

Saudi

Arabia

Forest

“Saudi Arabia Forest” is not a dream. Ensha-Allah it will be a reality.

First:

The Holiest Route known to mankind for fourteen centuries is the Hijrah Route between Makah and Madinah, where Prophet Muhammad (S) paved, and every year the anniversary of this event is celebrated by the Moslems all over the World as New Year. This Route must be turned into scenic drive and walk for pilgrimages.

Second:

Trees and greeneries of the Hijrah Route will be expanded westward and eastward as far as possible to achieve Saudi Arabia Forest.

A Foundation under the leadership of HRH Prince Fawaz Ben Nawaf Alshalan will undertake such a magnificent task for the next few decades, first to make the holy Hejrah Rout green and expand that to Riyadh and the whole Saudi Arabia.

An Agricultural School will be established in Jeddah.

Scientific institutions and experienced companies from all over the world will be contacted and they make presentations and teach the young Saudi Arabian engineers, by whom the Project will be continued.

This Agricultural School will supervise “the Project”, creation of “Saudi Arabia Forest”.

The Project needs topsoil and irrigation water.

By installing power plants and desalination plants along the Red Sea, the irrigation is achieved.

The power of the project is derived from Municipal Solid Wastes (MSW) of the major Cities.

A new and cheap desalination system makes the water supply for the project economical.

The topsoil could be imported or derived from Municipal Solid Wastes (MSW) of the major Cities in the country.

The map in the next page shows the location of the project.



## Production of compost from MSW:

The MSW will be sorted into three separate components:

The energy components such as plastic, paper, wood and other biomass suitable for gasification are separated from MSW.

This components after crushing and extrusion will be turned into Briquettes. Briquettes are the fuel for gasification to produce synthetic gas and ultimately electricity.



Separation and crushing

Each component are baled and sent to appropriate locations:



plastic

paper

wood

biomass

Briquette

2- Non energy components such as glass, metal and hazardous wastes, these components will be sent for recycling or safe dumping.



glass

metal

Aluminum

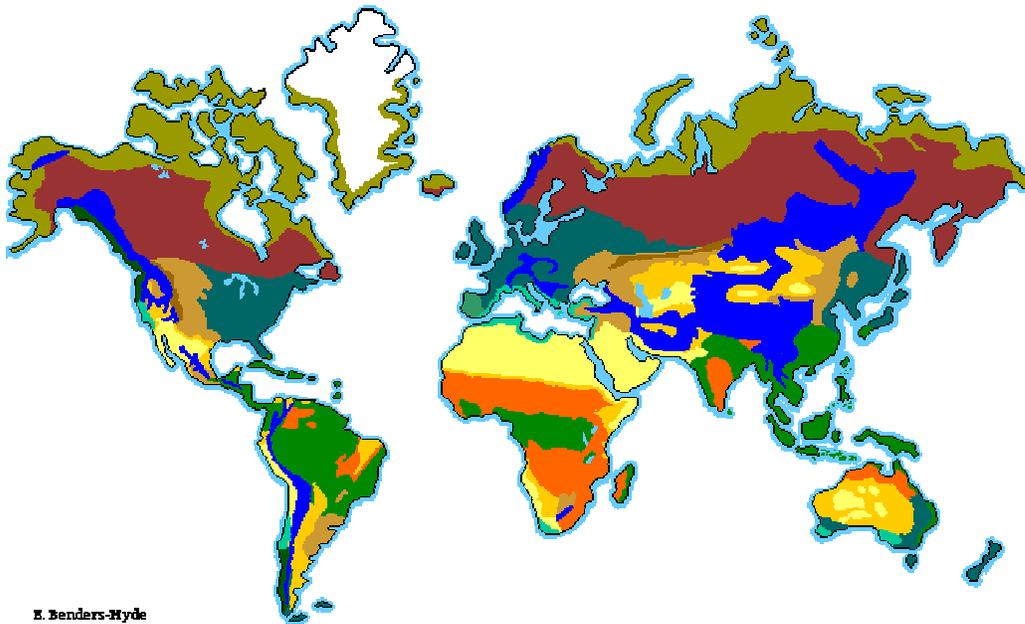
3- The organic components will be turned into compost in a traditional way.



This compost and perhaps imported compost and top soil will be transported to the project site.

Before studying the “Irrigation”, which is one of the subjects under generation of electricity, we will study different trees, which grow in desert and will find the best advise on the matter from experts who have done similar projects in the deserts of Australia and the USA.

# World Biomes



 Tundra

 Taiga

 Grasslands

 Deciduous  
Forest

 Chaparral

 Desert

 Desert-scrub

 Savanna

 Rainforest

 Alpine

## What is a Biome?

A biome is a large geographical area of distinctive plant and animal groups, which are adapted to that particular environment. The climate and geography of a region determines what type of biome can exist in that region. Major biomes include deserts, forests, grasslands, tundra, and several types of aquatic environments. Each biome consists of many ecosystems whose communities have adapted to the small differences in climate and the environment inside the biome.

All living things are closely related to their environment. Any change in one part of an environment, like an increase or decrease of a species of animal or plant, causes a ripple effect of change in through other parts of the environment.

The earth includes a huge variety of living things, from complex plants and animals to very simple, one-celled organisms. But large or small, simple or complex, no organism lives alone. Each depends in some way on other living and nonliving things in its surroundings.

**To understand a world biome, you need to know:**

What the climate of the region is like.

Where each biome is found and what its geography is like.

The special adaptations of the vegetation.

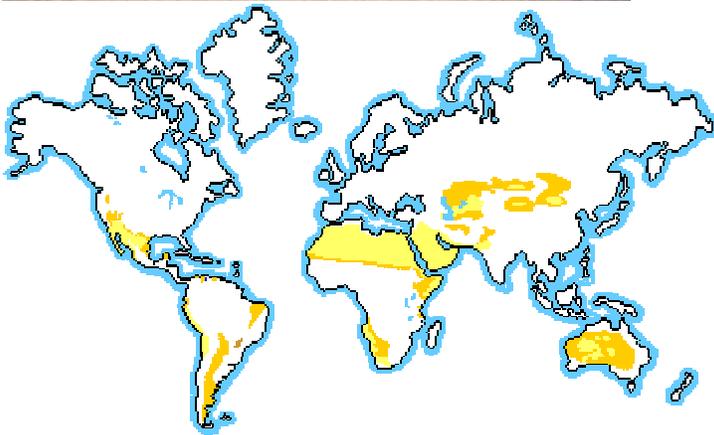
The types of animals found in the biome and their physical and behavioral adaptations to their environment.

**Ecological Relationships of Biomes**

The survival and well being of a biome and its organisms depends on ecological relationships throughout the world. Even changes in distant parts of the world and its atmosphere affect our environment and us. The eruption of a volcano in Mexico, or Southeast Asia can bring the temperature of the whole world down a few degrees for several years.

**Here, we are more concerned about region of Saudi Arabia.  
Therefore, will concentrate our thoughts on Desert Region.**

# Desert



In this report you will learn about Hot and Dry Deserts and Cold Deserts. I hope you enjoy!

A Hot and Dry Desert is, as you can tell from the name, hot and dry. Most Hot and Dry Deserts don't have very many plants. They do have some low down plants though. The only animals they have that can survive have the ability to burrow under ground. This is because they would not be able to live in the hot sun and heat. They only come out in the night when it is a little cooler.

A cold desert is a desert that has snow in the winter instead of just dropping a few degrees in temperature like they would in a Hot and Dry Desert. It never gets warm enough for plants to grow. Just maybe a few grasses and mosses. The animals in Cold Deserts also have to burrow but in this case to keep warm, not cool. That is why you might find some of the same animals here as you would in the Hot and Dry Deserts.

Deserts cover about one fifth of the Earth's land surface. Most Hot and Dry Deserts are near the Tropic of Cancer or the Tropic of Capricorn. Cold Deserts are near the Arctic part of the world.

Hot and Dry Deserts temperature ranges from 20 to 25° C. The extreme maximum temperature for Hot Desert ranges from 43.5 to 49° C. Cold Deserts temperature in winter ranges from -2 to 4° C and in the summer 21 to 26° C a year

The precipitation in Hot and Dry Deserts and the precipitation in Cold Deserts is different. Hot and Dry Deserts usually have very little rainfall and/or concentrated rainfall in short periods between long rainless periods. This averages out to under 15 cm a year. Cold Deserts usually have lots of snow. They also have rain around spring. This averages out to 15 - 26 cm a year.

Hot and Dry Deserts are warm throughout the fall and spring seasons and very hot during the summer. the winters usually have very little if any rainfall. Cold Deserts have quite a bit of snow during winter. The summer and the beginning of the spring are barely warm enough for a few lichens, grasses and mosses to grow.

Hot and Dry Deserts vegetation is very rare. Plants are almost all ground-hugging shrubs and short woody trees. All of the leaves are replete (packed with nutrients). Some examples of these kinds of plant are Turpentine Bush, Prickly Pears, and Brittle Bush. For all of these plants to survive they have to have adaptations. Some of the adaptations in this case are the ability to store water for long periods of time and the ability to stand the hot weather.

Cold Desert's plants are scattered. In areas with little shade, about 10 percent of the ground is covered with plants. In some areas of sagebrush it reaches 85 percent. The height of scrub varies from 15 cm to 122 cm. All plants are either deciduous and more or less contain spiny leaves.

Hot and Dry Deserts animals include small nocturnal (only active at night) carnivores. There are also insects, arachnids, reptiles, and birds. Some examples of these animals are Borrowers, Mourning Wheatears, and Horned Vipers. Cold Deserts have animals like Antelope, Ground Squirrels, Jack Rabbits, and Kangaroo Rats.

# Mojave Desert



The Mojave or Mohave Desert, is the smallest of the four North American deserts. It lies in South Eastern California at 35° to 36° latitude North and 115° to 117° longitude East. The Mojave Desert is situated between the Great Basin Desert to the north (a cold desert) and the Sonoran desert to the south (a hot desert). The Colorado River runs through the east of it, and the Sierra Nevada Mountains to the west.

The Mojave Desert is special because it has a little bit of everything. People refer to the Mojave Desert as a "high desert" because it has an elevation of 2,000 to 5,000 feet. It changes from a cold desert in the northern section and a hot desert in the southern section. The Mojave Desert covers 25,000 square miles. There are some fascinating features to be found in this desert, especially the Kelso Dunes. The Kelso Dunes are the largest of the Mojave dune fields, reaching 500 to 600 feet in height. When you run down these dunes you can hear an unusual "barking" sound. It is not entirely understood yet but some people believe that grains of quartz and feldspar rubbing against each other cause it.

It is a desert filled with desert scrub like the Brittlebush, Creosote Bush, Joshua Tree, and the Sagebrush. The Joshua tree is found in no other place in the world, except in some places in the Mojave Desert.

The Mojave Desert lies in the rain shadow of the Sierra Nevada Mountains. The hot, moist air from the Pacific Ocean goes up the Sierra Nevada's and is turned back by the cold air in the mountains. Although some of the rain goes over the mountains, most of it is evaporated by the hot air of the desert before it can reach the ground. The Mojave Desert is considered a dry desert because of the rain shadow effect. Rainfall in the Mojave is very changeable from day to night, and can range from 2.23 to 2.5 inches a year. A large amount of rain that the Mojave gets is in the winter season from October to March.

Animals of the Mojave have light colored feathers and fur to reflect the light of the sun. Desert tortoises have a good adaptation for the desert. They can store up to one quart of water in their bladder. They feed on plants in the spring so that they have enough water to last them the rest of the year.

Plants have adaptations also, such as shallow root systems, spines, and thorns. Shallow root systems can easily absorb rain because they are so close to the surface. Spines store water by expanding like an accordion. In addition, thorns protect the plants from danger. The Mojave Desert is jeopardized by large cities, such as Los Angeles, which are spreading rapidly through the desert. Military bases are moving in, and farms are developing along the Colorado River. Off-road vehicles are ruining the desert by churning up sand and destroying the shallow root systems. Due to wells and agriculture, the underground water tables are dropping to very low levels. In spite of all these dangers, half of the desert remains in its original condition.

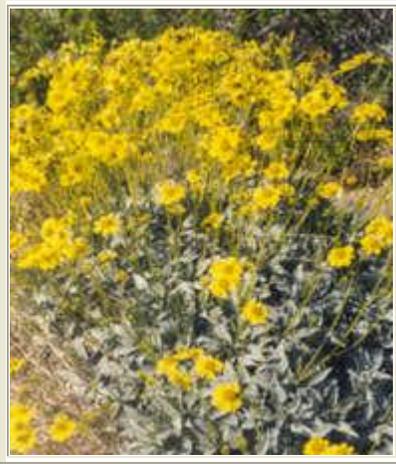
# Mojave Desert Plants

## Brittle Bush

**Common Names:** Incienso, White brittle bush

**Genus:** *Encelia*

**Species:** *farinosa*



The brittlebush is a common plant of the Mojave and Sonoran deserts. It is a small deciduous shrub which grows as a low, roundish mound 2 to 5 feet high. Brittle branches sprout from a woody trunk. The leaves have serrated edges, and are broader at the base than at the tip. They are about 1 to 4 inches long. The leaves are covered with a thick mat of short hairs giving a gray-green appearance. Many desert plants have this kind of hairy leaf. The hairs form a blanket over the leaves and act as an insulating layer against the heat and cold. They also trap any moisture that is in the air, and reduce the amount of water lost to dry air.

The brittlebush flowers from March to June, turning the desert bright yellow. It's a member of the sunflower family and its flowers resemble the sunflower, only in miniature form. The flower is disk shaped, on long bare stems, rising several inches above the mound of white leaves, giving an impression of a layer of color over the plant. It has a solitary head with a dark yellow-orange to purplish mound of disk-corollas from which radiate 1 inch yellow rays with a lobed, squared off tip.

Brittlebush can be found growing in the coastal chaparral and interior valleys of southern California, east to the creosote bush scrub, Death Valley through the Mojave Desert and the Colorado Desert, and south to Baja California. It likes to grow in dry slopes and washes. In most of these areas, the brittlebush and creosote bush dominate the vegetation. Brittlebush has had many uses in the past. The stems of the brittlebush secrete a clear resin which was used by Native Americans from the Southwest as a glue and also as a gum. Ground up it was used by the Seri Indians of Mexico as a toothpaste. They also would sprinkle the paste on sores or heat it and spread it on their bodies to relieve pain. The early Spanish missionaries burned it as an incense.

Mule deer and desert bighorn sheep browse on it, and kangaroo rats will eat its seeds, but aren't all that fond of it. Other than that, it isn't used for domestic livestock. Brittlebush is most useful for rehabilitating landscapes, and stabilizing disturbed areas. It is used in Arizona to minimize erosion near highways. It can be easily transplanted and grows well from seeds. The brittlebush is very abundant and is not on the endangered species list.

# Common Saltbush

**Common Names:** All-scale, Alkali Saltbush, Common Saltbush, cattle spinach.

**Genus:** *Atriplex*

**Species:** *polycarpa*

**Parts used:** seeds were cooked, twigs and leaves were used for making yellow dye by Native Americans.



The common saltbush is often mistaken for "sagebrush". It is actually related to the "tumbleweed", or Russian thistle and is part of the "goosefoot" or "pigweed" family. Other members of this family considered weeds include arrowweed and kochia. Spinach, Swiss chard and sugar beets are actually cultivated members of the same family.

Common saltbush is a grayish-white shrub that grows to be about 2 to 3 feet tall. It has many branches sprouting from the base of the plant. They aren't very pretty to look at, but

they are very well adapted to living in dry, alkaline environments, such as the Mojave desert. The stems and leaves are covered with small white scales called scurf, that help the plant conserve water. As a matter of fact, the common saltbush doesn't like lots of water. The leaves are sharp spines alternately clustered around the stem of the plant. In extreme droughts it will drop all of its leaves.

*Atriplex*es have yellow flowers which grow directly from the stem. A cup is formed by five fused sepals, with five stamens rising from the center. While the male flower is tiny, the female flowers grow in long open clusters two to sixteen inches long. They bloom from the middle of spring to the middle of summer.

It gets its name from the salty deposits on its leaves. When the saltbush takes up water from the salty, alkaline soil of the desert, it removes and deposits the excess salt in bladders on its leaves. This keeps the salt away from the plant cells and also attracts moisture in the air for the plant to absorb. When the leaves are eaten or fall off, the extra salt is removed from the plant.

Common saltbush is sometimes called "cattle spinach". It is very important as a browse plant for cattle and sheep because it is a great source of minerals, especially salt, which they need. This plant is a good source of food and shelter for many desert animals. Barn Owls and Northern Harriers use its branches to perch on. Pronghorn, deer, and many desert rodents eat the leaves.

The Pima Indians used to eat the seeds. Native Americans of the Southwest cooked the seeds of the four-wing saltbush like oatmeal, and they would eat the leaves either raw or cooked. The plant is rich in niacin, so it was very important to their diet. Navajos made the twigs and leaves into a yellow dye.

The common saltbush grows in cold desert shrub and salt desert shrub habitats with gravelly or sandy soils. It is a dominant plant in the Mojave desert.

# Creosote Bush

**Genus:** Larrea

**Species:** tridentata

**Parts Used:** leaves



The Creosote Bush is named that way because it smells a lot like the creosote tar that is used on telephone poles to preserve the wood. This shrub is mostly found in the southwest part of America and the northwest part of Mexico. You will most likely spot this plant in the desert slopes and plains of Utah, Nevada, California, Arizona, New Mexico and, Texas.

The bush's leaves were made into antiseptics and emetics by desert Native American desert tribes.

Antiseptics destroy germs, and emetics

induce vomiting to clear the stomach of poisons. Although they are no longer used for medical reasons today, they did greatly help the Native Americans in times of sickness. Well, I have told you of the way that the leaves of the Creosote Bush can be used, but I have not told you about how the bush looks. The Creosote Bush is unique. The bush is a robust shrub that grows very abundantly. The bush is basically a group of 4 to 12 plants that shoot up from one plant in all directions. Some bushes are thought to be thousands of years old.

The Creosote Bush has small (1-2 inch) pointy green leaves that are covered with a varnish. These leaves grow directly from the branches of the bush. The Creosote Bush has flowers that also grow along the stems. These flowers are yellow and about the same

size of the leaves. The fruit is small and round with gray or white hairy tufts growing from them.

This bush is very useful to us in our everyday lives just as it was to the Native Americans of the desert. It is, like many other plants, a contributor to the world in a small, but important way.

## **Desert Climate** Dry Tropical Climate (BW)

The dry desert is in Köppen's **BWh** climate category. It is a Low Latitude climate. The *B* stands for Dry Desert climates. All months have average temperatures over 64° F (18° C). The *W* stands for desert climate. Finally, the *h* stands for dry and hot, with average annual temperatures over 64° F (18° C). I guess they're trying to tell us its hot, hot out there.

The description of this awesome biome climate is quite odd, but also as it is odd, it is also very interesting.

Dry Desert climates are formed by high-pressure zones in which cold air descends. Then the descending air becomes warm but, instead of releasing rain, the heat from the ground evaporates the water before it can come down as rain. The ground is super hot because the sun's rays beat down on it directly overhead. Not a lot of atmosphere to protect it from radiant energy.

By the way, approximately 1 in. (.25 cm) of rain falls in dry deserts per year. The average annual temperature of these miles of hot sand is 64° F (18° C).

The latitude range is 15-28° north and south of the equator. Their global range covers about 1/5 of the earth, including the world's great deserts: Sahara, Sonora, Thar, Kalahari and the Great Australian.

Plants of the Dry Desert have adapted to the lack of water by using dew for moisture and taking in water through their leaves and stems.

# Desert Plants

## Barrel Cactus

**Common Name(s):** Barrel Cactus, Compass Cactus

**Genus:** Ferocactus

**Species:** wislizeni



When you imagine a desert, what do you think of first? Maybe it's sand, heat, or Gila monsters, but most likely it's cactus. Cacti are probably the most memorable characteristic of the desert. In all of the Speedy Gonzales cartoons, Speedy is always leading his unsuspecting predators into a cactus. And what is in the background as Wily Coyote accidentally blows himself up with Acme dynamite? Cacti of course!

American deserts is the barrel cactus. The Barrel cactus can be easily distinguished from other cacti

because of its cylinder-shaped body. The cactus usually reaches from around five to eleven feet tall, and at that height it is one of the largest cacti in the North American deserts. This cactus is really a man-sized (or bigger) cylinder with numerous parallel ridges that run down the sides. These ridges are topped with dangerously sharp 3-4 inch spines. The barrel cactus is also a flowering plant. It has rings of yellow-green or red blossoms at its top.

Like many plants of the world, this cactus has numerous uses. Native Americans who lived in the desert found the barrel cactus very useful. In the vast untamed land and scorching heat, you couldn't really hop in your air-conditioned car and cruise down to the local A&P. The Native Americans had to look hard to find food. The barrel cactus provided some very important provisions for them. They stewed the Barrel Cactus to make a cabbage-like food. They got water to drink from the pulp and they made fish hooks from the spines, which are pointed at the end. The pulp is also made into "cactus candy".

The Barrel cactus is found in the Mojave, Sonora, and the Chihuahua deserts. These deserts are found in the land of Speedy and the Roadrunner: Baja, Arizona, California,

Texas, and Central Mexico. The barrel cactus grows in the desert washes and slopes, but can also be spotted growing along canyon walls.

The barrel cactus is my favorite of all the cacti because it is very beautiful, but can really make you sore if you step too close. So keep an eye out for this cactus if you're anywhere in the vicinity of the southwest part of America. Just think, if you are ever stuck in the desert, you know what plant to boil for dinner.

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The early Spanish missionaries burned it as an incense.

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# Chain Fruit Cholla

**Common Names:** Hanging Chain Cholla, Jumping Cholla, Cholla Brincadora, Vilas de Coyote

**Genus:** *Opuntia*

**Species:** *fulgida*



The chain fruit cholla looks as much like a tree in the desert as a cactus possibly can. It has a central trunk from which sprout many spiny "branches". It is commonly found in dry, sandy soils of bajadas, valleys floors, and plains of the Sonoran and Chihuahuah Desert, south Arizona and northwest Mexico. It is found at elevations up to 4,000 feet above sea level.

The chain fruit cholla is a shrubby cactus. It has many segmented,

irregular, drooping branches. These are covered with a dense layer of sharp spines. These spines have a straw-colored sheath when young which turns a dark gray as they mature. The sheath acts to reflect sunlight and prevent over heating. As the cholla gets older the spines fall off and leave a rough and scaly bark on the trunk and old branches. It is the largest of the cholla, and can grow to a height of 15 feet, and be 6 feet across

The segmented branches have light-green leaves about 1/2 inch to 1 inch long when they are young. One inch long white and pink flowers streaked with lavender bloom from June to August. The flowers bloom at the end of the branches and on old fruit. The pear shaped fruit is about 1.5 inches long and half as wide. Clusters of these fruits sometimes stay attached for many years. New flowers will bloom on them every year and the chains grow longer with every year, sometimes as long as 2 feet. That is why they are called chain fruit cholla.



The chain fruit cholla is also called jumping cholla because the segments break off easily when brushed up against and stick to you,

giving you the impression that the cactus jumped at you. They attach themselves to desert animals and are dispersed for short distances. The ground around a cholla is usually covered with segments that have fallen off the parent. The fruit is not always fertile and the cholla relies mainly on fallen stem joints and fruit to take root and grow new plants. During droughts animals like the Bighorn Sheep rely on the juicy fruit for food and water. Large forests of chain fruit cholla grow in Arizona. The cactus is not considered to be vulnerable or endangered, mostly because they grow in inaccessible and hostile places of the desert.

## Creosote Bush

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**Species:** tridentata

**Parts Used:** leaves



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# Crimson Hedgehog Cactus

**Common Names:** Hedgehog Cactus, Claret Cup Cactus, King's Cup Cactus, Mound Cactus

**Genus:** Echinocereus

**Species:** triglochidiatus

**Parts Used:** pulp, flowers and stems



There are many different kinds of hedgehog cacti. The Crimson hedgehog cactus is a small barrel shaped cactus that grows in clumps of a few to a hundred stems. The stems are cylindrical in shape and are up to 1 foot long and 1 to 2 1/2 inches thick. There are about 9 or 10 ribs on the stem. This cactus has no leaves and has chlorophyll in the stems. The stems of this Crimson hedgehog are

shorter and more tightly packed together than other hedgehog cacti.

Echinocerens comes from the Greek word for hedgehog, echinos. Early settlers thought the spines of the cactus made it look like a hedgehog. Triglochidialus means "three barbed bristles". The hedgehog cactus has clusters of three spines along its ribs. Each spine can be 2 to 3 inches long.

The flowers are a beautiful deep red, with many petals that form the shape of a cup. The fruits are red, and edible. The flowers bloom from April through June, and are the first to

bloom in the desert. Unlike other cacti, they stay open at night, and bloom for about 3 to 5 days. This species is the only red-flowered hedgehog. They also have pink or lavender anthers.

Not only are the flowers open at night, but so are the plant's pores, or stomata. They use the cool night temperatures to exchange oxygen and carbon dioxide. During the day the plants do their photosynthesis, but they keep their stomata closed so they won't lose any moisture.

Some Native Americans collect the flowers stems, burn off the spines and mash them. Sugar is added and then it is baked to make sweet cakes.

The plants grow in middle elevations of deserts and mountain deserts. They often grow against rocky outcroppings. They can grow in colder climates because the stems clump so closely together. This reduces surface area through which it can lose heat. It can grow in elevations from 3,020 to 7,915 feet. This plant is native to the American continent.

# Desert Ironwood

**Common Names:** Arizona Ironwood, Palo-de-Hierro, Palo-de-Fierro

**Genus:** *Olneya*

**Species:** *tesota*

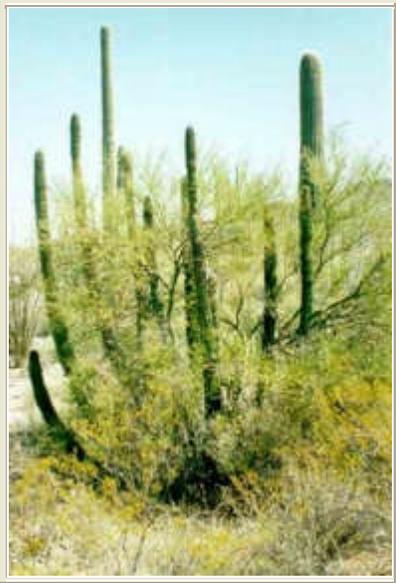


The desert ironwood only grows in the washes and valleys of the [Sonoran Desert](#) below 2,500 foot elevation.

The Sonoran Desert is located in southwestern Arizona, southern California, and the northwestern part of Mexico. The Sonoran desert is known as a hot, dry desert. The vegetation is mostly desert scrub. The boundaries of the ironwood's habitat and that of the Sonoran desert are almost the same. Desert ironwoods are usually found in sandy washes where water is available.

Desert ironwoods are from the pea family and their leaves and flowers resemble those of the sweetpea. They're the tallest trees in the Sonoran Desert, reaching heights of 15 to 25 feet, but they can grow as tall as 30 feet. Usually they grow as small, sparse trees. They are very slow growing, with bluish gray-green leaves, and a wide, spreading crowns. They are one of the longest living trees in the Sonoran desert, and can live as long as 1,500 years, although those are very rare.

The desert ironwood, or palo fierro in Spanish, provides desert plants and animals with the food and shelter they need to survive. Its importance comes from the part it plays in the survival of over 500 plants and animals in the Sonoran Desert. As the desert ironwood grows, it alters the environment around itself, and creates a micro-habitat. Its dense canopy shades the ground under it, bringing temperatures down at least 15° F. Its seeds provide food for many doves, quail, and small rodents. Insects thrive in the ironwood canopy, which also attracts birds and reptiles. They make their home under and in the ironwood, providing prey for cactus owls, hawks and coyotes. Its



nitrogen-fixing nodules on the root system, and nutrient-rich leaf litter fertilizes the soil around it. Native bees pollinate the ironwood flowers, which are also used as medicine.

The ironwood is known as a "nurse plant". It provides a safe place for seed germination, and protects seedlings from extreme cold. It also protects saplings from the damaging effects of the sun. Thorny, low-hanging branches shelter young saguaro and organ pipe cacti, night-blooming cereus, and other desert plants from browsing animals. Many wild flowers grow under the desert ironwoods, which are eaten by jack rabbits, desert bighorn sheep, Sonoran pronghorns, and mule deer. As many as 230 plant species have been recorded growing under the ironwoods.

The desert ironwood is the only member of the *Olneya* genus, but is part of the Fabaceae, or Pea family. Its leaves and flowers resemble those of the sweet pea. The tree usually grows from several trunks which can reach a diameter of 24 inches on very old trees. The bark on young branches is gray and smooth. Older bark becomes wrinkled and creased, eventually shredding on older trunks. It has leathery, compound, pinnate leaves about 2 inches long with 6 to 9 leaflets about .75 inches long. The leaves are covered with fine hairs. A pair of thorns about .5 inch long grows at the base of each leaf. During the dry season the ironwoods will drop their leaves to conserve water. They never drop all of their leaves, so their canopy provides protection from frost and high heat all year round.

They bloom from April to June just before the new leaves grow back.

Clusters of pea-like flowers ranging from pink, pale-rose, to white, grow in archs at the end of branches.

These develop into brown, bean-like seedpods about 2 inches long. Each seedpod has 1 to 4 brown beans in it. The ironwood seeds mature at a time of year when very few plants are producing fruit. Wildlife is highly dependent on its seeds. The seeds can also be roasted and eaten, or ground into a flour.



When given enough water the desert

ironwood is an evergreen tree. It is being used in landscape plantings as a shade tree. The desert ironwood is well adapted to the heat and lack of water of the Sonoran Desert however. The desert ironwood is drought deciduous, and will shed its leaves during dry periods to conserve water. This avoids loss of water through transpiration. The desert ironwood puts all of its energy towards flowering and regeneration after the spring rains . New leaves appear shortly after the tree has begun to bloom. The leaves have a soft covering of hair which protects them from damaging ultraviolet rays of the sun. The leaf litter under the tree acts as mulch and keeps the soil around the tree moist for longer periods after a rain. Sharp thorns discourage browsing by desert inhabitants.

The wood of the desert ironwood is very hard and dense. It actually sinks in water. It was used by the Seri Native Americans of Mexico for tool handles. Today the Seri Indians make carvings of desert plants and animals from the ironwood. Dead wood is gathered from the desert floor, and the carvings are made with hand tools. Tradition has it that carvings made from the desert ironwood bring good fortune and long life. The carvings are in much demand, especially large carvings, and bring in a lot of money. Illegal harvesting of ironwood is on the rise and live trees are being cut down.

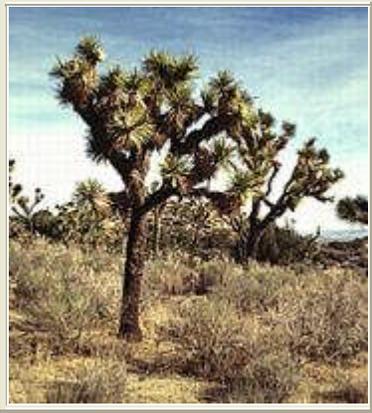
Desert ironwood burns very hot and is used to make charcoal. Woodcutting causes an average of 17% reduction in ironwood. Wood has been illegally cut even in the Organ Pipe Cactus National Monument and other protected areas.

Desert ironwood trees grow only in the Sonoran desert. Urban developments are threatening their habitat. Many of Tucson, Arizona's housing developments are expanding into the ironwood forests. The destruction of the forests means the destruction of the special ecosystem the ironwoods create. The already endangered cactus pygmy owl, which depends on the ironwoods for its prey, would be in greater danger of extinction. The threatened desert bighorns and Sonoran pronghorn antelopes depend on it for forage. It would mean the disappearance of the saguaro and the pipe organ cacti which need the shade of the ironwoods when they are young. Although it doesn't look like a very important tree, in the desert the ironwood tree enables life to flourish. Without it, that life would disappear.

# Joshua Tree

**Genus:** Yucca

**Species:** brevifolia



The Joshua Tree got its name from the Mormon pioneers who thought the tree reminded them of Joshua, from the old testament of the Bible, a prophet who was waving them on to the Promised Land. The unusual Joshua Tree grows in the protective setting of the Joshua Tree National Park in California and in the Joshua Forest Parkway in western Arizona. The Joshua Tree is the largest of the yuccas and grows only in the Mojave Desert. The Joshua Tree's height varies from 15 to 40 feet and has a diameter of 1 to 3 feet. The Joshua tree has a lifespan of about 200 years. The Joshua Tree is a member of the lily family. The growing

habitat of the Joshua Tree is similar to one of the palm trees.

The Joshua Tree bears 1.25 to 1.5 inch flowers that are a creamy yellow and green. The flower is bell shaped, and has many 12 to 18 inch clusters on each branch. There is a very unpleasant odor that goes along with the flower. Some Joshua Trees do not flower annually. The fruit of the Joshua Tree is green and brown, and is 2.5 to 2 inches long. Soon after the Joshua Tree's fruit matures in late spring, it will fry and fall off the branches. When the fruit falls it lets off many flat seed.

The Joshua Tree grows in arid deserts; they often grow in groups called groves. The Joshua Tree can be found in the Mojave Desert with elevations from 2,000 to 6,000 feet. The Joshua Tree has two sets of root systems, one stores any surplus water and it also develops bulbs. The bulbs are buried 10 to 30 feet under the soil. Sometimes they reach up to 4 feet in circumference and weigh up to 40 pounds. The other set is a shallow root system; the shallow roots only reach down to a couple of feet. The spiny leaf of the Joshua Tree is turned upwards in hopes it will catch any moisture in the air. Then it stores the water in the limbs and trunk. The Joshua Tree is only pollinated by the Pronuda Moth. The moth is commonly called the Yucca Moth. The moth evolved special organs so that it is possible for the moth to pollinate the Joshua flower. The larvae of the Yucca Moth feed on the seeds of the Yucca. The Joshua Tree could not reproduce without the moth's pollination and likewise the moth is equally dependent on the tree.

Both people and animals have relied on the Joshua Tree for survival. The Indians would remove the rope-like centers from the limbs to use as canisters for nuts and berries. They also used the lightweight bark for dishes and bowls. As far back as 1883 the pulp of the Joshua Tree was used to make paper for the London Daily Telegraph. During WWI, the

U.S. government used the strong wood as splints for injured soldiers. The pioneers used the Joshua Tree as fence posts, and roasted parts of the tree and gave it to children for a sugary treat.

The Joshua tree is plentiful in the wild but only grows in the Joshua Tree National Park. The Joshua Tree is protected by the U.S government and you must have permission to cut one down even if it is on your own property.

# Jumping Cholla

**Common Names:** Teddybear Cholla, Silver Cholla, Cholla Guera

**Genus:** *Opuntia*

**Species:** *bigelovii*



From a distance the jumping cholla, or teddy bear cholla, looks like a fuzzy, soft plant with many short, fuzzy branches looking like teddy bear arms, growing from the top. As you get closer you realize that the cuddly looking plant is completely covered with silvery spines. If you are unlucky enough to touch the spines, you will find yourself painfully stuck to a spiny segment that seems to have "jumped" off the plant. Segments will also "jump" when stepped on and attach themselves to your leg.

The segmented joint of the jumping cholla separate easily when brushed up against. These segments can be found littering the ground around the cholla. There they take root and grow, sometimes forming large forests of cuddly looking teddy bear chollas. Although the jumping cholla has flowers and forms fruit, the fruit is usually sterile, and the plant relies on the dropped stems to propagate. It's dense, 1 inch spines completely hide the stem. The cylindrical segments are light to bluish green. They are about 10 inches (25 cm) long, and 2.5 inches (4 cm) in diameter. The jumping cholla can be 3 to 7 feet (1 to 2 m) tall and has a single trunk with short branches at the top. The spines on young branches are silvery white, and have a detachable, papery sheath. As they age, they become dark chocolate brown to black in color.

The jumping cholla blooms from February to May. The greenish-yellow flowers grow at the end of the stems. They are about 1.5 (2 cm) inches in diameter. The fruit is less than 1 inch (2.5 cm) in diameter, and sometimes has spines growing on it.

The jumping cholla have developed several adaptations to survive in the arid desert environment of its habitat. The thick covering of spines shades the plant from the desert heat. They also prevent animals from eating them. The stems are separated into segments that store water and allow for photosynthesis. They separate easily so that animals, and even a strongwind can disperse them away from the parent cholla.

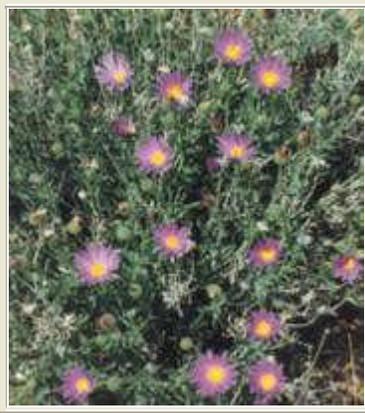


Jumping chollas grow on the valley floors of the Sonoran Uplands at 100 to 2,000 feet (30 to 600 m), the Mohave Desert, California, and Sonora, Mexico.

# Mojave Aster

**Genus:** Xylorhiza

**Species:** tortifolia



The Mojave aster is a member of the sunflower family (Asteraceae). It's a shrubby plant which can grow up to 30 inches high. The stems are gray-green and long. It has whitish-green to silverish-green, narrow, hairy leaves. They are about 3 inches long, and have small spike-like points on their edges .

Its flowers have narrow purple to lavender rays surrounding a yellow disk. The flower can get to be up to 2 inches in diameter. They usually bloom in March and May but will on occasion also bloom in the fall. It may get as many as 20 blooms. After flowering, the plant dies back.

The Mojave Aster grows in the Sonoran, Great Basin and Mojave deserts of southeastern California. It tends to grow in creosote scrub growths on rocky slopes, in canyons or dry, flat areas at about 2,000 to 5,500 feet.

The Great Basin Desert is colder than the Mojave Desert and the Sonoran Desert is very hot and dry. Although it grows in all three deserts, it grows abundantly in the Mojave.

# Ocotillo

**Common Names:** Candlewood, Slimwood, Coachwhip, Vine Cactus, Flaming Sword, Jacob's Staff

**Genus:** *Fouquieria*

**Species:** *splendens*



The Ocotillo has many interesting names such as Candlewood, Slimwood, Coachwhip, Vine Cactus, Flaming Sword and Jacob's Staff. The Ocotillo is indigenous to the Sonoran Desert, which is located in the Southwestern United States and Northern Mexico at latitude is 23° to 33° North and longitude 107° to 112° West.

The terrain of the desert is open and very rocky, and its soil is well drained. The elevation of the Sonoran Desert is about 5,000 feet. The average yearly temperature is 90°F, and the average yearly precipitation is less than 10 inches.

There are many plants indigenous to Sonoran Desert; one of interest is the Ocotillo, or Vine Cactus.

The Ocotillo prefers to grow in the Sonoran and Chihuahuan Deserts of Southeast

California to West Texas and south into Mexico.

The Ocotillo is abundant in the Southwest because the soil is well drained on rocky slopes, mesas, out washed plains and desert grasslands. The ocotillo is deciduous, drought tolerant shrub. From its root crown it grows stems that can be any where from 9 to 30 feet tall. These stems grow in an "S" like pattern making the shrub look like an inverted funnel. The stems are covered with spines that can be 1.5 inches long. The

leaves of the shrub are thick and leather like and grow several times in the growing season depending on the amount of rainwater available. The leaves are narrow 2-inch ovals, which can sprout within 3 day of a rainfall. The leaves turn brown and fall off when water is scarce. When the leaves die the stalk and part of the steam become woody and form spines. In the spring the Ocotillo produces flowers, which are tube like and bright red. The flowers are 1/2 to 1 inch in size with 5 lobes curled into 10-inch clusters. They can be seen from March to June and even later depending on rainfall. The Ocotillo can be leafless for a long time, because the roots are deep and do not get much water.



The Ocotillo has adapted to its environment by shedding its small leaves during dry spells. It can also grow new leaves 5 days after getting water. It has a shallow, but wide root

system, which it uses to gather rainwater. It produces food because the Ocotillo can perform photosynthesis during dry spells.

The Ocotillo is pollinated by hummingbirds that like the honey nectar it produces. They feed on the flowers during their travel north from Mexico to the mountains of the Western US.

The Ocotillo is very plentiful and not endangered because it's the only *Fouquieria* to be cultivated. The plant is easily grown from seed and cuttings and sold as nursery stock. The shrub is often use as "fencing" because its spines stop people and animals from passing through. The Ocotillo can be planted at anytime of the year.

The Ocotillo is a desert success story. It is a plant that has adapted to its environment, and it is useful to both animals and mankind.

# Palo Verde

**Common Names:** Yellow Palo Verde, Foothills Palo Verde, Littleleaf Palo Verde, Green Stick

**Genus:** Cercidium

**Species:** microphyllum



The yellow palo verde is a very strange looking shrub or small tree which grows in the Sonoran Desert of the southwestern United States and northern Mexico. It has adapted in unique ways to survive the killing heat of the desert sun.

Palo verde, or "green wood" in Spanish, has a thin, almost waxy

looking green bark studded with large of thorns. The smooth greenish trunk and branches have for a large part taken over the photosynthesis. The green bark contains [chlorophyll](#), which gives it the ability to carry on [photosynthesis](#) when the tree has shed its leave during dry, hot periods. This way the tree doesn't have to shut down completely and can still store up energy in its roots. The tree has a very deep root system to access any underground water supply. Palo verdes are "branch deciduous", meaning that they may shed some of their branches during severe droughts, becoming a smaller tree.

The palo verde has low hanging, dense and twiggy branches and a strange irregular shape. Six to four major stems sprout out about 8 inches (20 cm) from the ground. The crown is 12 to 18 feet (3.7 - 5.5 m) wide. Palo verde can get to be 10-20 feet tall, but grow very slowly and are considered climax species in the Sonoran Desert.

Its leaves are [compound](#) and [pinnate](#), and about 1 inch (2.5 cm) long, with tiny, round leaflets. The palo verde is [drought deciduous](#), and drops its leave during dry, hot periods. This is an adaptation that prevents water loss through [transpiration](#) for some desert plants.

The flowers of the palo verde are 1 inch solitary blooms that flower in



late spring. The small, pale yellow flowers grow on the edge of a branch, and are pollinated by insects. They may not flower every year, depending on the rainfall.

The one to five seeds are contained in 2 to 3 inch (4-8 cm) long pods which pinch in between each seed. Seeds are produced when the spring has been wet and cool. They ripen in July, and cling to the branches. Rodents will often cache the seeds underground, where some of them will germinate after a rainy season. The seedlings are very sensitive to drought for the first two to three months of their lives, and only about 1.6% will survive after germinating. Those that do survive usually have germinated under triangle bursage.



The palo verde is a very important tree in the Sonoran Desert ecosystem. The black-tailed gnatcatchers use the palo verde as nesting sites, and the Gambell's quail use them as roosts. White-throated woodrats also use them for shelter. [Desert bighorn sheep](#), mule deer, [jackrabbits](#) and other rodents browse on its leaves. [Javelinas](#) like to eat the seed pods. The canopy cover reduces the temperature below the palo verde which is very important for the germination of other desert plants. The palo verde is the primary nurse plant for the [saguaro cactus](#).

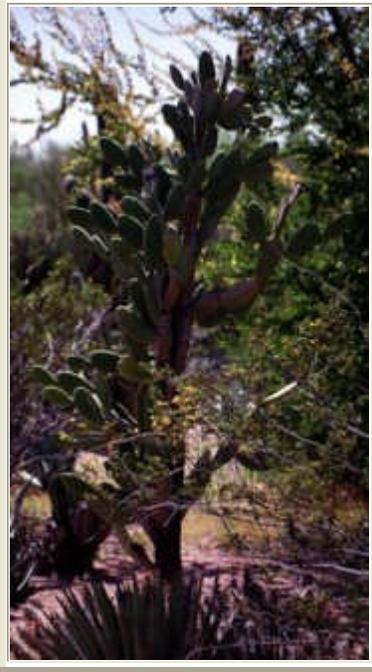
Palo verdes grow in arid to semiarid climates with mild winters and hot summers, and two distinct rainy seasons. They are found on gradual to steep lower mountain slopes and alluvial outwash plains at altitudes of 1,000 to 4,000 feet (305-1,219 m). They are the dominant species of the Arizona Uplands of the Sonoran Desert.

The seeds can be ground up and used for flour. The Seri Indians of northern Mexico used the seeds and flowers as a food source, and made necklaces out of the seeds. Red dye can be made from the flowers. Palo verde wood is only good for fire wood, and the tree is not an endangered species.

# Pancake Prickly Pear Cactus

**Genus:** Opuntia

**Species:** chlorotica



The prickly pear cactus is a widely used and versatile cactus. It can be used in many different ways such as foods, crops, etc.. In many places the prickly pear is grown as a crop, but in others they are just grown in the wild. The prickly pear has started to grow as a weed in some areas but in others it is vulnerable.

The prickly pear cactus grows in many places. It's found in the Sonoran and the Mojave Desert. The Sonoran Desert is located 25.3° to 33° North and 105° to 118° West.

In the Sonoran Desert it's very hot and dry, and the ground is very sandy. The temperatures drop very low at night and rise very high during the day. In the Sonoran Desert, rainfall, rather than time of the year, more clearly predicts the seasons than the calendar. It does have two rainy seasons. The Sonoran Desert is the wettest desert in North America with temperatures that

vary in different months. In January the average temperature is 51.8° F, in April it's 65° F, in October it's 70.6° F, and in July it's 85.9° F. This cactus likes to grow in dry hot areas, as well as areas with intense monsoons and high temperatures.

The pancake prickly pear cactus grows up to 7 feet tall. It has circular pads arising from a thick, round trunk. The pads are actually fast growing stems. This cactus grows in a upright position with pads sticking out at all angles covered with barbed spin. The pads are four to six inches long, 9 inches wide, and .75 inches thick. The pads are very course and covered with spines. There are flowers located on the pads of the cactus. They are yellow with red centers and three to four inches wide. Several flowers grow on the edges of each pad. The fruit that grows from the flower are red or purple and turn gray when they get old. The fruit is one and six tenths to two and four tenths in diameter. The seeds of the plant are tan or cream colored and smooth with four-millimeter diameter.

There are many adaptations that the pancake prickly pear cactus has to the Sonoran Desert. Cacti have reduced their leaves to spines to reduce water loss and to protect the cactus. The roots of the prickly pear cactus are also made for very dry environment to help adapt to the deserts hot weather. Plants in the desert don't require much water or they need a way to store it for a drought. For example, the pads of the prickly pear cactus are used to store water for when they need it during a drought. In some places these adaptive significances help well. In some places these adaptive significances help well. The pancake prickly pear cactus thrives as both a wild and domesticated plant.

# Saguaro Cactus

**Genus:** Carnegiea

**Species:** gigantea



The Saguaro Cactus has a smooth and waxy skin and is covered with two-inch spines that are located on the tree's vertical ribs. In May and June, the Cactus bears creamy white flowers with yellow centers that measured about three inches. The Saguaro Cactus flower can be found on the end of the branches. The flower only opens on cooler nights and is closed during the heat of midday. The stem of the cactus can be 18 to 24 inches in diameter, The Cactus and its branches grow upright as do all cacti in the southwestern U.S. When it rains the Saguaro Cactus soaks up water and holds it in its ribs. Since it does not rain a lot in the desert, the cactus uses the water that it stores when it doesn't rain. The Saguaro Cactus is Arizona's state flower. The average lifespan for a Saguaro cactus is about 200 years.

The Saguaro Cactus lives in an especially rocky terrain consisting of desert slopes and flats. The Saguaro cactus also lives in bajadas or lowlands. The cactus likes a hot, dry climate. It does not need a lot of water to survive. The Saguaro Cactus lives only within the

## Sonoran Desert of southeastern

California, southern Arizona, and northwestern Mexico. In the Sonoran Desert, the Saguaro Cactus can grow in very limited areas below elevations of 3,500 feet.

The Saguaro Cactus can absorb a lot of water because the ribs on the plant can expand. The Saguaro Cactus has an amazing root system. The root system is very shallow for such a tall, heavy plant. The Saguaro Cactus has one tap root that is only about three feet long. It also has two sets of radial roots. One is a thick root system, which is only about one foot long, and there is also a thinner root system that grows to a length equal to the height of the Saguaro Cactus.

The Saguaro Cactus has a very strong framework consisting of three different structural features. There is a woody tissue that runs parallel up and down the Saguaro to form a cylindrical shape. There is also a thick whitish pith, and a fleshy tissue. Downward pointing spines make it easier to direct rainwater into the depressions of the cactus. The spines help to cool the outer skin. The spines also help redirect the wind and insulate the plant. Many animals eat the Saguaro Cactus; the Long-Nosed bat, bees, wasps, ants, and butterflies drink the nectar of the Cactus flower. Small animals such as the Pack Rat, and Pocket Mice will come to eat the Cactus. Gila woodpeckers like the interior of the Saguaro Cactus because it is the only plant it can hollow out for their nest in the desert. The woodpecker will drill 2 to 3 holes before it decides to live in one. It will peck right into the soft tissue that is used to store water. The cactus will fix the damage by sealing up the inside with "callous scar tissue" and that stops water loss. The Saguaro Cactus is protected by the United States government, because the Saguaro Cactus was beginning to disappear from the landscape. There is a national park to protect the Saguaro Cactus. The name of the park is Saguaro National Park.

# Soaptree Yucca

**Genus:** Yucca

**Species:** elata

**Parts Used:**



Imagine bumping down a dusty desert road, looking at the wide open land stretching out in all directions. Along the sands are plants, some squatting in the burning sun, others standing tall, watching the sky for a chance of rain. As you speed along, you notice an exotic looking plant growing in the mesas and washes of the desert. You turn to your driver and inquire about the plant. The driver tells you that it is the Soaptree Yucca.

The Soaptree Yucca is commonly found in the Sonora and Chihuahua deserts, Texas, New Mexico, Arizona and northern Mexico. Thanks to its exotic look, the

plant has been introduced to eastern soil,  
and can be found growing in  
climates that are not just hot and dry like the desert.  
The Soaptree Yucca is a tall 10-18 foot plant with palm treelike leaves. These leaves are at the base of the plant. They are very similar to those of a palm tree in the respect that the green leaves of the Soaptree Yucca are long and triangular shaped and are not wide. The stalk that shoots up from the leaves is a twig-thin stalk with small white flowers growing at the top. The plant's fruit is also on the stalk and is a brown capsule until the summer, when it splits into three sections that contain black seeds.  
Maybe you are wondering why the plant is call the "Soaptree" Yucca. There is a logical reason. Inside the roots and trunk of the plant is a soapy substance. This substance was commonly used as a substitute for soap. In a drought, ranchers use the plant as an emergency food supply for their cattle. In the days when Native Americans dwelled in the deserts, the fiber of the Soaptree Yucca's leaves were used to weave baskets. This plant gave them a head start to finding enough food, because the Native Americans most likely used the baskets to collect food. The Yucca is also used for decoration in many American gardens. So this plant's leaves, roots, trunk and stalk have been useful to humans since the time of the Native Americans.  
The Yucca is a very climate compatible plant because if you look hard you can find it almost anywhere.

## Triangle-leaf Bursage

**Genus:** Ambrosia

**Species:** deltoidea



Triangle-leaf bursage is a native plant of the Sonoran Desert and can be found throughout southwestern Arizona, USA, south into Sonora and Baja California, Mexico.

Triangle-leaf bursage can be found growing in upper and lower bajadas, lowland creosote growths and desert grasslands. It grows at altitudes of 1,000 to 3,000 feet on open flat, spaces, and steep, gravelly hillsides. Triangle-leaf bursage prefers to grow in coarse soils with a high pH where rain

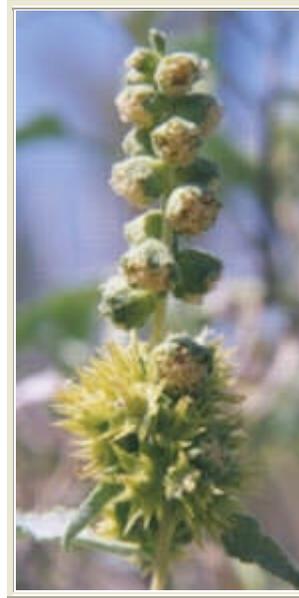
percolates quickly and drains away. It is the dominant plant in the Upland Subdivision of the Sonoran Desert where it gets two rainy seasons. It is found growing with palo verde, mesquite, ironwood and mixed varieties of cacti.

Triangle-leaf bursage is a small, round shrub about 1 1/2 feet tall and 2 feet wide. It has many slender and brittle branches that grow from the base to create a dome-like crown. The crown contains many old, dead growth.

Young branches and leaves are hairy and resinous, but become smooth with age. The triangle shaped leaves are about 1 inch long and 1/2 inch wide. The margins are serrated but can sometimes be smooth. They have a gray-green color on top and are white and fuzzy underneath. Triangle-leaf bursage is drought deciduous and will lose its leaves during the dry seasons.

Triangle-leaf bursage has small, 1/4 inch wide yellow-green flowers without petals. They grow in pairs from the end of growth spikes and flower from February to July. Bursage gets its name from its burr-like seeds. The round seeds are covered with hook-tipped spines that attach themselves to the fur of passing animals. The plants produce many seeds after both summer and winter rains.

For a desert plant it has a short life-span, only 50 years. Its most significant function is as a "nurse plant" for other species. Because it prefers to grow in open, sunny areas, it is one of the first plants to populate an empty space too hot for other seedlings. Once it is established, it provides a microhabitat for the seedlings of other species and protects them from herbivores with its tangle of branches. In time the area becomes populated with many different species of desert plants.



Triangle-leaf bursage is well adapted to desert life. Because of its long taproot and well-developed lateral roots it can survive with very little precipitation. During droughts the tiny rootlets that grow on the main root system after it rains die off. When it grows among creosote bush and jumping cholla, bursage has a very distinct root zone. No other plant will grow near triangle bursage roots, cutting down the competition.

The triangle-leaf bursage is a member of the Sunflower family and a cousin of common ragweed.

# *Permaculture*

Permaculture (the word, coined by Bill Mollison, is a portmanteau of permanent agriculture and permanent culture) is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. It is the harmonious integration of landscape and people — providing their food, energy, shelter, and other material and non-material needs in a sustainable way. Without permanent agriculture there is no possibility of a stable social order. Permaculture design is a system of assembling conceptual, material, and strategic components in a pattern which functions to benefit life in all its forms.

The philosophy behind permaculture is one of working with, rather than against, nature; of protracted and thoughtful observation rather than protracted and thoughtless action; of looking at systems in all their functions, rather than asking only one yield of them; and allowing systems to demonstrate their own evolutions.

Permaculture in Landscape and Society

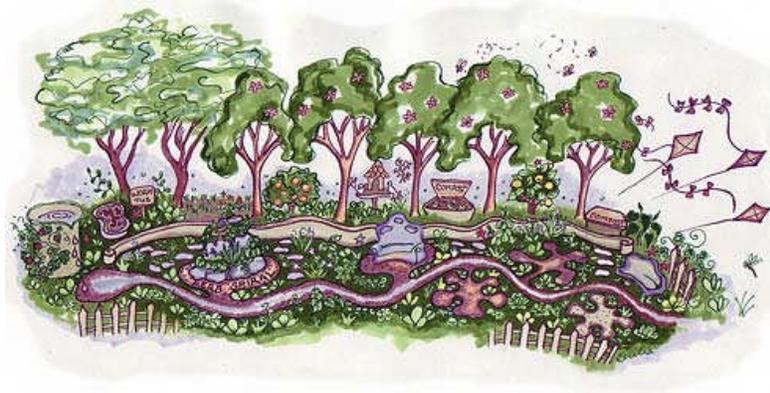
As the basis of permaculture is beneficial design, it can be added to all other ethical training and skills, and has the potential of taking a place in all human endeavors. In the broad landscape, however, permaculture concentrates on already-settled areas and agricultural lands. Almost all of these need drastic rehabilitation and re-thinking. One certain result of using our skills to integrate food supply and settlement, to catch water from our roof areas, and to place nearby a zone of fuel forest which receives wastes and supplies energy, will be to free most of the area of the globe for the rehabilitation of natural systems. These need never be looked upon as “of use to people”, except in the very broad sense of global health.

The real difference between a cultivated (designed) ecosystem, and a natural system is that the great majority of species (and biomass) in the cultivated ecology is intended for the use of humans or their livestock. We are only a small part of the total primeval or natural species assembly, and only a small part of its yields are directly available to us. But in our own gardens, almost every plant is selected to provide or support some direct yield for people. Household design relates principally to the needs of people; it is thus human-centered (anthropocentric).

This is a valid aim for settlement design, but we also need a nature-centered ethic for wilderness conservation. We cannot, however, do much for nature if we do not govern our greed, and if we do not supply our needs from our existing settlements. If we can achieve this aim, we can withdraw from much of the agricultural landscape, and allow natural systems to flourish.



Illustration by [Cecilia Macaulay](#)



Recycling of nutrients and energy in nature is a function of many species. In our gardens, it is our own responsibility to return wastes (via compost or mulch) to the soil and plants. We actively create soil in our gardens, whereas in nature many other species carry out that function. Around our homes we can catch water for garden use, but we rely on natural forested landscapes to provide the condenser leaves and clouds to keep rivers running with clean water, to maintain the global atmosphere, and to lock up our gaseous pollutants. Thus, even anthropocentric people would be well-advised to pay close attention to, and to assist in, conservation of existing forests and to assist in, the conservation of all existing species and allow them a place to live.

We have abused the land and laid waste to systems we never need have disturbed had we attended to our home gardens and settlements. If we need to state a set of ethics on natural systems, then let it be thus:

Implacable and uncompromising opposition to further disturbance of any remaining natural forests, where most species are still in balance;

Vigorous rehabilitation of degraded and damaged natural systems to stable states;

Establishment of plant systems for our own use on the least amount of land we can use for our existence; and

Establishment of plant and animal refuges for rare or threatened species.

Permaculture as a design system deals primarily with the third statement above, but all people who act responsibly in fact subscribe to the first and second statements. We believe we should use all the species we need or can find to use in our own settlement designs, providing they are not locally rampant and invasive.

<http://www.permaculturenews.org/>

**Postal Address:**

The Permaculture Research Institute

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**Advice and/or Resources:** If you're seeking help for your site, please complete our [project questionnaire](#) and email it to info (at) permaculturenews.org in the first instance.

This is designed to gather information about potential projects before you make contact so that our initial conversations can be more situation specific.

*Clip from U.S. Water News Online*

**SANTA ROSA, Calif.** -- DRiWATER, Inc., a manufacturer of pioneering water-conservation technology, has announced the completed planting of 1 million DRiWATER irrigated trees in a single development outside Cairo, Egypt. The company, which ultimately will plant over 17 million trees in the development, also announced it has secured a lucrative package to establish a manufacturing facility in Tunisia. Both milestones reflect the growing interest of water-poor regions, both in the U.S. and abroad, in DRiWATER's extremely efficient and environmentally safe form of plant irrigation, say company officials.

"DRiWATER is bringing water-dependent vegetation to regions that formerly could only dream of such growth, and Egypt and Tunisia are leading the way by embracing our technology," said Joseph Paternoster, President and Chief Executive Officer. "There is no greater proof of DRiWATER's capabilities than to see 1 million trees suddenly bloom in the middle of the Sahara Desert. Whether it is increased potential for economic development, reduced water and labor costs, or improved living conditions, the benefits of DRiWATER are revolutionizing the way the world uses water."

Egypt is using DRiWATER gel to grow eucalyptus, acacia, olive, mesquite, gazira, ficus, and orange trees in and around its new Sixth of October city development. The millionth tree completes phase one of the three-phase project, which calls for DRiWATER to plant more than 17 million trees over 35,000 acres.

Tunisia, the world's second-largest grower of olive trees, reacted to DRiWATER's success in Egypt by offering the company a generous package to establish a Tunisian manufacturing facility. The incentives include a 25 percent grant to build the factory, another 35 percent of overall project costs, a 10-year income tax exemption, and a permanent import tax exemption on all materials used in the production for export. Tunisia will continue to purchase DRiWATER from the company's 30,000 square-foot Egyptian factory until the Tunisian facility is completed.

DRiWATER, Inc., a Santa Rosa, CA-based company, is the manufacturer of DRiWATER, water bound in gel form that slowly releases moisture into soil over time. The product is used to irrigate plants in commercial and retail markets.

Phone: 707-588-1444

Address: 1042 Hopper Avenue Santa Rosa, CA 95403

<http://driwater.com/>

For irrigation, if water is not available, the cheapest way is a new discovery from University of Surry, England:



MODERNWATER

# Manipulated Osmosis Desalination

## Real-World Solutions

Modern Water's patented process consistently delivers significant reductions in energy use, reducing opex and reliably producing high quality product water, even in the most challenging conditions.

MOD PLANT, AL KHALUF AUG 2010



### KEY ADVANTAGES OF MANIPULATED OSMOSIS DESALINATION PROCESS:

- Reliable and robust membrane process
- Energy consumption up to 30% lower than conventional reverse osmosis
- Forward osmosis membranes are chlorine tolerant and compatible with a variety of biocides
- Forward osmosis membranes are fouling resistant
- Inherently low product boron levels, when compared to conventional reverse osmosis
- Higher availability than conventional reverse osmosis plant due to low fouling and simple cleaning when required

Modern Water has successfully deployed and operated internationally their patented desalination process, operating with real seawaters in challenging environments.

Modern Water is the world leader in this technology and, as of November 2010, has the only two operational seawater plants in the world using the Manipulated Osmosis Desalination process.

The first plant is located in Europe, at Gibraltar on the Mediterranean Sea. Since commissioning in September 2008, this plant has been used for development work, and is where a number of manipulated osmosis membranes have been tested, evaluated and proven in real-world conditions. The plant has been supplying water for public consumption since 1st May 2009 and has never required membrane cleaning.

The second plant is located in the Sultanate of Oman, at an existing Public Authority for Electricity and Water seawater desalination site. Modern Water's facility shares a common pre-treatment system with the existing conventional reverse osmosis plant, which allows the two processes to be compared using identical feedwater. The plant was fully commissioned in November 2009 and has been exporting water for public consumption since that time. As of November 2010 the membranes have never been cleaned despite the very challenging feed water conditions (an open, shallow seawater intake), whereas the conventional plant has required cleaning multiple times over the same period.

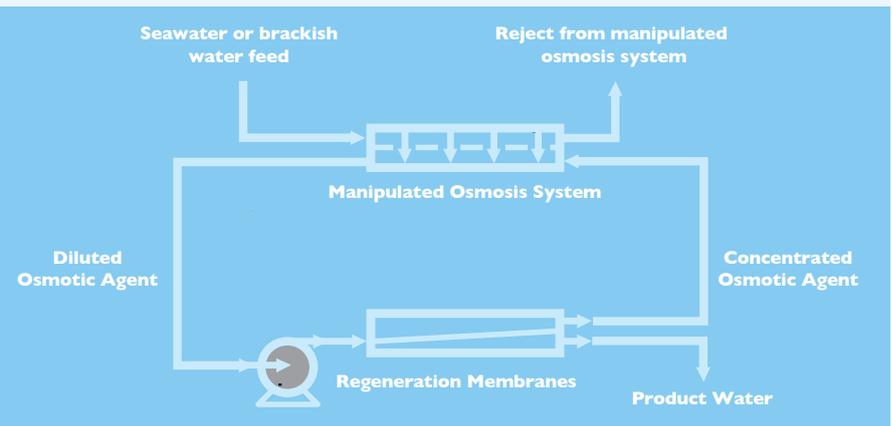


MODERNWATER

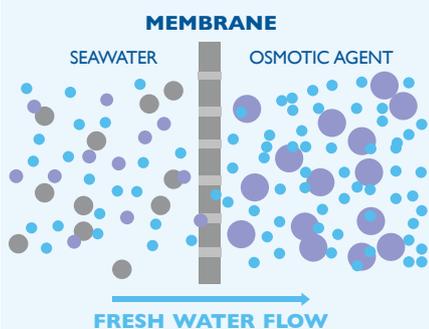
# Manipulated Osmosis Desalination explained

## How does it work?

At the heart of the Modern Water process is a recirculating “osmotic agent” system that transfers pure water from the feedwater (eg seawater) to the regeneration (permeate extraction) system. By linking two highly optimised systems, the manipulated osmosis system and the regeneration system, significant benefits are achieved.



## EXTRACTING FRESH WATER FROM SEAWATER USING MANIPULATED OSMOSIS



### KEY

- WATER MOLECULE
- MONOVALENT ION
- DIVALENT ION
- OSMOTIC AGENT MOLECULE

In the first stage, feedwater is fed under low pressure to the manipulated (forward) osmosis membranes, which are highly resistant to fouling and are resistant to oxidising agents. The osmotic agent, on the other side of the membrane, draws fresh water from the seawater due to a difference in osmotic pressure. This fresh water dilutes the osmotic agent.

In the second stage, permeate is extracted from the system. The pure water is removed from the dilute osmotic agent which is regenerated (or concentrated) for reuse in the first stage. This can be achieved in a number of ways depending on the proprietary osmotic agent selected. Modern Water currently uses a membrane separation process, similar to reverse osmosis, to extract the fresh water.

## Delivery of Benefits

The manipulated osmosis membranes are inherently less prone to fouling because only low pressures ( $\approx 2$  barg) are applied to the membranes. This compares to conventional reverse osmosis systems, where very high pressures ( $\approx 82$  barg) compress the foulants in the feedwater onto the membrane surface. Less pre-treatment of the feedwater is required.

A highly optimised regeneration (permeate extraction) system is possible, because the normal limitations in the process are removed by careful selection of the chemistry and operating parameters of the osmotic agent. This leads to a lower energy consumption compared to conventional reverse osmosis, and a saving of up to 30% is possible.

A lower boron content in the product water is achieved compared to a conventional plant, due to the membranes and control of the osmotic agent. This inherent capability may eliminate the need for post-treatment designed to remove problematic boron, which would otherwise increase the cost of the water produced.

## MORE INFO:

[www.modernwater.co.uk](http://www.modernwater.co.uk)  
or call +44 (0) 1483 696 000