
L I V I N G
L I M E S T O N E

Caves are subterranean fascinating worlds. Deep beneath the earth's surface there is life; bats and blind, colourless creatures known as troglodytes have adapted to a cave existence over eons. Ancient wall paintings or etchings are evidence of thousands of years of Aboriginal occupation. Today, tourists marvel at the well-lit 'developed' caves. Elsewhere, seasoned cavers squeeze through muddy cracks and wade chest-deep through icy water, hoping, perhaps, to discover a new passage or cave system.

by John Watson, Barbara York-Main and Bill Humphreys

WESTERN AUSTRALIA's oldest limestone caves are about 350 million years old. They lie in the Devonian Reefs in the Napier and Oscar Ranges of the Kimberley. Caves in Tertiary limestones (14-45 million years old) occur in the Cape Range National Park near Exmouth, and on the extensive Nullarbor Plain in the Eucla Basin. The Nullarbor caves may be small sinkholes or huge underground tunnels with lakes and submerged passages.

The most impressive formations (speleothems) are found in the youngest caves that have developed in the Pleistocene aeolian limestones (over 10 000 years old) fringing the South-West coast. The greatest concentrations of caves are in the Nambung National Park, around Yanchep and along the Leeuwin-Naturaliste ridge.

HOW DO CAVES FORM?

Caves are just one feature of a weathered limestone landscape ('karst') that formed along with underground streams, gorges and other features. Rain absorbs carbon dioxide from the air, and seeps through decaying vegetation in the soil surface, absorbing further acids. The weak acid solution dissolves the limestone, especially along cracks and other lines of weakness such as faults or old tree root channels.

Some caves were formed when underground lakes gradually dissolved the rock to create passages and chambers. Others were carved by underground streams and rivers. Occasionally they are formed from physical processes, such as the action of waves pounding coastal limestone.

Dissolved calcium carbonate or other minerals may create impressive formations, from minute helictites only a few millimetres long to huge pillars and flowstones weighing several tonnes. There are also stalactites, stalagmites, shawls, columns and straws.

Shawls at Yallingup Cave. Colour variations result from traces of minerals such as iron in the water.
Photo - Robin Morrison
Courtesy of *Reader's Digest* ◄

The common sheath-tail bat (*Taphozous georgianus*) roosts in deep caves and rock fissures in tropical and sub-tropical regions of Australia.
Photo - Jiri Lochman ▲

This large stalagmite flowstone was built up in sections from the floor of a cave in the Leeuwin-Naturaliste National Park.
Photo - Jiri Lochman ◄

CAVE FAUNA

Caves, with their relatively constant temperature and humidity, are ideal environments for some forms of wildlife. They are used by bats, specially adapted insects and water dwellers. Many contain bone deposits that may have been preserved for thousands of years.

In WA five main groups of caves harbour fauna - those of the Nullarbor (post-Miocene), the South-West and Jurien Bay areas (Pleistocene limestones), the Nambung area (also Pleistocene) north of Perth, and the North West Cape (Miocene). Each region has a distinctive fauna of a different relative age.

Vertebrate remains of the extinct marsupial lion, various rodents and small marsupials, the Tasmanian devil, thylacine, wombat and koala have all been found in caves of the South-West. They may have been carried into the caves from outside by predators such as owls (deposited as fragments in undigested pellets) or by floods. Occasionally animals may have accidentally stumbled into the caves or sought temporary shelter. Identifying and dating these remains, and the geological age of the sediments in which they are found, can show which animals were living around the caves at particular periods of time and indicate what sort of climate prevailed.

A velvet gecko (*Oedura kalumburu*) spends some time in caves.
Photo - Jiri Lochman ▲

Blind cave spider from the Cape Range area.
Photo - Derek Mead-Hunter ◄◄

The blind gudgeon (*Milyeringa veritas*) is a troglodyte, living in the water of caves and rock strata beneath Cape Range.
Photo - G Allen, WA Museum ◄

All cave systems have a particular suite of living invertebrates but none is entirely 'closed'. In Nullarbor caves bats are often the 'go-between', feeding outside the caves at night and roosting inside by day. Their droppings form the base of the food 'pyramid' for a whole suite of invertebrates from mites, cockroaches and beetles to predatory crickets, pseudoscorpions and spiders. The North-West cave invertebrates depend almost entirely on leaf litter that washes into the caves. In some deep caves, and in those with standing water, the food chain may start with insects that either fly into the caves or feed on organic matter in the water in their larval stages.

Invertebrates have adapted to cave existence; they often lose pigment, eyes and hairs. Depending on the ecology and degree of modification, invertebrates are classified as trogloxenes, troglophiles or troglobites. The last category are so modified that they can no longer exist in outside habitats.

Their relationships to species in other parts of the continent or regions of the world are fascinating. The vertebrate fossils of the relatively young caves of the South-West indicate that the forest was once much wetter and more lush, as it supported such animals as the Tasmanian devil (now found only in Tasmania). There must also have been a relatively well-forested corridor across the Nullarbor, or to the north, for such vertebrates to have been connected with their counterparts in the south-east. The 5000-year-old remains of a Tasmanian tiger, or thylacine, from a Nullarbor cave substantiate this theory. Fossils of small vertebrates from the Jurien Bay region indicate a dry period during the Pleistocene.

Whereas some of the vertebrates died out with the shrinking forests, some invertebrates managed to survive in smaller microhabitats or were able to change their lifestyle by retreating into caves. In the Nullarbor caves, for example, there is a blind mygalomorph spider (*Troglodiplura lowryi*) of the trapdoor and funnelweb group, a Gondwanaland relic of great significance. It has no near relatives in Australia and probably belongs to a group of primitive web-weaving genera otherwise found only in South America.

Some cave invertebrates have close taxonomic affinities with those other continents and New Zealand. The relationships are of ancient origin and some, such as that of the blind mygalomorph, are probably older than 65 million years. Thus our cave-living

CAVE FORMATIONS

DRIPSTONES form when water, saturated in carbon dioxide, drops from the roof and leaves behind a small amount of calcium carbonate. Gradually, each successive drop precipitates further layers of crystals, forming a stalactite. When drops of water fall on the same spot on the cave floor, the same thing happens, but the formation grows up from the floor and is called a stalagmite.

Each stalactite and stalagmite grows at a different rate, depending on the wetness and temperature of the cave, and the thickness of the limestone bed above it. Some stalactites grow an inch a year; others take one hundred years or so to grow that much. Often the stalagmites growing upward meet the stalactites growing down and form columns.

PORE DEPOSITS result when seepage through pores and cracks is too slow to form water droplets. Helictites - small irregular tubed growths - are the most common.

FLOWSTONES, including over-hanging shawls and canopies, frozen waterfalls and clusters of glistening nodules, are the bulkiest cave deposits. They are formed from films of calcite left by flowing water.

POOL DEPOSITS are level terraces at pool edges and the crust of crystal on the walls and bottoms of underground water pools.

Illustration - Ian Dickinson

invertebrate fauna is a living link with past faunas of adjacent surface areas and other Australian regions, with northern, tropical Australian rainforest habitats, and thence to South-East Asia and even Africa, and with South America.

WHERE TO SEE CAVES

All caves are different. Guided tours are provided to most of the caves open to the public.

CRYSTAL CAVE

Crystal Cave in Yanchep National Park has fine examples of active stalactites and stalagmites, helictites, flowstone, shawls and other formations. There are beautiful reflections in the main grotto when it is wet. An underground stream occupies most of the floor in this section but the level of water varies with climatic conditions. Crystal Cave is a "stream cave" and has a horizontal, tubular shape caused by flowing groundwater removing the calcium carbonate.

Cave Systems in Western Australia

MAMMOTH CAVE

Mammoth Cave, about 21 kilometres south of Margaret River, is extremely large and has many long chambers and smaller passages. During winter a stream flows through it, creating reflections and giving the cave new life. The cave features stalactites, stalagmites and large columns where the two formations meet. A coloured shawl is prominent in one of the smaller chambers.

The WA Museum has located and removed several fossils left there by Aborigines who used the entrance cavern for shelter. The jawbone of an extinct marsupial about the size of a cow (*Zygomaturus trilobus*) is visible in the wall of this cavern.

An underground stream occupies most of the floor of Crystal Cave at Yanchep.
Photo - Cliff Winfield ▲

Cave explorers need to be properly equipped and should be accompanied by other experienced people.
Photo - Jiri Lochman ▼

Entry to the cave is from the eastern side and the exit is on the western side of Caves Road. A short bushwalk through the forest takes visitors back to their cars.

LAKE CAVE

Lake Cave, located three kilometres south of Mammoth Cave, is the deepest and smallest of the tourist caves. A series of stairways and paths descend through a large "crater" (collapse doline) with huge karri trees growing from its depths. The lake never dries up and the path runs along its edge. It is heavily decorated with fragile white calcite straws, shawls, stalactites and stalagmites. A prominent feature is the Suspended Table, a large flat area of flowstone supported just above the lake from above by two large columns.

JEWEL CAVE

Jewel Cave, about 37 kilometres south of Margaret River and eight kilometres north of Augusta, is the largest and most recently-opened tourist cave; it was opened on Boxing Day 1959 (Lake and Mammoth Caves were opened in 1901-2). Entry is through a huge, spectacular cavern. The natural entrance, now closed, is a small solution pipe through which the first cave explorers were lowered.

Tourist Caves of the South-West

The cave contains the longest straw in any tourist cave in the world (just over 5.9 metres). There is also a huge area of flowstone that looks like karri forest, and a stalagmite estimated to weigh 20 tonnes. The cave was named after a smaller section known as the Jewel Casket and its crystal formations.

Mammoth, Lake and Jewel Caves are open every day, except Christmas, for guided tours run by the Augusta-Margaret River Tourist Bureau.

YALLINGUP CAVE

Yallingup Cave is renowned for its spectacular shawls. Visitors use a self-guiding circuit through the main chamber, which generally takes about an hour. The Green Chamber has recently been reopened to the public for the first time since 1904. Special guided adventure tours through some other parts of the cave are also available by appointment. Most of these areas are unlit but helmets and torches are provided.

TUNNEL CREEK

Tunnel Creek National Park, part of the Devonian Reef system in the Kimberley, is for the more adventurous. There is no guided tour available and visitors have to negotiate the 750 metre cave through the limestone of the Oscar Range by themselves.

The cave has an interesting history. Late last century, it was used as a retreat by the Aboriginal hero Jundamarra (known to Europeans as Pigeon) when

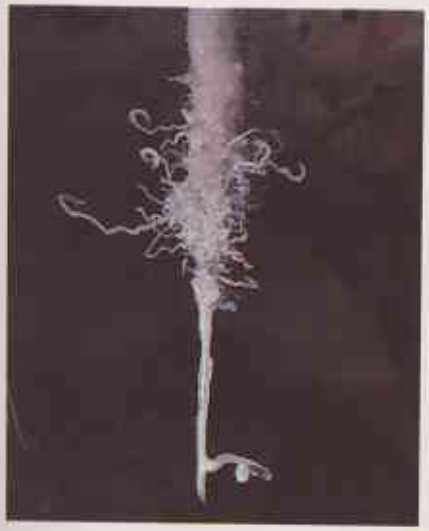
he and his followers waged guerrilla warfare on early Europeans who had settled his tribe's traditional land. Jundamarra called this the "Cave of Bats" - at least five species of bats live there.

CONSERVING CAVES

The two main caving groups in WA are members of the Australian Speleological Federation (ASF) and both accept newcomers. The clubs are actively involved in various research projects and new exploration throughout WA.

Caves need to be protected from obvious damage and more subtle influences such as surface land use; not just in the areas immediately above them but in the entire catchment area of any streams or drainage lines that enter them.

The effect of visitor pressure on the cave environment can be highly significant. Even the dirt on visitors' shoes and fluff or dust from clothing can, in time, build up on speleothems and spoil their appearance. Large numbers of visitors also increase the amount of carbon dioxide in the cave air. The high CO_2 levels affect the rate of formation of speleothems and the suitability of the cave environment for fauna.



Delicate helictites - experts are not really sure how they are formed.
Photo - Rob Klok ▲

Blatant vandalism is the ultimate threat to cave speleothems. In a few moments a vandal can destroy something that took thousands of years to form. Most well-known caves in Australia have suffered some vandalism. Hopefully, more enlightenment now prevails.

These cave pearls were formed by calcite depositing and building up on grains of sand.
Photo - Norm Poulter ▲

Tunnel Creek cave runs beneath an ancient limestone barrier reef formed 350 million years ago.
Photo - Marie Lochman ◄

CAVES OF THE CAPE

There are two groups of caves in the North-West Cape peninsula. The subterranean waters of the coastal limestone caves support blind shrimps, the gudgeon fish and the rare blind eel. The 200 or more caves in Cape Range are mostly vertical "wells" although only four contain water. These dry caves now have little life but contain important vertebrate remains, including those of a thylacine.

The limestone of Cape Range is honeycombed with sinkholes and caves.
Photo - Michael Morcombe ▲

The more humid caves have a rich invertebrate fauna of cockroaches, millipedes, slaters and spiders. Species such as the micro-whip scorpions (not found in any other cave systems in the State) and pseudoscorpions indicate that the area was once covered by tropical rainforest.

These creatures depend on leaves washed into the caves by the unpredictable rainfall of Cape Range. Some caves flood after little rain while others require exceptional rain, flooding only every five years. So the food input comes in pulses, allowing the invertebrates to build up to very high numbers. The populations stop breeding as the cave dries and the organic matter is depleted, leaving small residual populations.

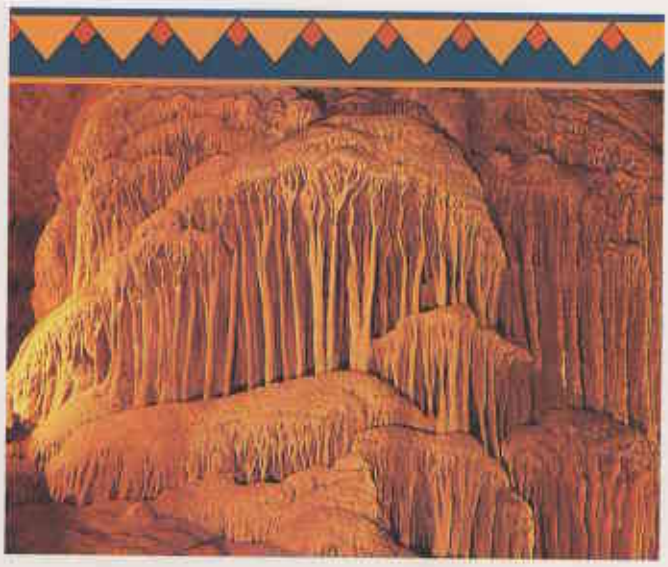
The deep gorges isolate populations between caves - providing a fascinating natural laboratory for studies of genetic differences.

CAVE MANAGEMENT

The first step in managing caves is to classify all known caves in terms of their values. Only then can the managing authority define the type of management and degree of protection needed for each cave.

This is fairly easy for recently-discovered caves and those where people have had minimal impact. Frequently, however, the damage has already been done. In some cases a decision may be made to 'let the cave go' and encourage use by large groups of inexperienced or recreational cavers. Existing tourist caves are a special case where there has been a degree of abuse on one hand but a degree of controlled access and management on the other.

The Working Group on Cave Protection and Management, convened by the EPA, addresses statewide issues such as cave classification, the need for cave legislation and cave management issues. It has representatives from the two major WA speleological groups, the WA Museum, the EPA and CALM.



This striking flowstone in Jewel Cave was formed from calcite left by flowing water.
Photo - Alex Bond ▲

CALM recently formed a Leeuwin-Naturaliste Cave Management Committee to protect caves in the Leeuwin-Naturaliste National Park from increasing pressure from amateur cavers and the general public. Speleologists, other local interests and CALM staff sit on the Committee.

At the national level, the ASF has strict guidelines and ethics for cavers and addresses issues such as cave protection, use and management. The ASF has acted as consultant to various State and Federal Government departments and, in Western Australia, has conducted studies on Yallingup Cave and the Nullarbor.

Cave management requires close consultation and assistance from all cave users. Most of the major cave systems of WA are located in CALM managed lands. The challenge is how to conserve and manage caves, their unique formations and their very special inhabitants. ⊡

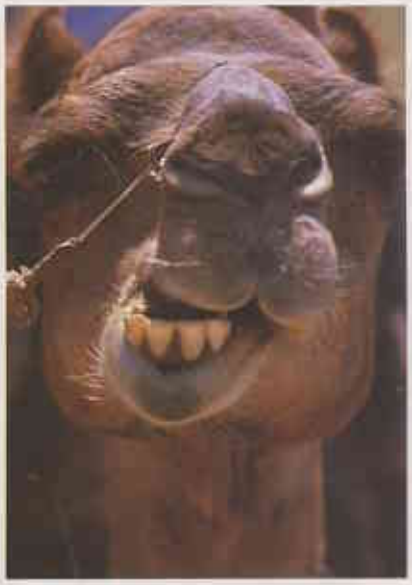
Sections of this article are based upon John Watson's *Caves in Western Australia* (Dept of Conservation and Environment), Bulletin No 51, September 1978.

LANDSCOPE

VOLUME 5 NO 2 SUMMER EDITION 1989/1990

Dolphins, whales and seals frequently strand along the WA coast. Find out who helps them and what they do on p. 10.

Powerful forces have formed the rocks and land surface of WA over billions of years. See p. 48.



Why are the thousands of feral camels that roam inland Australia the scourge of the desert? Turn to p. 22.

Explore the fascinating subterranean worlds deep beneath the earth on p. 28.

Inlets and rivers, towering karri and tingle forests, rugged coastline and remote wilderness areas - Walpole-Nornalup National Park has it all. See p. 15.

C O V E R

Australian sea-lion (Neophoca cinerea). *Photo - Nick Gales*

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