularity of the Baja California Desert.

Cleaving this arid region into two divergent but fundamentally united biomes (the Baja California and Sonoran Deserts) is the Gulf of California. The Gulf is the greatest physical barrier in Northwest Mexico. It opened at least 5.5 million years ago, splitting Baja California from the mainland. Since then, this barrier has impeded dispersal by many plant and animal species from the mainland to the -peninsula, and vice versa. This near-insularity of the Baja California Peninsula has been the most crucial factor to determine the uniqueness of this desert.

In addition to the isolated nature of the peninsula as a whole, scattered and sequestered habitats at different scales are superimposed on the desert along its length. Sea islands of various sizes are present along the Pacific coast; they are especially abundant throughout the Gulf of California. The highest tips of the mountain ranges that form the backbone of the Peninsula contain small sky islands of relict temperate ecosystems.

Scattered palm oases in deep and sheltered disjunct canyons represent mesic (moderately moist) refuges within a landscape of dry rock and sand. Both seacoasts are dotted with coastal lagoons often harboring mangroves, here at their northernmost occurrence in North America, that constitute critically important wetland ecosystems. This mosaic of insularity at different temporal and spatial scales, constitutes the driving force of biological speciation: adaptation to local, isolated micro-environments with distinct microclimates.

In contrast to other coastal deserts in the world, the Baja California Desert is a bi-coastal desert. On the western side of the peninsula is the cold Pacific coast, its chilled waters of the California Current coming from polar latitudes. Meanwhile, the eastern coast is warmed by the Gulf of California, which has been considered the only large evaporation basin of the Pacific Ocean due to the high temperature in the region. The contrast of climatic influences between two coast lines, separated by the narrow width of the peninsula, combined with the presence of trans-peninsular mountain ranges acting as barriers between the two climatic influences, establishes a sharp west-east climatic gradient. At the same time, there is a long ecological transition between the northern temperate region showered by winter rains, and the southern dry tropical forest soaked by summer storms and hurricanes. Consequently, the central part of the Baja California Desert contains a bi-seasonal and unreliable precipitation regime.

Throughout this climatic background of scarce and unpredictable precipitation, there are anomalous events of abundant precipitation. These are caused by two principal climatic sources, tropi-

cal cyclones from the south in summer months, or ENSO (El Niño Southern Oscillation) years that bring above-average winter rain. These pulses of abundant resources are crucial periods in the ecological organization and dynamics of the Baja California Desert. In these brief periods of intense activity, the desert becomes renewed and prepares to tenaciously face the next years of hardship.

Biota of the Desert

The existence of recurrent insularity during millions of years and different climatic influences along both north-south and east-west axes has stimulated the forces of evolution and generated a plethora of singular life forms of desert plants and animals. Many of these are endemic, evolved and found here and nowhere else. About 20 percent of vascular plant species here are endemic, whereas within animals the level of endemism is particularly high in invertebrates (scorpions, at least 40 percent, and tenebrionid beetles, 45 percent) and mammals (ca. 45 percent, at the subspecies level), followed by amphibians and reptiles (30 percent).

Some of the most striking vegetation gradients in the world are seen in Baja California. If one heads south from the U.S.–Mexico border in Tijuana, the trip begins in the Mediterranean region where rain only comes in winter months. Typical plant species here include the blue fan palm (*Brahea armata*) and California fan palm (*Washingtonia filifera*), both of which cluster in moist oases and canyons. Around 30 degrees latitude, a dramatic change in the landscape occurs, a transition from the Mediterranean coast to the desert. Suddenly one sees giant columnar cacti called *cardones*, rosy boa (*Lichanura trivirgata*), and a bizarre, massive carrot-shaped plant called the boojum tree (*Fouquieria columnaris*). There is no doubt, one is in a strange desert land.

Further south, cold marine air and fog from the Pacific Ocean along the western side of the peninsula stimulate the growth of plants with much reduced stems that instead have succulent leaves to allow them to persist through the long dry summer months; these include agaves, yuccas, and dudleyas. Air plants and lichens are seen clustered on the stems of many shrubs, able to exist detached from the soil due to the cool Pacific fog from which they absorb moisture. However, a few kilometers to the east, on the other side of the mountains, along the warm-water Gulf of California coast, there is a flora dominated by woody legumes and trees with gigantic and fleshy stems , such as *copalquín* or elephant tree (*Bursera microphylla*), the copal (*Hymenaea spp.*), and various *Jatropha* species.

Further south still, these give way to dense and diverse vegetation where cacti, trees, shrubs, and other succulents intermingle. The southernmost part of the Peninsula is rich in legume tree species and columnar cacti of tropical origin. These life forms singularize the physiognomy (the morphological appearance) of the vegetation of this

Baja California desert during a lush spring in March 2010 with cirio and cardón plants rising above the various other desert scrub species. About 20 percent of vascular plant species in the Baja California desert biome are endemic. (Benjamin Theodore Wilder)

desert, which give it the unexpected appearance of a strangely arborescent arid wilderness, compared with other nearly barren deserts of similar latitude in other parts of the world. The voyage from the Mediterranean region to the tropics has concluded.

However, that is not all. If one travels through the Baja California Desert in one of those rare years when unpredictable and large rain events occur, one can observe a hidden treasure. Ephemerals, plants that complete their life cycle in one year, are seen in abundance during these periods of plenty, making the desert come alive in color while they replenish their seed banks. Fields of yellow, purple, violet, and orange run the length of the peninsula during such times. Meanwhile, long-lived desert plants establish during these brief intervals of bonanza, and initiate growth and resource accumulation in order to resist the long droughts soon to come. Usually unseen frogs and desert toads emerge full of activity and sound-looking, to close the magic circle of reproduction and leave a set of descendants that then await the next precipitation pulse.

Hallmark animal species of the Baja California Desert range from reptiles like the coastal whiptail (*Aspidoscelis tigris stejnegeri*), peninsular leaf-toed gecko (*Phyllodactylus nocticolus*), and the endangered Santa Catalina Island rattlesnake (*Crotalus catalinensis*) to mammals such as the ringtail cat (*Bassariscus astutus*), peninsula coyote (*Canis latrans peninsulae*), and the endangered black jackrabbit (*Lepus insularis*).

More than 500 species of birds inhabit the biome, thanks in part to the ample watering areas on either flank. Endemic birds include the Guadalupe caracara (*Caracara lutosa*) and Xantus's hummingbird (*Basilinna xantusii*); among the endemic waterfowl that haunt the periphery are Craveri's murrelet (*Synthliboramphus craveri*), yellow-footed gull (*Larus livens*), and Townsend's shearwater (*Puffinus auricularis*).

Climate and Habitat Change

The isolation of the Baja California Desert and its extreme environmental conditions have maintained low levels of human presence through time. Even after European colonization in the 17th century introduced agriculture and livestock to the peninsula, human populations remained relatively low until the 1950s. The consequently minor level of anthropogenic activities allowed the peninsular desert to remain largely undisturbed, preserving the majority of its wilderness.

However, the last decades have brought rapid population growth in urban centers to the north and south regions bordering the desert. In 1950 there were 288,000 inhabitants in the peninsula; in 2010 there were 3,792,000 inhabitants, a population increase of 1200 percent. The pressure of natural resource use has also been slowly increasing and spreading through the desert lands. Some areas along the Pacific coast that were developed for intensive agriculture production in the middle of 20th century are now suffering from depletion of underground aquifers. Free-roaming cattle that have been long established in many desert areas throughout the peninsula have affected vegetation dynamics in a still unknown way.

Tourism-based urban sprawl, adventure-tourism, (e.g., off-road vehicle use in the open desert), and clearance of mangroves for coastal developments have made large negative impacts on peninsular ecosystems, especially coastal areas. Additionally, invasive plant and animal species are becoming widely established in the Baja, representing a growing threat to the native species.

Additional pressure stems from global warming. Warmer, drier winters have become the norm, and even more dislocating is the later onset of the winter rains. Research by the University of Arizona has shown that lacking the colder temperatures provided by these rains, germination of such plants as the curvenut conseed (*Pectocarya recurvata*) is pushed back. Stunted growth is one outcome that seems likely; the studies have shown that desert shrubs are growing to shorter heights in general, which conserves both energy and water.

Perhaps more profound, the later emergence of such flora, when temperatures are colder, means that they will better support the cold-tolerant animal species. Over time, this will tend to shift animal populations toward those that depend on colder weather for major feeding and growth periods. This could positively affect populations

of such key Baja California Desert species as desert bighorn sheep (*Ovis canadensis*), which keep to the colder, higher elevations. The same species would, however, be negatively impacted by continued decreases in annual precipitation.

Acknowledgement of the natural treasures of this unique land has grown among the local population, those that visit, and within public administrations during recent decades. This awareness has led to the declaration of more than three million hectares of land placed under legal conservation status, and more importantly, to a growing consciousness that the future of the people is inextricably linked to the future of desert.

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Further Reading

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Balkhash, Lake

Category: Inland Aquatic Biomes.
Geographical Location: Central Asia.
Summary: Lake Balkhash, one of the largest lakes in Asia and unique in having both freshwater and saltwater tributary rivers, is in danger from diversion of water and from over-usage.

Lake Balkhash is located in east-central Kazakhstan in Central Asia, in the deepest part of the Balkhash-Alakol depression, currently at about 1,222 feet (342 meters) above sea level. The Balkhash-Alakol depression was formed by the sloping trough of the Turan Plate during the Neogene-Quaternary Period, between 23 and 2.6 million years ago. Lake Balkhash is located within an endorheic basin, a closed drainage catchment that retains the water that flows into it without releasing any water through other rivers, lakes, or oceans.

Some 375 miles (605 kilometers) long from east to west, the surface area of Lake Balkhash varies from about 6,000 square miles (15,500 square kilometers) in dry years, to as much as 7,300 square miles (19,000 square kilometers) during peak inflow years. Changes in the total area are accompanied by about a 10-foot (3-meter) change in the water level, depending on how much water is flowing into the lake.

Lake Balkhash contains both freshwater—mainly from the Ili River flowing in from the western end—and saltwater from the Karatal, Aqsu, and Lepsi Rivers flowing in from the east and southeast. Ili River water originates from melted snow coming off the glaciated Tien Shan mountains of China's Xinjiang region. Before the late 20th century, the Ili River had provided Lake Balkhash with as much as 90 percent of its total inflow; this proportion has decreased, in part due to municipal and industrial use, but the Ili still provides up to three-fourths of the inflow. From scouring minerals in the arid Balkhash-Alakol basin, the rivers to the east bring in sufficient saline content to equate to salinity levels in eastern Lake Balkhash that reach up to eight times that of the western area of the lake.

The western, freshwater part of Lake Balkhash is wide and shallow, with its depth not reaching further than 36 feet (11 meters). The saline, eastern part of the lake is more narrow and relatively deep, reaching up to 85 feet (26 meters). A narrow, shallow segment, Uzynaral Strait, and an associated peninsula help keep east-west exchange of water to a minimum. The depth here is approximately 21 feet (6.4 meters).

Winters tend to be harsh in Kazakhstan and around Lake Balkhash, with the whole lake actually freezing over from the end of November to the beginning of April each year. The region receives about 17 inches (43 centimeters) of precipitation per year, yielding an arid grassy plain or steppe, in