

# What is a desert?

Imagine a world where water is in such short supply, and so unpredictable, that it determines the pattern of life. Not just across the landscape, or through the cycle of a year, but across a decade, a century or a millennium. Deserts are difficult places for people because of their dryness, their unpredictable ecology, and also because they are patchy environments — where food, water, and plants are often concentrated in small pockets.

True deserts are ecosystems with sparse or no vegetation due to low, infrequent and largely unpredictable rainfall and often high evaporation. Many deserts have high average temperatures during the day and cool nights due to no, or little, cloud.

## Deserts are areas with low rainfall

The common thread to all deserts is dryness or aridity. This dryness is often a combination of low rainfall and high water loss from evaporation, surface run-off and seepage deep into the soil.

Areas receiving an average rainfall of less than 100mm a year are considered true deserts. Areas that receive an average rainfall of 250mm or less are termed arid, and if an area receives between 250 and 350mm it is described as semiarid. Places with up to 500mm of rain a year may have arid-like conditions if the temperature and evaporation rates are high.

## Different types of deserts

Deserts come in all shapes and sizes and there are lots of different ways of looking at them. One way is to look at where they are located and their climate. Another way is to look at the ground cover and main types of plants.

We usually think of deserts as being hot but this is not always the case. There are also cold, coastal and semiarid deserts.

**Hot deserts** are often located near the equator. Day temperatures can reach more than 38°C but the nights are usually very cold. Deserts generally have no cloud cover. This allows them to heat up and cool down very quickly. The Great Sandy Desert and the Simpson Desert in Australia are hot deserts.

**Cold deserts** are found further from the equator and are usually in the centre of continents. They are often high in mountainous areas. In winter, these deserts can be covered with snow and ice. The Patagonian Desert in Argentina, South



PHOTO: DI KINLOCH

*The iconic dunes of Sossusvlei rise majestically above the claypan Namib Desert. The huge red dunes dwarf everything in sight.*

The dry Namib Desert, along the south-western African coast



PHOTO: KAREL TOMEL

America is a cold desert. Antarctica is also an extreme example of a cold desert.

**Coastal deserts** are found on the west coast of continents. They have warm summers and cool winters and are often called cool deserts. Examples of coastal deserts are the Namib Desert in south-western Africa and the Atacama Desert in South America.

**Semi-arid deserts** receive between 250mm and 350mm of rain. The summers are long and dry with moderate temperatures between 20°C and 30°C. Any rain usually falls in the winter months. Over one-third of Australia is semi-arid desert.

## Why are deserts dry?

To understand why deserts are dry you need to consider the water cycle.

On earth, water follows a path called the water cycle. The sun's energy heats water making it evaporate from the land and sea. As the water vapour rises it cools and forms clouds. Wind may blow the clouds over land and as the clouds are blown upward over hills and mountains the water droplets cool and fall as rain.

The rain flows through the soil and rivers and the water is carried back to the sea, where the water cycle starts over again.

In hot deserts, the high temperatures cause any moisture to evaporate very quickly.

### Inland deserts far from the sea

Most rain falls near the coast. Deserts can form in the middle of large continents where they are sheltered from the winds that bring rain clouds, either by distance from the ocean or by mountains.

As clouds blown in from the ocean rise over a mountain, rain falls. The air that is left is dry and as it moves further inland it has no rain to release. This is the reason the centre of the Kalahari and Australian deserts are dry.

### Coastal deserts by the sea

Water does not evaporate from a cold ocean as quickly as it does when the water is warm. Air blown onto the coast from a cold ocean contains no moisture to fall as rain.

During the day, water evaporates from the land further helping to make a desert. At night the land cools and some of the moisture in the air above the land condenses to form fog.

Cold ocean currents flow up the west coast of Africa (Benguela current) and South America (Humboldt current) from Antarctica. This cold water breaks the water cycle creating the Atacama and Namib deserts.

## Are all deserts sandy?

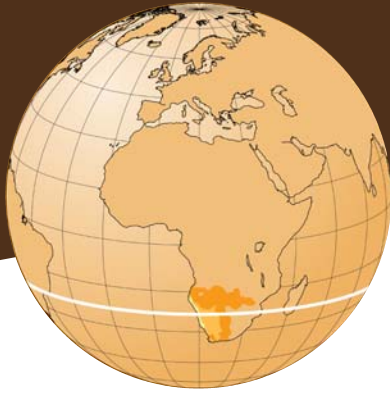
Not all deserts are shifting sands or barren rock. Some, like the Australian desert, are a sea of spinifex and acacia shrubs.

About 20 per cent of the earth's deserts are sandy, made up of dunes and large areas of sandplains. In other places the sand has been blown away, resulting in stony deserts covered by pebbles and gravel.

Some deserts such as those which hug sections of the Orange River, in the Kalahari Desert, are made up of large exposed rocks. The rocky desert forms as the desert is eroded by wind, and water that can fall very briefly but very rapidly.

## Living in the desert

People have lived in deserts for many thousands of years. Some groups, known as nomads, keep moving to find food and water. Some live off their herds of animals. Others hunt and gather. Today, very few people still live like this.



## Great deserts of the Southern Hemisphere

The great deserts of the Southern Hemisphere form a band along the Tropic of Capricorn at 23 degrees South.

### Atacama Desert in South America

The Atacama in Chile is a narrow desert bordered by the sea on one side and the Andes mountains and a high plateau called the *altiplano* on the other.

The Atacama is the driest place on earth. 'Imagine a vast undulating plain', wrote one Scottish traveler in 1851, 'whereon no trace of life is seen, where no insect shows itself, where no plant grows' and where 'the mummies of mules, of horses, and of human beings, are seen dried and decomposed — and you may have a faint picture of the Atacama'.<sup>A</sup>

In parts of the Atacama rain does not fall for many years and life is sustained by fog.

### Namib and Kalahari Deserts of southern Africa

Much of southern Africa is made up of two great deserts. On the south-western coast, the Namib forms a barren strip

of sand, with dunes up to 300 metres high, and bare gravel plains. Inland, the Kalahari is an immense tract of deep sands and acacia savanna. These are different deserts, with different possibilities for people, but with shared histories.

The Namib Desert is a narrow desert in which floodwaters from nearby highlands rejuvenate its dry rivers. Dry channels often have wells and springs tapping underground water.

In contrast, the Kalahari is immense and, as AV Hodson, a Bechuanaland Protectorate policeman said in 1912, it is 'not quite an ordinary desert. [In] some parts it is covered with thick bush. Its good rains are quickly lost in the deep sands, making the Kalahari the most difficult of the southern deserts for people. The local Tswana people call it *kgalagadi*, literally "great thirst".'<sup>A</sup>

### Australian deserts

Almost half of Australia is arid country, often referred to as the outback. There are many different regions within the arid zone of Australia each with its own characteristics. Sand dunes dominate the Simpson, Tanami, Great Victorian and Great Sandy deserts. The Nullarbor Plain and Barkly Tablelands are flat and smooth while the Gibson Desert and Sturts Stony Desert contain low rocky hills.

A large part of Australia's arid region, known as the rangelands, are grazed by cattle.



Flood plains of the Namib Desert after rain



Red sand dunes of Central Australia

A: Mike Smith curator from *Extremes: Survival in the Great Deserts of the Southern Hemisphere* exhibition, National Museum of Australia, Canberra (2005)



## Activities

- Brainstorm with students what they know about deserts. Ask students to draw what they believe is a desert or write down words and emotions that describe a desert.
- Ask if any student has lived in a desert environment — do people live in deserts?
- Using an atlas or globe ask students to locate desert regions of the world. Where are these deserts located? Are these deserts hot, cold or coastal deserts?
- Using an atlas or map locate the desert regions within Australia. What are the main features of these desert regions — does the name give you a clue? What towns and rivers are found in or near these desert regions? Contact the Bureau of Meteorology, search the internet and library to collect weather data (rainfall, temperature) for towns found in and near desert regions.
- Discuss with students the terms biome, ecosystem and habitat. Identify with students the biome that their school is part of.
  - Environment — is your surroundings and can extend from the classroom out to the furthest star in the known universe. You are inside (part of) the environment and not viewing it like a picture on the wall.
  - Biome — a large natural area with its particular climate, physical conditions, plants and animals. Earth can be divided into several major biomes; including deserts, tropical rainforests, temperate forests, grasslands, Antarctica region and marine (ocean) biome.
  - Ecosystem — is a community of living organisms together with their non-living surrounds (air, soil, water, light).
  - Habitat — is where an organism is found or its home (address).

## Activity: The water cycle

### You will need

- A small aquarium or clear plastic container
- Potting soil
- Seeds of easy-to-germinate plant (radish, pea, wheat or marigold)

### What to do

- Place potting soil into the bottom of the clear container/aquarium. Plant a couple of seeds in the soil and water the soil.
- Cover the container with a tight fitting lid or plastic wrap. Place in a sunny position.
- Observe what happens to the water in this closed container. Have students observe the different parts of the water cycle.
- Have students observe the 'container' for a few weeks. Ask students to record their observations in a journal.

### Extension activities

- Demonstrate **evaporation** by boiling water in a kettle and have students observe what happens (the steam rising is evaporation). Alternatively, measure a small volume of water into two shallow dishes, leave one dish in a sunny spot and the other in a shady spot. Observe the water for a couple of days. What happens? Evaporation is when water heats up and turns into vapour or steam.
- Demonstrate **condensation** by holding a bowl of ice over boiling water. What happens on the outside of the cold bowl? (water vapour cools and condenses into liquid) Condensation is when water vapour in the air cools and turns back into liquid.
- Demonstrate **precipitation** by leaving the bowl of ice near boiling water for a length of time. What happens? Precipitation occurs when so much water condenses that the air cannot hold it anymore. Precipitation falls from the clouds as rain, hail or snow.

Have students write a short story or poem about a drop of water as it travels through the stages of the water cycle. Ensure students mention the terms 'precipitation', 'evaporation' and 'condensation'. Begin the story with: 'In a cloud high above the ocean lived a rain drop named (...). The wind started to blow the cloud towards the land...'

# Animal adaptations to life in the desert

Desert animals face many problems, from getting enough water to function effectively, to preventing dehydration, coping with the heat of the day, the cold nights and finding sufficient food, while trying to survive.

Despite the problems of desert life, many animals thrive in the desert as they have evolved a wide array of adaptations that allow them to cope with the heat and lack of water.

Most desert animals use one of three basic methods — expiring, evading or enduring — to thrive in the desert.

## Expiring — allowing a species to survive

Rain is unpredictable in deserts. Many desert animals expire (die) during long periods of drought. However before death some animals leave a legacy. These animals complete their life cycle in very short periods of very good conditions. They produce thousands of eggs which are capable of surviving years of dryness and scorching heat. These eggs hatch when heavy rains fall, and their life cycle starts over again.

Shield shrimps (*Triops*) are tiny fast-growing crustaceans found throughout the Australian desert regions.

In puddles and lakes formed on claypans after heavy rain, Shield shrimps grow almost before your eyes. Tough, resistant eggs produced by shrimps the last time it rained have been blowing about the desert and when it rains they begin to hatch in puddles and lakes.

Within a week the shrimps grow to a length of about 1.5cm. As the shrimps are maturing, the water in the puddle, pools and lakes is rapidly evaporating such that the shrimps' life is a race against time. By the twelfth day, when they are about 3cm long, hundreds of tiny eggs form on the underbodies of the females. Usually by this time, all that remains of the pool or lake is a large, muddy patch of wet soil.

During the final hours of their brief lives, the shrimps lay their eggs in the mud. As the last of the vanishing water becomes ever-thickening mud, they die in large numbers.

The eggs can remain dormant (resting) for many years waiting for the next rain to fall.

## Evading the bad times

A second strategy used by desert animals is to leave when conditions deteriorate. Many bird species living in desert regions migrate to avoid the harsh conditions, returning only in good seasons. They often breed only after significant rain has fallen and when there is enough food for their young.

In the Australian deserts, budgerigars (*Melopsittacus undulates*) travel hundreds, even thousands, of kilometres when conditions become too dry. In good seasons they can be seen in their thousands while at other times they are entirely absent.

Unfortunately, sometimes these drought-evaders are caught, unable to flee soon enough, and die in their thousands. During a dry period in 1930 over five tonnes of dead budgerigars were found at one waterhole in central Australia.

CSIRO scientists in the 1970s discovered that desert birds have many other strategies that help them tolerate the harshness of the desert environment. Often they can change their behaviour to reduce the effect of the heat and evaporation. Such behaviours include not hunting for prey during the hottest part of the day, flying to water during the cool of the morning or afternoon, avoiding fighting other birds and maintaining long-lasting bonds between pairs that avoid the necessity for active, elaborate display before breeding. These behaviours help birds to keep cool and conserve water.

## My desert – my home: enduring the heat and dryness

Many animals live permanently in the desert regions of the world. They endure the desert climate through a range of behavioural, physiological (body function) and structural adaptations.

### Getting water from the food you eat

The spinifex hopping mouse (*Notomys alexis*) lives throughout the central and western Australian arid zones, occupying mainly spinifex-covered land. They obtain water by eating succulent green plants but can survive extremely dry periods by living off dried spinifex or grass seeds.

How do they do it? The trick is that when they break down these seeds to make energy, water is produced. They use this water to stay alive. They also reduce water loss from their body in a number of ways:

- being most active during the cool of the night and avoiding the intense heat of the day by living in deep burrows one metre below the ground where the sand is cool and slightly moist
- excreting almost completely dry faeces and concentrated urine
- having almost no sweat glands on their bodies, except for a few on their toes.

The carnivorous striped faced dunnart (*Smithopsis macroura*) gets the water it needs from eating insects and spiders that it captures during nightly hunts.

### Nocturnal existence

Many desert animals avoid the heat of the day by living deep underground in burrows where it is much cooler or sheltering

in vegetation such as spinifex. At night the desert comes alive when the nocturnal animals emerge to search for food. These animals hop, slide, wriggle and move around leaving their tracks in the desert sand. During the day the tracks left during their night-time adventure are often the only visible sign of their existence in the desert.

### Fog harvesting beetles of the Namib Desert

*Stenocara* beetles live in the cool coastal sand dunes of the Namib Desert. They depend on fog blown in from the misty ocean to provide life-giving water.

*Stenocara* live among the sand dunes waiting for the arrival of mist and fog. When fog is blown in from the ocean they travel to the top of a sand dune where they turn their body into the wind, straighten out their rear legs and lower their head. The fog collects on their back, forming droplets of water which roll downwards into its mouth. The beetles drink and survive.

The *Lepidochora* beetles also depends on the fog of the Namib Desert for water and survival. These beetles live in the coastal sand dunes where each morning they build furrows in the crest of sand dunes. These furrows run perpendicular to the flow of the fog winds.

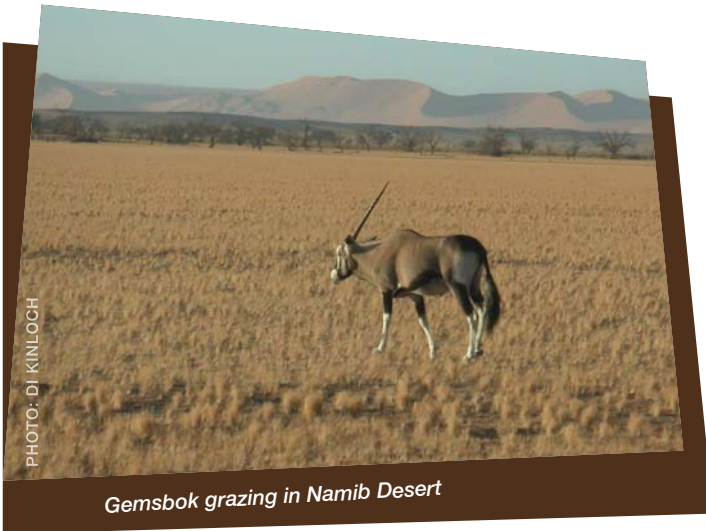
The tiny raised sand ridges made by these beetles are built to intercept the incoming fog. The beetles creep along these moisture laden ridges sucking up the collected water.

Like the *Stenocara* and *Lepidochora* beetles, humans in the Namib and Atacama deserts depend on structures built to collect water from fog. This collected water is vital to people existing in these dry environments.

*Giant sociable weaver nest built in a quiver tree, Namib Desert*



PHOTO: SCOTT KEOGH



- conserving (saving) water by producing dry faeces and concentrated urine
- being able to survive an increase in body temperature by up to 12°C, which means the animal does not need to sweat to keep cool and can save water
- losing up to 25 per cent of its body weight when there is no water available and re-hydrating rapidly as soon as it gets water (a severely dehydrated camel may drink up to 150 litres of water in ten minutes)
- storing fat in their humps to survive long periods without food
- long eyelashes which protect the eyes, and nostrils that can be closed during sand storms
- a thick coat of fur and under-wool providing warmth during cold desert nights and helping to insulate against the burning midday sun
- being able to drink salty water without getting sick.

### **Nest sharing birds of the Kalahari and Namib Deserts**

There are not a lot of large trees in most deserts, so what do tree nesting birds do when looking for a place to nest? They share.

Sociable weavers (*Philetairus socius*) live in the Kalahari and Namib deserts of south-western Africa. As their name suggests, these birds live a communal lifestyle by sharing giant apartment style nests. Up to 400 birds may share a single nest, each with its own 'apartment'. New birds return each year, adding to these giant nests.

### **Gemsbok – keeping a cool brain without sweating**

If large mammals controlled body temperature by sweating they would lose more water than they could drink. Gemsboks (*Oryx gazella*) and other animals such as camels solve this problem in a special way. They stop sweating and let their body temperature rise to 45°C — a temperature that would kill most animals.

Gemsboks survive because they have a blood-cooling circulation network in their nose that keeps their brain cool.

### **The ship of the desert**

The camel is an icon in the desert and known as the 'ship of the desert'. Much of the success of human desert exploration is a result of the camel's ability to survive the hot and dry desert environment.

Camels were introduced into Australia in the 1800s to support human exploration into central Australia. Today, camels run feral in parts of central Australia.

The camel has a range of adaptation techniques to survive the hot dry days and cool desert nights. These include:

## **Activities**

- Discuss with students 'what is an adaptation?' (Adaptation is a characteristic that helps an animal (or plant) survive in its environment). Ask students how they would spend a day in a hot desert (most will answer — seek shelter, which is a type of behavioural adaptation). Have students design an animal adapted to life in the desert.
- Look at other biomes (rainforest, grassland, ocean, Antarctica) and adaptations animals have that allow them to live in these environments.
- To demonstrate evaporation, dip paper towel into water and wring off the excess. Wipe the paper towel across the blackboard and observe what happens. Ask students, 'what has happened to the water?' (It evaporated into the air.)
- Have students dampen paper towel, wring out excess water and roll into a ball. On a footpath or playground where there is both sun and shade, ask students to place one ball of paper towel on the sunny side and another on the shady side. Ask students to observe which one dries up more quickly? Why? Which side of the footpath is warmer? Ask, 'If you were an animal living in the desert what might you do to keep cool and not to lose water?'
- Humans sweat when they get too hot and need to cool down. Ask students to dip one arm in a bucket of water and leave the other arm dry. Have them wave both arms around in the air. Which arm is cooler? Why? (Evaporation of water from the wet arm makes it feel cool). Ask students if they think many desert animals would sweat? (No) Why? (Because they would lose water and there is very little water to drink to replace the water.)

# Activity: Conserving water in the desert

## Background

Animals living in dry environments need to conserve water. Water is important for their survival and animals have adaptations — body parts or actions — that help them prevent water loss. In this activity students devise ways of preventing water loss from an animal.

## You will need

- Small sponges and plastic plates
- Balance or scale
- Water

## What to do

- Provide each student or small group with a saturated sponge on a plate. Ask students to record the weight of the sponge and plate.
- Ask students to think about what may cause the sponge to lose water and what can be done to stop the sponge losing water (conserving water). Have students manage their sponge for 24 hours as if the sponge was an animal not wanting to lose water. Their animal (sponge) must remain in the open for at least four hours to feed.
- Have students plan their strategy to conserve water and write down what they think will happen. Students should make observations during the 24-hour period of the experiment.
- At the end of 24 hours ask students to weigh the sponge and plate. Compare this weight with the original weight and comment about the results in relation to real animals.
- A control sponge and plate should be left in the open to compare the students' results with.
- Conduct a class discussion of methods, results and how it relates to adaptations for desert survival in real animals and plants.

## Possible discussion points

- Which animal (sponge) lost the most/least water over the 24 hours? Why?
- What are some ways that animals lose water (sweating, panting, faeces and urine)?
- Why do we sweat and how does sweating cool us?
- What are some ways animals conserve water?

# Plant adaptations to life in the desert

Despite the perception that deserts are places devoid of plant life, some deserts are permanently covered with vegetation – even in the driest of seasons. The main challenge for desert plants is to avoid water loss in a dry, often windy environment. Desert plants have evolved ways of conserving and efficiently using the water available to them. These adaptations allow plants to either have a short but productive life (ephemerals) or endure a longer life over many years.

## Ephemerals – a short but productive life

Ephemerals are short-lived plants appearing when there is abundant moisture following good rains. They respond rapidly to rain – germinating, growing, flowering and setting seed all within a very short period of time while the desert soil remains moist.

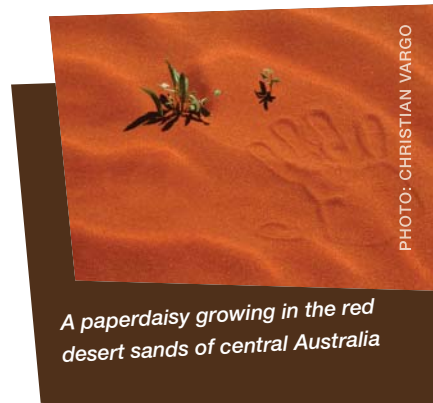
Ephemeral plants are famous for transforming the barren desert landscapes into awesome displays of colour. In the Australian deserts most notable are members of the daisy family, especially paperdaisies. After sufficient rains in the semiarid zones of Western Australia, thousands of paperdaisies carpet the landscape. As drought returns, these plants wilt and disintegrate, scattering their seeds far and wide in immense numbers.

South Australia's floral emblem – the bright red Sturt's desert pea (*Swainsona formosus*) – is another ephemeral that takes advantage of infrequent rains. Easily recognised in the Australian desert, Sturt's desert pea produces many distinctive red flowers that set seed in a very short time.

The seeds of desert flowers spread very easily. Some have miniature parachutes and use the wind to spread. Others use animals to move the seed across the desert. Some even have explosive capsules to spread the seed.

They are able to survive the dryness of the desert in lots of clever ways. Built into each seed are sensors that respond to levels of water, temperature and light. Germination is only triggered when enough rains have fallen; they will not germinate when passing showers merely wet the ground for a short period.

Many ephemeral plants have seeds that need a long period of rest (dormancy) so that the seeds will germinate only when conditions are suitable. This protects against unpredictable environmental factors. Some desert plant seeds have an extremely hard outer coating that needs scratching or fire to prepare them for germination. Others sprout only after exposure to the freezing temperatures of the desert winter.



A paperdaisy growing in the red desert sands of central Australia

PHOTO: CHRISTIAN VARGO



*Sturt's desert pea, floral emblem of South Australia*

## The endurers – living through the dry times

Many desert plants have adaptations that allow them to cope with low and infrequent rainfall. Desert endurers must get as much water as possible from the soil and at the same time reduce the evaporation of water from their leaves. Leaves have small openings called stomata, which allow water and gases to move in and out of the leaves. Desert plants must minimise water loss through these leaf stomata.

### Enduring by resting during the dry times

Some desert plants survive by remaining inactive (dormant) during dry periods, then springing to life when water becomes available.

Following rain these plants quickly grow new leaves to photosynthesise food. Flowers bloom within a few weeks and, when seeds become ripe and fall, these plants lose their leaves and re-enter dormancy.

Another example of plants that rest to avoid dry times are bulbs. The tops of bulbs dry out completely, leaving no trace of their existence above ground when they are resting during the dry times. They are able to survive the dry times without actively making food by storing enough nourishment in their bulbs during the good times.

Some species of acacia survive in the Australian outback by hibernating during very dry periods. These acacia shed their leaves and becoming totally inactive, until they are awakened by the next heavy rainfall.

### Long roots to tap into underground water

Phreatophytes are plants that have adapted to desert environments by growing extremely long roots, allowing them to acquire moisture stored deep in the soil.

Welwitschia (*Welwitschia mirabilis*) is a bizarre plant that grows on the barren sand dunes of the Namib Desert. It has only two leaves that can grow to a metre wide and to almost ten metres in length. Its leaves have large pores enabling it to absorb water directly from night-time fogs blowing into the Namib Desert. It also has a long taproot that not only reaches deep underground for water, but is also capable of storing water. Scientists suggest Welwitschia can live for more than 1000 years.

The Inara melon (*Acanthosicyos horrida*) grows in coastal parts of the Namib Desert, where fossil evidence suggests it existed 40 million years ago. Like Welwitschia, this plant has a long taproot which grows deep into the desert sand in search of water deep below the soil surface. It is dependent on this source of underground water for survival which is why it is often found near dry river beds.

### Enduring by changing to suit the environment

Xerophytes are plants that have adapted to the desert environment by changing their physical structure. This usually involves having special ways of storing and saving water, such as reducing the number and size of leaves.

The Australian mulga (*Acacia aneura*) is one of the most common wattles in the Australian deserts. It has a resourceful way to utilise every drop of rainfall – an arrangement of leaves and branches that channel water to the stem and onto the



*Spinifex plain near Paraburdoo, Western Australia*

ground where the roots are able to access it. The Australian mulga also has a deep taproot with small seedlings often having a taproot reaching up to three metres into the desert soil.

The horse mulga (*Acacia ramulosa*) is another that uses its leaves and branches to direct water towards its trunk. After trickling down the trunk, the water is directed to a dense growth of roots at the base of the shrub that suck up the water before it drains away into the desert soil. The trunk base is shaded by leaves to reduce evaporation. Scientists have shown that a five-metre shrub can collect 100 litres of water from a 12 millimetre rainshower.

Spinifex (*Triodia* sp.) is a tussock grass common across much of the arid region of Australia. The silvery surface of the leaves reflects sunlight, reducing water loss from leaves, and its clumping growth creates a cool micro-environment which reduces evaporation from the soil. The cool micro-environment of the spinifex is home to many desert animals.

Few animals eat spinifex because of its tough, spiky leaves. Even early explorers of central Australia complained of being spiked by the bayonet-like blades of spinifex.

Succulents are plants with fleshy leaves or stems that are able to store water. Worldwide, the cactus is the most famous desert succulent, but in the Australian outback the boab tree and saltbush are well known.

The boab tree (*Adansonia gregorii*) stores water in its trunk, giving it a distinctive bottle shape. In periods of extreme dryness it is able to lose its leaves to further help conserve water.

Saltbush (*Atriplex* sp.) is the main shrubby species in arid Australia. Saltbush is covered with small succulent leaves that store water. It also has the ability to tolerate high levels of salt by secreting salt onto the leaf surface. This allows it to grow in salty soil conditions that would kill most other plants. Saltbush has wide spreading roots that can soak up soil moisture over a large area.

Unlike other deserts, American deserts are dominated by cactuses. The Cardón cactus (*Echinopsis atacamensis* ssp. *pasacana*) is the signature plant of the Atacama Desert and is an important source of fruit and timber for local people.

Cactuses are among the most drought-resistant plants due to:

- the reduction of leaves to spines which reduces water loss from leaves
- shallow root systems on most cactuses which spread far to capture water; in others a deep swollen taproot which stores water



*Cardón cactus, the signature plant of the Atacama Desert*

PHOTO: JAIME PLAZA VAN ROON

- a thick waxy cuticle, sometimes with a matted surface of hairs to retain water and protect plant tissues
- a succulent habit where water is stored in swollen stems
- extensive ribs on many cactuses to help channel water to the roots
- the ability of some cactuses to absorb water from mist and fog.

Many other trees and shrubs have adapted to survival in the desert by replacing leaves with thorns or spines or greatly reducing leaf size to eliminate transpiration (water loss from the leaves).

Two of the most amazing desert plants are the *Lithops* spp. or living stones (*Lithops* sp.) found in the deserts of southern Africa and *Tillandsia* (*Tillandsia* spp.) growing in the Atacama Desert. *Tillandsia* are well adapted to the foggy Atacama Desert as they are able to take water through special cells in their leaves and can exist without any roots. They are often attached to trees where they live an epiphyte existence (live on another plant but do not receive any nutrient from that plant — non-parasitic).

*Lithops* look like stones in which the body of the plant is a pair of leaves able to store water. These rounded leaves look like stones or pebbles, which is a great camouflage from grazing animals.



## Activities

- Discuss with students ‘what is an adaptation’ and how seeds are dispersed. (Dispersed by wind and water, stuck to fur of animals, eaten by animals, shot into air from plant) Using an oval or kidney shaped drawing as a template to represent a seed, ask students to draw adaptations on the seed to help it fly in the wind, float on water, stick to an animal and be eaten by birds.
- Using a big pair of woolly socks that fit over shoes, have students go for a walk around the school grounds or nearby park. Ask students to walk through different areas. Back in the classroom examine the socks with a magnifying glass and use tweezers to remove the seeds. Try planting the seeds and see what grows. This activity works best in summer or autumn.
- Using a pot plant or tree have students tie a clear plastic bag around one leaf and leave in a cool sunny position for a few hours. Observe what happens. (Water droplets appear in the bag as a result of plant transpiration.)
- Ask students to devise an experiment to test how much water a seed needs to germinate. Test the experiment with a range of seeds from both desert (paperdaisies, acacia) and non-desert plants (wheat, mustard, radish). Hard, coated seeds such as acacia will need scarifying with sandpaper. Suggestion — plant seed onto cotton wool on three saucers; add no water to one saucer, ten drops initially then one drop of water per day on second saucer, and ten drops initially then five drops of water per day on third saucer.

## Activity: Will curly leaves conserve water?

### Background

Some plants curl up their leaves in dry weather. Is this an adaptation to conserve water?

### You will need

- water absorbent cloth
- scissors
- tray
- jug of water and warm, sunny spot.

### What to do

- Cut two identical sized pieces of cloth. To make it interesting the cloth should be cut into a leaf shape.
- Dip one piece of cloth (leaf) into a jug of water and hold it over the jug until it stops dripping.
- Spread the cloth out on the tray.
- Dip the second piece of cloth into a jug of water and hold over the jug until it stops dripping.
- Roll up the second piece of cloth and place on the tray.
- Place the tray in a warm place (sunny window) for an hour. Check the dampness of each piece of cloth (leaf).

### Possible discussion points

- Which piece of cloth is damper? Why do you think this is?
- Name examples of plants which curl their leaves to conserve water (grasses)?

# Dr Desert

Scientists researching the great deserts of the Southern Hemisphere

Scientists are curious people. Many are intrigued by the diversity of plants and animals that have adapted to the hot and dry desert conditions. Others research ways to assist people to live a sustainable life in the harsh desert environment. Early scientific expeditions into the Australian outback were viewed with scepticism by the general public. Many people thought these scientific expeditions were going out in search of gold. They could not understand that a group of scientific men would go into the desert for any other reason. Today many scientists devote their careers to researching in and about the desert.

## Living in outback Australia

Deserts in the form of semiarid and arid lands cover over two-thirds of Australia. These vast areas are valued for their unspoiled, remote and unique environments. They are also prized for the products they contain, and the remarkable range of cultures they support.

Scientists from two significant Australian research organisations — CSIRO Centre for Arid Zone Research (CAZR) and the Desert Knowledge Cooperative Research Centre — are researching the management, sustainability and conservation of the arid environment.

In order to contribute to the long-term future of this region, scientists are researching ways to protect the native plants and animals that live in this region while maintaining a sustainable grazing industry, tourism and Aboriginal lands.

Australia needs people living securely in the outback to service major tourism and mining industries and to manage our vast arid areas. Many people want to live in the outback, particularly Australia's Indigenous people. Scientists are researching methods to help them develop sustainable livelihoods.

One such scientist is Margaret Friedel, located in Alice Springs in the Northern Territory. Margaret is researching the management of grazing lands in the arid zone. She is looking at how to involve local communities in land use planning that will obtain a better outcome for everyone. Margaret is also exploring how satellite imagery can contribute to understanding the impact of land use in the Indian Desert.

## Shifting sands and shifty lizards of the Kalahari Desert

On rocky outcrops in southern Africa, both within and east and west of the Kalahari Desert, live African flat lizards belonging to the genus *Platysaurus*. There are a number of species of these lizards, all of which are endemic (only found) in southern Africa.



Brightly coloured male flat lizard, Kalahari Desert

These lizards are known as flat lizards because they are flattened lizards that retreat to narrow rock crevices. The males are spectacularly coloured and ‘show-off’ their bright colours to attract the plainly coloured females.

Male lizards are very territorial and display a ‘war and peace’ style existence. One species lives on the rocky outcrops beside the Orange River, which cuts through the Kalahari Desert. They spend the day on a small patch beside the river feeding on midges, fighting with other males and trying to attract female partners. At sunset both females and ‘warring’ males retreat to narrow rock crevices to spend a ‘peaceful’ night together, safe from predators. In the morning they return to their territory beside the river, feeding, fighting and attracting partners.

Canberra scientist Scott Keogh and colleagues in South Africa have been researching these lizards — not because of their strange behaviour but because they may provide a clue to the history and spread of the Kalahari Desert.

The sands of the Kalahari Desert have been moving slowly eastward and southern Africa has a number of major river systems that could act as barriers to animals moving into new parts of the desert.

Scott and colleagues have been studying populations of flat lizards at different sites within and outside the Kalahari Desert. They have been studying the genetic relationship between populations and species. They hope to determine how long ago individual species of flat lizards evolved. They are also examining whether the eastward movement of the Kalahari Desert could have contributed to the isolation of the lizards and new species of flat lizards evolving. An understanding of these questions may give further clues to the age and history of the Kalahari Desert.

*Rocky gorges formed by the Orange River, Kalahari Desert — home to the flat lizard*



PHOTO: SCOTT KEOGH



PHOTO: DI KINLOCH

*The gravel plains of the Namib Desert*

## A research station in the middle of nowhere

On the site of a deserted village in the heart of the Namib Desert there is a world-renowned research centre. The Gobabeb Desert Research Station is located on the banks of the rarely-flowing Kuiseb River at Gobabeb — ‘the place of the fig tree’ in the language of the nomadic Hottentots.

This research station opened in 1963. It was the vision of a German scientist Charles Kosh who, in 1948, joined an expedition to the Namib. He studied the desert beetles in the Namib and found there was a huge gap in scientific literature on the diverse desert flora (plants) and fauna (animals).

After many years of travelling throughout the Namib Desert and intensive research, he confirmed the Namib provides an extraordinary place for life. His research raised considerable interest from other scientists, which led to the establishment of the Gobabeb Desert Research Station.

The area surrounding Gobabeb presents ideal research locations with several ecological systems including sand dunes, gravel plains and river beds both within and outside the fog belt. In this area human disturbance is minimal, enabling unimpeded studies of ecosystem interactions and interrelations to be undertaken.

Today a large part of the research is focused on environmental issues of climate change, desertification and biodiversity.

## Spiderman of the Namib Desert

One of the scientists working at the Gobabeb Desert Research Station in the Namib Desert is Joh Henschel. Joh is known as ‘spiderman’ by his peers and the sand dunes near Gobabeb are his laboratory. Among the sand dunes, Joh is able to find dancing white ladies (spiders not humans), formidable hunters

that live in holes in the sand. He also finds wheeling spiders that curl themselves into a ball and roll down the slip-faces of sand dunes to escape spider-hunting wasps intent on using them as living food for their grubs.

At night, with the aid of an ultraviolet light, you can find masses of scorpions lurking under the bark of trees in the river bed. On occasions you can also spot a gecko, transparent under the ultraviolet. The gecko's enormous eyes are designed to collect dew which the little creature drinks with lightning flicks of its tongue across its face.

## Out in space or just out in the Atacama Desert

The Atacama Desert of northern Chile is known for its lack of living things. This may change as the Atacama Desert becomes the training ground for NASA scientists, eager to test automated robots designed to detect life on Mars and other planets. It is the vision of these NASA scientists that if these robots can find life in the harsh Atacama Desert, they might have a chance of finding life on Mars — if it exists.

Two exploration robots are presently undertaking mapping and geological studies of Mars. It is hoped the robot called Zoe — which is Greek for 'life' — presently being tested in the Atacama Desert may be able to detect life on Mars and other planets.

The robot uses a fluorescent imager located beneath the robot, which is capable of detecting the presence of particles that indicate life. Scientists back at NASA evaluate the scientific data transmitted by Zoe, while others direct the search remotely.

## Clouds on tap — fog harvesting

The only moisture that falls on parts of the Atacama and Namib deserts is fog. For many years the remote fishing village of Chungungo in northern Chile relied solely on water brought in on trucks.

In 1987, life for people of Chungungo changed with the installation of a fog-collecting system, which now provides dependable and affordable water.

The technology behind fog collection is simple — erect massive vertical shade nets and as the fog blows in, tiny water droplets are deposited onto the net. As the droplets become larger they run down the net into gutters attached to the bottom.

The fog harvester is a simple innovation that could become more efficient from studies on the *Stenocara* beetle. The *Stenocara* beetle lives in the Namib Desert in south-west Africa. The beetle collects water from fogs blown in from the ocean, by standing at the top of a sand ridge and turning its body into the wind, straightening out its rear legs and lowering its head. The fog collects on its back, forming droplets of water which roll down into its mouth.

Scientists examining the *Stenocara*'s back have found a combination of hydrophilic (water-repelling) ridges and waxy hydrophobic furrows. Scientists hope to mimic the beetle's technique to design more efficient fog harvesting nets and possibly more efficient dehumidifiers and distillation equipment.



## Activities

- Discuss with students how people and animals in the Atacama and Namib deserts depend on fog to obtain water. Have students design and construct a fog harvester from shade cloth, flyscreen mesh and other mesh material. Search 'Google Images' <[www.google.com.au](http://www.google.com.au)> for images of fog harvesters. Have students test the efficiency of each material using a spray bottle containing a predetermined volume of water. Collect and measure the water from each fog harvester.

## Activity: Research and conservation

### Background

A healthy desert requires a wide variety of organisms to sustain the diversity of life. Unfortunately, many Australian native desert plants and animals are under threat from introduced pests and weeds, changed fire regimes, tourism and changed land management. In this activity students are asked to investigate threatened native desert plants and animals and how they may be conserved or protected.

## What to do

- Discuss with students the importance of the diverse range of animals and plants living in the Australian desert. Explain that each student has been given \$5 million to put towards conservation of a desert plant or animal.
- Have students make a list of Australian desert plants or animals that will benefit from this conservation project. List them in order of preference, with the animal or plant with greatest need for conservation at the top of the list. Also include why each animal or plant is included on the 'conservation list' — why is it threatened?
- Ask students to select one threatened native plant or animal and decide how the money will be spent on conserving this species. Will they buy up the desert and turn it into a reserve? Will they ban four-wheel drive vehicles from the desert? Will they collect the remaining animals from the wild and relocate them to a 'safe' location (zoo, reserve, isolated desert area)? Will they invest in research to control the threat? Have students justify how they will spend they money?
- Conduct a class discussion on what species the students have chosen to conserve and how they will spend the money conserving their species.
- Following this discussion, select a plant that was not well-funded but still under threat. Tell the students that following discussions with Indigenous people, scientists have found that this plant contains a compound that prevents people who eat it from gaining weight. This plant could be used to produce a medicine that prevents people overeating — potentially preventing obesity in people. This plant only grows in a desert habitat near a popular tourist destination. Ask if students are willing to take funding from their top-ranked species and put it towards conserving this plant's habitat. If this plant is successfully used to produce an important weight-loss medicine, who should get the royalties — local Aboriginal people who have used the plant for hundreds of years, scientists who researched the plant and identified the important ingredients or the medical companies that manufacture and sell the medicine?

# Learning from the past

## Scientific research in the Australian desert

Central Australia is a desert. By world standards it is not an exceedingly harsh desert and Aboriginal people have inhabited this environment for thousands of years.

Central Australian Aboriginal peoples have an intimate knowledge of the desert environment, which was probably seen by early European explorers but not given due recognition. To many early Europeans, desert Aboriginals were viewed as almost subhuman, struggling for existence in a harsh and forbidding environment.

The boom and bust nature of the Australian desert provides an opportunity for people to move into the desert. The real problem is staying there when the hard times return. What can scientists learn from Aboriginal people about the Australian desert? How has European settlement of the Australian desert altered the flora and fauna? How can Australians utilise the desert in a sustainable way? There is much that can be learned from the past and scientists are using this knowledge to create a sustainable future for the Australian deserts.

### The first major scientific expedition into the Australian outback

In May 1894, a band of men, members of the Horn Scientific Expedition set out on camels from Oodnadatta bound for the MacDonnell Ranges in central Australia. The expedition was organised and led by William Augustus Horn, a wealthy South Australian farmer and miner. The expedition also included five scientists, each given responsibility for a particular area of science — botany, zoology, geology, anthropology and meteorology. This was the first organised scientific expedition into the Australian desert with the aim to investigate the geology, the plants, animals and Indigenous people of central Australia.

At the time of the expedition many people thought they were in search of gold. Why else would 'sane men' venture into the harsh desert environment voluntarily?

Collecting plant and animal specimens as they travelled north to the MacDonnell Ranges was frustrating when riding on the back of a camel.

*'You may often see, say a lizard or an insect which you are anxious to secure, but long before you can persuade your camel to sit down the animal is far away.'*<sup>A</sup>

The expedition members were at first frustrated by the 'monotonous and small series of animals' they collected. After rain however, the desert came alive with insects, birds and lizards.

*'Insects formerly unseen come about in swarms ... caterpillars in thousands creep about, the majority simply falling prey to the lizards and birds which increase with like rapidity.'*<sup>A</sup>

The expedition collected many plant and animal specimens, including more than 170 species new to science. They commented on the faunas' (animals) ability to thrive in arid conditions and their notes on the animals' survival techniques were pioneering studies in desert ecology. Their work was illustrated with magnificent drawings that give a lasting visual record of the animals and plants collected. The expedition's findings are described in a four- volume journal published in 1896.

<sup>A</sup> Walter Baldwin Spencer reported in: Walter Baldwin Spencer (editor). *Report on the work of the Horn Scientific Expedition to Central Australia (1894)*. First published in Melbourne by Melvill, Mullen and Slade and in London by Dalau and Co., 1896.

The Horn Expedition generated an interest in the land and resources of central Australia that continues to today.

## Learning from the past

Horn's Scientific Expedition journeyed through the country of Arrernte and Luritja people. The local Aboriginal people supplied specimens, artefacts and information to the expedition members and were crucial to the expedition's success. Despite the important role local Aboriginals played in the expedition's success, the expedition failed to adequately acknowledge the Aboriginal people as the principal source of much of the reported information. At the time Aboriginal values were either not recognised, or held without significance, by white people. Today Indigenous communities and scientists are working together to better understand and maintain the desert environment.

## Australian desert trees to Africa

Many Australian acacias are fast-growing trees that thrive in arid conditions. Scientists from the CSIRO Australian Tree Seed Centre have been studying the suitability of growing Australian desert plants in arid regions of Africa to provide timber and firewood for local people.

During the 1970s and 1980s Australian acacia trees (mainly *Acacia coleii*) were planted in Niger, central west Africa to ease firewood shortages and create windbreaks against the blasting sand storms that sweep in from the Sahara Desert. These trees were chosen for their fast growth and drought tolerance. The acacia's ability to regrow after its trunk is cut allows it to be used as an ongoing supply of firewood.

## Learning and sharing Indigenous knowledge through bush tucker

The seeds of many Australian desert acacias can be ground into edible flour. To pre-European Australian Aboriginal people acacia flour was an important food source.

The Hausa people of central west Africa have been growing drought-tolerant Australian acacia trees for many years to provide firewood and timber. These same acacias also provide an edible seed that can be stored for a long period. With the support of Aboriginal knowledge and CSIRO scientists the Hausa people have learnt to use the Australian acacia seeds to famine-proof their land.

Scientists only discovered this knowledge by learning from Australia's own Indigenous desert communities; communities

that have survived in the desert for thousands of years. Without the help of Australian Indigenous communities the same knowledge may never have been uncovered.

Aboriginal women from Australia's Tanami Desert have travelled to Niger to share their knowledge directly with the Hausa people. The opportunity for the African villagers to see Australian Aboriginals as dark-skinned as the Hausas and learn how to prepare the flour highlights the significance of this being a main traditional food of Australian Aboriginals.

## A healthier future from desert plants

Scientists are also working with Indigenous communities to explore desert plants for possible new medicines that may be used to treat conditions such as heart disease, diabetes and cancer; and help transfer traditional knowledge to future generations of Indigenous people.

This project is being led by senior Indigenous women who are using it to teach their children about their desert plant heritage. There is also great potential to incorporate health-giving desert plants or seeds into the Australian diet to protect against chronic diseases of modern society.

In the Kalahari Desert of southern Africa, a 'cactus' eaten by the San Bushmen for thousands of years to ward off hunger and thirst may help alleviate obesity in developed countries. South African scientists have discovered the cactus contains a previously unknown molecule which may form the basis of an organic pill that suppresses appetite and attacks obesity.

## Biograzing — farming and wildlife co-existing in arid Australia

Much of arid Australia is dry pastoral land and home to many native animals and plants. There are plants and animals that change in abundance under different grazing pressures — some plants decrease in numbers with increased levels of grazing (decreasers), while others are increasers. Some decreasers are so sensitive that they occur only where there is little or no grazing pressure.

As cattle, native and feral grazing animals all need to drink water frequently during hot conditions they do not wander far from water holes. As a result, areas that are not grazed are usually a very long way from water points. As the number of artificial water points in pastoral areas (water troughs connected to bores tapped into the Great Artesian Basin) are increasing, the grazing is spread more evenly and there may be a severe decline in the number of species that are very sensitive to grazing.



Scientists conducting fire experiments, Northern Territory

To enhance the survival of decreaser species, CSIRO scientists are working with pastoralists on a regional scale to integrate conservation with property planning and identification of new water point locations. The Biogroze project aims to manage the interactions between grazing and biodiversity in the dry pastoral rangelands of arid Australia.

## Desert fire

Fires are a part of the Australian outback. Today there are fewer small fires but the fires that do burn are of greater intensity which may threaten native plants and animals.

Scientists are researching different fire regimes in desert regions across Australia so they can be better managed to conserve plants and animals, protect Indigenous traditions and desert communities, and enhance existing and new industries.

## The future of tourism

Some responses to deserts are technological, in an attempt to overcome the limitations of these extreme environments. New four-wheel drive vehicles with long-range fuel tanks, satellite

Crossing a flooded water course in the Kalahari Desert



phones, and all-terrain tyres make travel easier, for visitors and locals alike. Better roads and telecommunications make remote communities seem less isolated.

In central Australia, tourism plays a major role in regional development and investment. The challenge is to develop a sustainable tourism industry. CSIRO scientists are working with the local tourism industry, regional planners and pastoralists to develop a holistic approach to tourism, land management and natural resource conservation so as to ensure a sustainable future and long-term benefit to everyone living in and visiting the arid regions.



## Activities

- Ask students to research foods that are native to Australia. A good place to start is the Australian Native Foods website <[www.clw.csiro.au/nativefoods/](http://www.clw.csiro.au/nativefoods/)>.
- Collect acacia seeds and grind into flour. Buy acacia flour from a health food shop and bake an 'acacia cake'.
- Have a class discussion about students' favourite holiday spots and any problems the influx of tourists may bring to the areas (pollution, increased demand for water and food, damage to the environment).
- Visit the Tales of the Todd website <<http://www.cazr.csiro.au/education.htm>> on the CSIRO Centre for Arid Zone Research website. It contains activities and information on the Todd River and freshwater in an arid environment.
- Research early Australian explorers, such as Ludwig Leichhardt, and Burke and Wills. Using an atlas, postcode directory and street directories identify parts of the Australian landscape which have names of early Australian explorers — for example Ludwig **Leichhardt**; suburb of Sydney and Brisbane, a small town near Bendigo in Victoria, Mount Leichhardt (near Alice Springs), Leichhardt Highway and several Leichhardt creeks, rivers and property names.

## Activity: What bird sound is that?

### Background

Birds and other animals make distinct calls or sounds. To help scientists study where animals live they use tape recorders to record their calls and sounds. From these sound recordings scientists are able to identify if certain birds and animals are present in different parts of the ecosystem.

### **You will need**

- 8–10 small empty glass bottles of the same size — fruit juice bottles are ideal
- water
- sheets of paper.

### **What to do**

- Arrange the bottles in pairs and fill each pair of bottles with water to the same level. Each pair of bottles represents one species of birds. Make sure the water level is different for each pair of bottles.
- Cover the bottles with paper so the water levels are not visible.
- Ask the students to blow over the top of the bottle to make different bird calls.
- Mix the bottles up and have the students try to find the pairs. By doing this they are matching each bird to its own species.

### **Alternative activity**

Film canisters or other suitable containers may be used instead of glass jars. Part fill the canisters with different objects that will make different sounds when you shake them. Suitable objects are sugar, marbles, water and seeds.

Ask the students to shake the canisters and see if they can match the sounds.

# The diversity of life in the great deserts and threats to this diversity

Although deserts may appear to have few living things, they are actually very rich in plants and animals. Australian deserts have the largest number of lizard species anywhere on earth. The arid Atacama Desert contains mountain-foot oases, springs and marshes and *puna* grasslands which add to the biodiversity of this harsh desert, while the hostile sand dunes and gravel plains of the Namib Desert are home to a myriad of creatures which use remarkable survival techniques to defy a land of extremes.

## What is biodiversity?

There is much biodiversity, or biological diversity, in the great deserts of the Southern Hemisphere. Biodiversity is more than the variety of life forms — plants, animals, micro-organisms and fungi. It also includes the difference between individuals within one species (genetic diversity) and differences between organisms living in different ecosystems.

An ecosystem is a community of organisms living together and using non-living things such as air and water. Within each of the great deserts there are a range of ecosystems, such as sandy deserts, gravel and grass plains, rocky outcrops and shrubby deserts.

## Australian deserts

Australia has over 7 per cent of the world's estimated 13.6 million species that live on earth, making it very rich in biodiversity. Many of these plants and animals are highly unique. They are not found anywhere else in the world. Australia is made up of a wide range of ecosystems: coastal regions, grasslands, arid desert, tropical rainforests and alpine regions.

Arid land makes up over 70 per cent of Australia and contains many of the different types of animals and plants. Within the arid zone there is great variation in climate and soils which provide home to a diverse range of plants and animals. This biodiversity is important to the health and function of the arid landscapes.

### Life in a sand dune

The diversity of the Australian desert is best illustrated by looking at one ecosystem, the sandy desert, and one habitat (home) — a sand dune. A sand dune may be home to up to 40 species of lizards, as well as insects, small mammals, spiders and scorpions.

One well-known lizard inhabiting the sand dunes is the thorny devil. They can change colour depending on the temperature and use their spines to trap any moisture and direct it into their mouth. The keeled slider is a kind of skink

*Bearded dragon, a lizard found in the Australian desert*



PHOTO: CHRISTIAN VARGO

which 'swims' under the loose, dry sand of the dune, keeping off the hot surface and conserving energy. The spinifex hopping mouse and the hairy-footed dunnart are just two of the small mammals that make the desert dune their home.

Humans benefit from desert biodiversity in many ways. Tourism and other land uses rely on the desert biodiversity as visitors come to see the wildlife and natural environments as part of their 'outback' experience. Desert biodiversity also provides traditional bush foods for the Indigenous people.

### **Desert life under threat**

Desert biodiversity is under threat. The homes of animals are being altered or destroyed. Introduced pests, plants and animals brought into Australia compete with native species and make it hard for them to survive.

One of the main ways desert habitats (homes) are threatened is by changing fire regimes. Traditional Aboriginal fire techniques involved regularly burning small patches of land, resulting in a patchwork of areas at different stages of growth. This meant that when lightning strikes started fires, the damage was small because some areas had already been burnt.

The patchwork approach provided a diversity of habitats, enabling a variety of plants and animals to survive. When traditional burning was stopped, massive wildfires burnt out of control with nothing to stop them. The large wildfires decreased biodiversity by damaging fire-sensitive species, wiping out large areas of habitats, as well as killing native animals.

Feral (wild) cats thrive in desert areas because they have no natural predators and do not need to drink if they can catch live prey. They cannot be controlled in the traditional way by using baits because they prefer to catch live food. Baiting is only effective when the cats are hungry and when the baits are easy to find.

Other threats include the invasive buffalo grass. Initially it was introduced as cattle feed but it spread rapidly and is now found all across Australia except in Victoria. It replaces other native species and is a bushfire risk; fueling very hot fires that damage fire sensitive plants.

Even small animals can cause problems. Big-headed ants were first identified in 2001. They are very aggressive and have destroyed some native ant species and displaced other small animals in the ecosystem. They can be controlled by baiting.

The bilby is a symbol of the rapid decline in animal species and change in arid zone biodiversity. One hundred years ago the bilby was found in most of the arid zone. Today its numbers have declined dramatically and is now restricted to a few isolated populations scattered through the desert. The decline of the bilby and other native mammals such as bandicoots,

dunnarts and native mice are a result of the introduction of cattle grazing, predation by non-native predators (foxes and cats), competition with introduced rabbits and changing fire regimes.

### **Scientists looking for solutions**

The introduction of grazing, foxes, cats and rabbits and changing fire regimes has reduced the ability of some native plants and animals to persist. As a result, a large number of mammals have become extinct and many plants and animals are endangered. Scientists from CSIRO and other research institutions are trying to develop solutions to reducing biodiversity decline and at the same time allow for humans to live and farm the land in a sustainable way.

In many instances scientists do not understand why some animal and plants have declined or how much the diversity of life has changed. CSIRO scientists are trying to understand the effect of changes in biodiversity and develop solutions to these environmental problems.

## **Kalahari and Namib Deserts**

The Namib Desert has six main regions, all with very different plants and animals. The Skeleton Coast in the Namib Desert is so dry that it has to rely on fog from the sea to bring moisture to its plants and animals. Even in this harsh environment there are large numbers of birds including flamingos, penguins and pelicans. On the more vegetated plains there are large numbers of springboks and gemsboks.

The Kalahari Desert is a sand-covered plain. It has no permanent water but does have a large number of plants and animals. Giraffes, desert elephants and zebras are found in the northern regions, as well as lions, cheetahs and leopards. The drier southern region supports wildebeest and a variety of antelopes.

*Welwitschia growing in the Namib Desert*

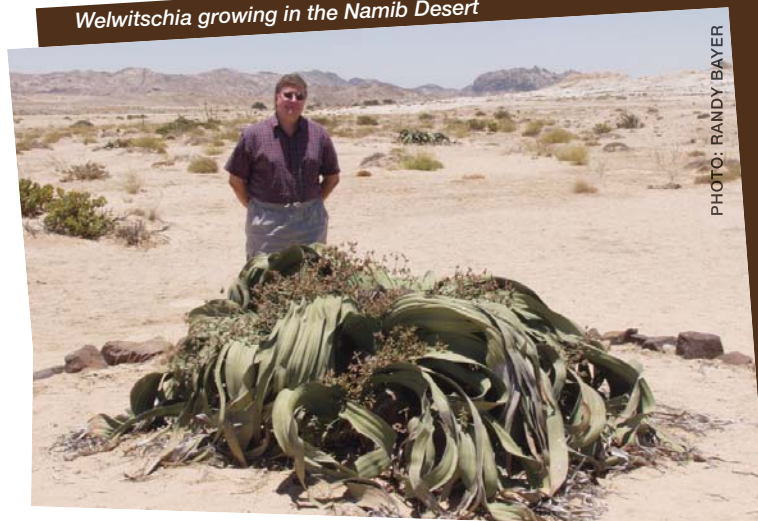


PHOTO: RANDY BAYER

## Welwitschia – the living fossil plant

Botanists have identified over 3000 types of plants in the Namib Desert. At least 300 of these have the ability to store water. One such plant is the Welwitschia (*Welwitschia mirabilis*), a strange-looking plant that can purportedly live for up to 1000 years.

Welwitschia have only two leaves that become shredded by the wind. Their roots can go down for 20 metres to get water. They possess medicinal properties and are at risk of poaching.

## Obesity may be 'cactus'

Hoodia (*Hoodia* sp.), a cactus growing in the Kalahari Desert and eaten by San bushmen to ward off hunger and thirst during long hunting trips, may help alleviate obesity among people in the western world. Scientists are testing its ability to trick the brain into thinking you are not hungry, with a view to developing an organic weight-loss pill.

How many other plants with potential human health benefits are growing in the great deserts of the Southern Hemisphere?

## Biodiversity under threat

The biodiversity found in the Kalahari and Namib deserts is under threat. The largest problem is a lack of land management with uncontrolled and disorganised use of land near and in the desert. Mining activities adversely affect plants and animals and disturb soil profiles. Local residents and tourists contribute to the problem with activities such as four-wheel off-road driving and plant-poaching.

Ecotourism has the potential to introduce diseases into wild populations of desert animals. Scientists suspect that humans were responsible for the serious outbreaks of tuberculosis in mongooses and meerkats which occurred in Botswana during 2002.

Up until now, the southern African deserts have been saved from high rates of extinction and severe environmental degradation because the human population is very low. With increased tourism this situation may not last.

## Atacama Desert

The Atacama Desert has several unique features. In the west, it has a chain of mountains on the coast, with high plains that stretch to the Andes.

The coastal desert is among the driest deserts in the world and seemingly devoid of life except for the occasional oasis or patch of drought-resistant plants.

In the midst of the Atacama Desert are areas of green vegetation, called *lomas*. The plants in these areas survive on the winter mists. These plants are mainly annuals or



PHOTO: MIKE SMITH

Llama, Machuca village, Atacama Desert

bulbous plants that endure the summer as seeds or underground bulbs.

*Lomas* flourish in winter with a relatively high abundance of plant and animal life then in summer dry up leaving shrivelled vegetation.

In other parts of the Atacama Desert plants survive on underground water. These areas are home to a range of cactuses and other vegetation.

Llamas (*Lama glama*) are woolly mammals related to camels. They are revered animals in the Atacama Desert, providing a means of transport through the desert as well as providing wool and hide for clothing, meat and dung for fuel.

## Desert life under threat

Like other deserts of the Southern Hemisphere the diversity of animals and plants in the Atacama is under threat from tourism. Other threats include uncontrolled use of land for farming. This has caused destruction of the plants that are vital for the health of the desert and its inhabitants.



## Activities

- Have students research animal pests and weeds that threaten desert biodiversity. What country did these pests and weeds come from? How did they get into Australia?
- Show students a photograph of a pristine desert environment and have them debate whether a four-wheel drive track should be built through this area.

## Activity: Desert wall

### Background

Although deserts may appear to have very few living things, they are actually rich in plants and animals. When you enter a desert you may not see the range of animals — only their tracks and scats (poo) indicate their existence. However you are likely to feel the warmth, smell the dryness and hear the winds blowing across the flat desert landscape.

You may not see all of them, but the desert is home to a truly amazing and diverse range of organisms.

### You will need

- Access to books, internet and other sources of information on organisms that live in deserts
- Butcher's paper, coloured cardboard
- CD with 'music' of the desert.

### What to do

- Ask students to select one organism found in a desert and find out more about it. You may have all students select an organism from one of the deserts of the Southern Hemisphere or divide the class into three groups and give each group a particular desert region — Kalahari and Namib, Australian and Atacama deserts.
- Ask students to prepare a poster to present their findings. Ask students to cut their poster cardboard so that it looks like the shape of the organism.
- Decorate a wall of your classroom to look like a desert. You may choose to use two walls — one depicting desert by night and the other desert by day. Add sand dunes, rock outcrops and the sun or moon.
- Ask students to place their poster in the area of the desert that the organism can usually be found in the day or night-time. Play a 'desert' CD and direct a spotlight onto the desert daytime wall. Your class can now relax in its own desert wall.

### Possible discussion points

- Why did you choose a particular organism? Where do these organisms get their food and water?
- Are there any threats to these organisms? What are they? What can we do to alleviate these threats?