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WINTER 1993

# LANDSCOPE

W.A.'s CONSERVATION, FORESTS AND WILDLIFE MAGAZINE



## OUR NATURAL ADVANTAGE

*Nature-based tourism in  
Western Australia*

## WILLIAM DAMPIER

*A tale of an Englishman in  
New Holland*

## FOOTPRINTS ON THE SANDS OF TIME

*Kalbarri National Park's  
earliest inhabitants*

Philippe Nikulin  
July 1993

# We have a place for you at the frontier of discovery.

## Five *LANDSCOPE* Expeditions for 1993

Here's your chance to go bush in the cause of nature. Come along on one of our *LANDSCOPE* Expeditions and you'll join CALM scientists on one of several vital research projects. Help them as they work with birds, plants or animals.

### OBSERVING WATER BIRDS AT LAKE GREGORY

**August 1993 — 9 days ex Broome**

Lake Gregory, at the junction of the Tanami Desert and the Great Sandy Desert, is a wetland of international importance, supporting among the highest bird numbers of any inland wetland in Australia. The water in the lake is at record levels following the 1993 wet season — this is the year to visit. The expedition will focus on bird identification, behaviour, habitat use and diet.

### OBSERVING WATER BIRDS AT BROOME

**August 1993 — 6 days ex Broome**

Roebuck Bay, just south of Broome, is a significant staging post during migration for Palaearctic wading birds. Volunteers will help scientists examine the movements of migratory waders, determine the distribution of wader species within Roebuck Bay, and describe feeding areas of different species in relation to tidal movement. We stay at the Broome Bird Observatory.

### MONITORING ENDANGERED MAMMALS IN THE GIBSON DESERT

**September 1993 — 12 days ex Perth**

Participate in a plan by CALM to reintroduce native mammals extinct on the Australian mainland. Working alongside CALM research scientists, volunteers will take part in pit-trapping, handling and identifying small mammals and reptiles, and in radio-tracking and observing signs of golden bandicoots released into the Gibson Desert Nature Reserve from Barrow Island in 1992.

### BIOLOGICAL SURVEY OF MOUNT ELVIRE

**September 1993** *Details to be advised*

Mt Elvire Station in the north-west Goldfields region was purchased by CALM in 1991 for sandalwood conservation and regeneration. The principal aim of this project is to carry out a biological survey which will document the vertebrate fauna and the vegetation of the fauna sites. The project may extend to a waterfowl survey of Lake Barlee.

### FAUNA OF THE BATALLING FOREST

**November 1993 — 5 days ex Perth**

The jarrah forest at Batalling is thought to contain one of the largest assemblages of small- and medium-sized animals in WA, and is also home to a high diversity of lizards and other reptiles. The mammals include the brushtail possum, quenda, brushtail wambenger, pygmy possum, echidna, woylie, chuditch, mardo, and western grey kangaroo. This expedition will contribute to a major new study of the effects of disturbance on ecological processes in the forest and the impact of fox baiting on mammal abundance.

These expeditions are offered by *LANDSCOPE*, a quarterly magazine devoted to wildlife, conservation and environmental issues in Western Australia. They are run in association with UWA Extension from The University of Western Australia.

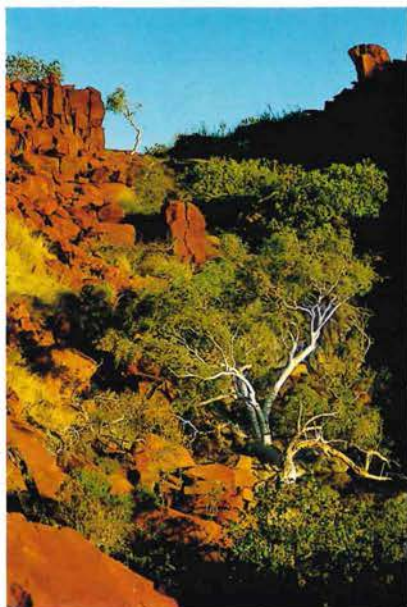
These absorbing expeditions provide opportunities for self-supporting volunteers to join CALM scientists in field-based research projects, often in remote areas of the State. They are not only exciting and fulfilling; they give you a chance to experience environmental research at the frontiers of discovery. Expedition fees are calculated to cover the considerable costs of the expedition, including food, accommodation, transport, camping gear and fuel, and to support further research. Fees do not cover personal expenses, such as travel costs to the departure point.

Enquiries/bookings:

*LANDSCOPE* EXPEDITIONS, UWA Extension, The University of WA, Nedlands WA 6009. Tel: (09) 380 2433 Fax: (09) 380 1066

*LANDSCOPE* Expeditions  
Working at the frontiers of discovery





Nature-based tourism is a rapidly-growing industry and WA is poised to take a slice of that growth. See 'Our Natural Advantage' on page 10.



Frogs can be an interesting addition to any suburban native garden. Grant Wardell-Johnson describes how to attract them to your garden on page 16.

# LANDSCOPE

VOLUME EIGHT NO. 4 WINTER ISSUE 1993



'Seagrass, Surf and Sea Lions' (page 21) are just some of the features of a string of islands that dot the WA coastline north of Lancelin.



Forrestdale Lake is an 'Outer City Sanctuary' for thousands of visiting and resident waterbirds. See page 35.



When is a flower not a flower? Neville Marchant, from CALM's WA Herbarium unravels the intricacies of the State's many 'False Flowers' on page 39.

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## COVER

The bull frog (*Litoria moorei*) is very large and has a voracious appetite. It is a frequent visitor to gardens and may be found particularly in greenhouses, ferneries and wet areas such as streams and ponds.

The illustration is by Philippa Nikulinsky, inspired by a Peter Marsack photograph, courtesy of Lochman Transparencies.



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## SUSTAINING THE ADVANTAGE

*When we began publication of LANDSCOPE, back in 1985, I had a secret fear that we would run out of interesting subjects to feature. As it turns out, our biggest problem is selecting the best from a vast array of first class articles submitted by contributors within and, increasingly, external to the Department.*

*In retrospect, it's hardly surprising that there are so many exciting and unique things to write about and experience. After all, Western Australia is one of the oldest places on earth. It has a vast range of climates and some of the earth's most unusual soil conditions. It is an island on an island.*

*All these factors have resulted in Western Australia possessing a treasure-trove of plants, animals and places of unique beauty. Our space and isolation, and the age of our landscapes has created dozens of little 'arks', throughout the State, which harbour rare animals, plants and a host of other natural phenomena, many of which occur nowhere else on earth.*

*But the uniqueness of our natural environment does carry its penalties. While many of our ecosystems are remarkably resilient, it is also true that without proper management we could easily lose some of our natural assets. We have the responsibility - not just to ourselves, but to the world - to preserve them.*

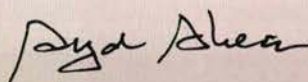
*It can be argued, as it is by some people, that the only way to protect the unique parts of Western Australia's environment is to quarantine them from people. But if a neutron bomb that selectively killed all humans in this State went off tomorrow, many of our environmental problems would continue and some would even intensify. In any case, just as King Canute had problems with the waves, we would have great difficulty in preventing people from around the world wanting to share our natural assets with us.*

*We can accommodate more people, provided that we can manage our natural assets effectively and responsibly. But management is expensive, and what we require to ensure that Western Australia's unique natural wonders are maintained is more human intervention in the form of dollars.*

*Increasingly, world governments are recognising that the only way to improve the protection of natural environments is to use them sustainably to create the very resources required to protect them, because we can no longer expect that the general community will continue funding conservation initiatives from consolidated revenue.*

*Nature-based tourism provides a classic example of how we can integrate economic and environmental objectives. It is also an activity that is tailor-made for the application of value adding principles. An essential part of any nature-based experience is the explanation of the scientific basis of the phenomenon being observed.*

*This issue of LANDSCOPE, like its predecessors, illustrates the unique natural beauty that is Western Australia and I hope, in its own small way, adds value to it.*



The Publisher

## LIKE A PHOENIX

In the Summer 1992-93 issue of LANDSCOPE and the article "Endangered", you mention *Lambertia propinqua* as coming from the Albany area. There is at least one small population near Busselton. About half was burned some 18 months ago in a CALM fire. Does it resprout from rootstock, or will it have to start again from seed?

DENNIS COOPER  
BUSSELTON

The article stated that *Lambertia propinqua* had "a more widespread distribution around Albany", but did not state that this was by any means its only location. The population near Busselton is well known to Herbarium staff. On the question of regrowth following a fire; the seed is released by fire, as with many other WA plant species, and regrowth is from the newly released seed. - ED

## ADAPTING TO THE ALIEN

By way of introduction I am the retired Director of Nature and Environmental Commission [in South Africa] but still active in the field by serving on committees and acting as consultant.

I am a regular reader of LANDSCOPE which, incidentally, I consider an outstanding publication by world standards. In the latest [Summer 1992-93] issue I was particularly fascinated by two articles, viz the rehabilitation of the chuditch and "Masterly Marauders". Naturally, I know nothing about the chuditch, but found your programme sound and most laudable.

Predation, however, was a problem with which I was deeply included [sic] as we have major predators of sheep and goats, and also feral domestic cats. I was

instrumental in the abolition of the bounty system and its replacement by a programme of what I termed "technical aid". But to return to the article, which was excellent. My only comment is that both the domestic cat and fox are alien predators and there must have been natural balances in predator/prey relations before they were introduced. They are alien intruders - placental mammals - which must have had a marked impact on small native mammals. But the article seems to give the impression that they are natural predators to which your fauna has adapted. Can this be so?

(DR) DOUGLAS HEY  
CAPE TOWN, SOUTH AFRICA

It was certainly not my intention to imply that Australia's wildlife is adapted to the depredations of two alien predators - the European fox and the feral cat. Indeed, under the present circumstances, it would seem that many Australian species are ill-adapted to cope with such efficient predators as the fox and feral cat. Perhaps it is significant that a carnivore comparable to the fox is missing from the modern Australian fauna, and thus the fauna has not had to evolve appropriate anti-predator lifestyles.

Regardless of the above, we have a major predation problem that is compounded because the fauna is so vulnerable. In discussing these issues, it was not my intention to convey the impression that we have a predator-prey system where predators and prey have co-evolved together. Nonetheless, it is appropriate to discuss the issue within the context of past and current predator-prey theory, though I expect we will encounter a few surprises when the facts are known. - Jack Kinnear, CALM Principal Research Scientist.

## EUCALYPTUS OIL

My husband and I are always very interested in *LANDSCOPE*. In this particular issue [Summer 1992-93] your article on eucalyptus oil is of great interest to me because my father, Jonah Parker (J.S.W. Parker), had a wheat and sheep property at Dangin, 40 miles east of York. My father built a distillery and in 1892 the distillation of eucalyptus oil was commenced on his estate. The oil was extracted from young salmon gum leaves by choppers, after which it was distilled three times. Earthenware casks were used to transport the oil to York where it was further purified before distribution.

This distilled eucalyptus oil took first prizes at the Melbourne Exhibition in 1893, and in the year 1901 won a Commemorative Award at the Glasgow Exhibition [Scotland]. This eucalyptus oil was marketed under the name "Parker's Eucalyptus Oil".

The oil distillation industry was discontinued after a bad storm damaged the large vats. The manufacturing rights were bought by F.H. Fauldings of Perth. Jonah Parker introduced the eucalyptus oil industry to Western Australia.  
E M LEGGOE (MRS)  
DUNCRAIG

Thank you for your fascinating letter. This issue of *LANDSCOPE* has an article on the work presently being done to revitalise the industry and improve the yield of eucalyptus oil from mallees. See "Oil in the Leaves" on page 49 - ED

## PARTNERS IN RESEARCH

I enjoyed Keith Morris's article "Return of the Chuditch" in the latest issue of *LANDSCOPE* [Summer 1992-93]. However, I did feel the

APB's related research also deserved a guernsey in the article.

A few years ago, Dennis King carried out trials in the north-west in which telemetered northern quolls were exposed to 1080 baits, with zero losses. Unless my taxonomy is hopelessly wrong, the chuditch is closely related and occupies the same ecological niche as the northern quoll.

Both the tolerance of native carnivores and their food preferences have been studied by APB researchers. Moreover, current work on fox ecology is being conducted by the APB as part of the Cooperative Research Centre for biological control of vertebrate pests program.

Perhaps we could put a little more effort into emphasising the successful cooperation which has and continues to take place between our organisations.

FRANK SMITH  
AGRICULTURAL PROTECTION  
BOARD OF WA

*Mr Smith is correct when he says that there is good cooperation between CALM and APB researchers and this is reflected in WA's leading position in threatened fauna management within Australia. Some LANDSCOPE articles about the role of fox control in fauna management have been jointly authored by CALM and APB scientists (see "Vandals in a Vulnerable Land", spring 1990 issue). The article "Return of the Chuditch" was written to provide an insight into the progress being made on the implementation of the chuditch recovery plan. While APB have undertaken much of the research into the use of 1080 in fox control, they are not involved directly with the recovery plan's implementation.*

- Keith Morris, CALM Senior Research Scientist.

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## A MAGIC MOMENT

Rarely is it possible to be in the right place at the right time. However, a recent trip to the Eyre Bird Observatory for a bird-banding course provided one such moment - to witness the hatching of a malleefowl.

The Observatory, south of the Eyre Highway near Cocklebidy, is set in the mallee and coastal vegetation of the vast Nuytsland Nature Reserve.

On the last day of the course, the group went out late in the afternoon to dig into an active mound of a malleefowl (*Leipoa ocellata*). The aim was to supply a sample of discarded eggshell to a researcher at the South Australian Museum, where the extraction and analysis of DNA will assist his study of various malleefowl populations across Australia.

The chosen mound was in

a shallow valley of mallee woodland, with a scattering of native pine (*Callitris* spp.). It was about four metres in diameter and one and a half metres high. A number of orange-fruited bodies of saprophytic fungi stood out of the sloping sides of the mound. Saprophytic fungi live on dead organic material, and was evidence that active composting was occurring within the mound, providing the heat for egg incubation.

Under the direction of course leader Dr Stephen Davies, excavation slowly proceeded to about a metre. From there Stephen continued cautiously until a bright pink egg was uncovered.

With further searching another egg was found adjacent to the first. No sooner had this been discovered, when there was tiny explosion,

and out of the egg popped a malleefowl chick!

Although light conditions were poor, those with cameras were busily clicking away trying to record this magic moment.

Under normal circumstances, the chick would take 24 hours to dig its way to the surface of the mound thus drying out its wings. On emerging the hatching must be completely independent as the parents take no interest in its welfare once it has hatched.

Since this chick had not been through the drying process, it was taken back to the Observatory to keep it dry



*Two days after emerging from its egg, this malleefowl found near the Eyre Bird Observatory had dried and was ready for release. Photo - Peter Hewett*

and warm overnight and then released the following morning. While it was none the worse for its close encounter of the human kind, those present were enriched by the experience.

Peter Hewett

## SHELL BEACH CONSERVATION PARK

The unique Shell Beach at Shark Bay is now a conservation park. The park, gazetted earlier this year, is the first for the Mid-west region.

Shell Beach, a stretch of

coastline about 150 kilometres long, is formed from billions of tiny white shells deposited almost 10 metres deep.

The Department of Conservation and Land

Management (CALM) plans to develop day-use facilities at the site compatible with the protection of this unique feature.

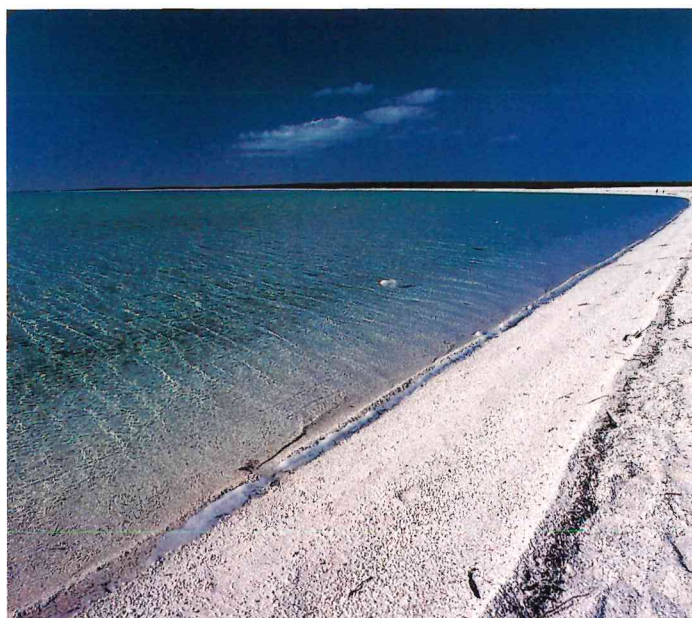
Virtually everyone who visits Monkey Mia by car calls in to Shell Beach. Despite this, local agencies had little scope to control visitor activities because the beach was on vacant Crown land. Vehicles were often driven on to the beach, breaking and compacting the shells and forming unsightly tracks in this unique landform.

CALM will attempt to rehabilitate the beach to its former state.

The shell deposits on the beach formed some 4 000 years ago, when large populations of the bivalve *Fragum erugatum* flourished in the ultra-saline conditions of L'Haridon Bight and the nearby Hamelin Pool. Over time, the lower and older deposits became compacted to form solid material known as coquina.

Several buildings in Denham and on surrounding stations are built from blocks of the compacted shells taken from Hamelin Pool. This activity is now strictly controlled and blocks can only be cut to repair existing shell-block buildings.

Conservation parks are areas with significant regional or local conservation or recreation values and are managed in the same way as national parks.



*Shell Beach is formed from billions of tiny bivalve shells lying some 10 metres deep. Photo - Robert Garvey*

## LIVING WITH POSSUMS

The common brushtail possum is one of the most well-known Western Australian marsupials. Hunted extensively for its fur during the Depression, the species is now fully protected. Although still found throughout much of its former range in the south-west of the State, its numbers have been reduced in recent years.

Recent studies by the WA Museum have shown that the Tuart Forest National Park has the highest densities of brushtail possums in the State. More than 80 individuals occupy a 40-hectare site near the Abba River. Young are born between April and June. Hence, ranges overlap extensively, with up to five adults occupying an area of about three hectares. Peppermint is the principal diet at Ludlow, with some tuart also eaten.

While it may be tempting for campers to feed possums, the long-term effects on the animals can be negative. Changes to behavioural patterns could occur, with possums around campsites changing from leaf gatherers to scavengers, making them more susceptible to predation and injury. Any build-up of animal numbers around the campsites may also make the animals more prone to disease. They could also become a nuisance to campers.

For many years, possums in suburban roofs were removed with traps and released in other areas. Recent studies, however, have indicated that relocated animals do not fare very well, with resident possums forcing them out of trees and onto the ground, where they are more vulnerable to predation.

In any case, new possums soon move in to replace those removed. Instead of advice on

trapping, information on how to live with possums, blocking up holes in roofs, netting fruit trees and so on, is now given out by wildlife officers from the Department of Conservation and Land Management. This has been well received, and has resulted in much less trauma for the possums.

*Right and below:*  
In the metropolitan area, the common brushtail possum (*Trichosurus vulpecula*) is one of the few native mammals that has survived in close proximity to human society. However, its range in WA is now greatly reduced, probably due to predation by the introduced fox. Photos - Ray Smith



## SHOALWATER SHINE-UP

CALM volunteers and members of the public turned out to clean up the islands off Rockingham as part of this year's Seaweed. Around 50 people helped Department of Conservation and Land Management staff 'shine-up' the Shoalwater Bay islands.

The theme of Seaweed this year was 'Caring for our Coast', and the Shoalwater Shine-up was a first step in encouraging people to do this in the Rockingham area.

Volunteers were broken into two groups. One group spent two hours on Penguin Island checking signs and cleaning up areas usually inaccessible to the public. Another smaller group cleaned up Seal Island.

A great deal of litter reaches the islands from the mainland, and from boating and fishing activities and this was removed. Unfortunately, rough weather prevented a clean-up of smaller,

less accessible, islands and rocks. The large turn-out was really encouraging. Had the weather been fine the project would have been overrun by volunteers.

The Shoalwater Bay islands are important nature conservation areas. Penguin Island, the largest of the chain, is a popular tourist destination, attracting about 70 000 visitors each year. It supports the largest breeding population of little penguins on the west coast of Australia.

*Rough weather didn't deter CALM volunteers and staff from cleaning up Shoalwater Bay islands during Seaweed.*  
Photo - Terry Goodlich



### APOLOGY

**LANDSCOPE** apologises to Alcoa and its Kwinana employees for any distress that may have been caused by the unidentified photograph of Alcoa's Kwinana Refinery on page 14 of the Autumn 1993 issue of the magazine, and for any inference of guilt by association that may have been wrongly assumed from its inclusion.

### LANDSCOPE Western Australia Calendar 1994



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A CALM publication  
Department of Conservation and Land Management

## ARBOR DAY

Arbor Day, on June 11, was celebrated right across the State. Observed in WA since late last century, it aims to focus attention on the part trees play in our lives.

The day began on 6WF, with the winners of LANDSCOPE's Arbor Day Poster competition for WA school children being announced on Ted Bull's program.

Another highlight was the establishment of a rare flora garden in The Hills Forest, east of Mundaring, with the help of school children, invited guests and the eastern hills branch of the Wildflower Society. Poster displays, a tree talk and an environmental education program for school children, *Discovering The Hills Forest*, were

also featured.

Wheatbelt primary school children went on bushwalks with CALM's David Mitchell and Anthony Sutton.

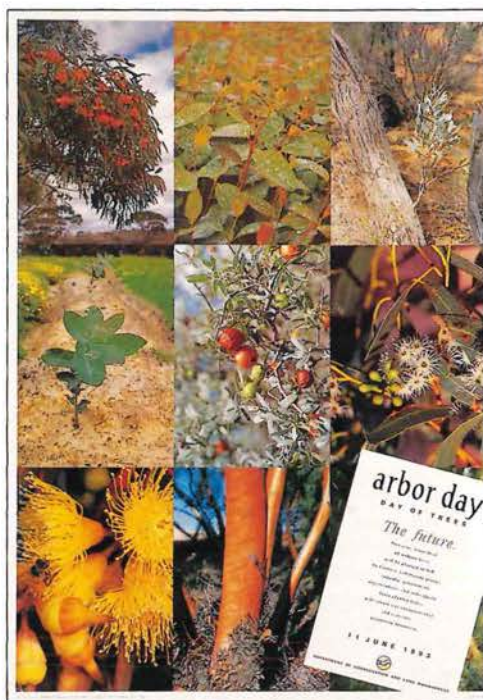
In the Mid-west, rare rose mallee (*Eucalyptus rhodantha*) seedlings were given to local schools in the Three Springs-Watheroo Shire for planting on Arbor Day, as part of a recovery plan for the species. In Denham, a tree-planting ceremony and barbecue was held at the homestead on François Péron National Park for Shark Bay Primary School children and their parents.

In Exmouth, school children planted trees and children from Karratha enjoyed CALM's *Coastal Capers*, looking at mangrove forest and dune

vegetation. In Millstream-Chichester National Park there were displays at the Homestead Visitor Centre, on park rehabilitation work and Tom Price hosted talks by CALM staff at local schools.

These and other activities made Arbor Day a day to remember.

*The 1993 Arbor Day poster*



## FALCON TALES

A pleasant encounter greeted Science and Information Division officers from the Department of Conservation and Land Management (CALM) last October.

Research scientist Patrick Pigott and technical officer Warwick Roe were monitoring salmon gum woodland understorey in a 40-hectare water reserve east of Narrogin, when an adult peregrine falcon (*Falco peregrinus*) voiced its

disapproval of the pair.

The tell-tale, harsh, staccato 'kek kek kek' from the alarmed bird circling overhead, pierced the lazy spring air, obliterating all other sounds within the remnant of bush.

Nearby, in a large salmon gum tree-hollow about eight metres from the ground, the profile of a downy chick could be seen - an unexpected pleasure for the two officers.

Patrick and Narrogin forest ranger Darren Graham returned

two days later with a ladder to discover three healthy chicks about two weeks old.

The nest hollow was approximately 30 cm wide and 10 cm deep, very similar to a cliff-face nest. The bottom had a layer of decomposing woody material and a number of fallen leaves.

The reserve, while mainly featuring a majority of healthy, mature salmon gum, also comprised morrel, York gum, wandoo and rock casuarina.

Nest hollows in this type of woodland are very important for a variety of Wheatbelt birds as most similar habitat in the upper

*Above right: Technical officer Warwick Roe searches for peregrine falcons to photograph for LANDSCOPE. Photo - Darren Graham*

*Left: Peregrine falcon chicks. Photo - Warwick Roe*



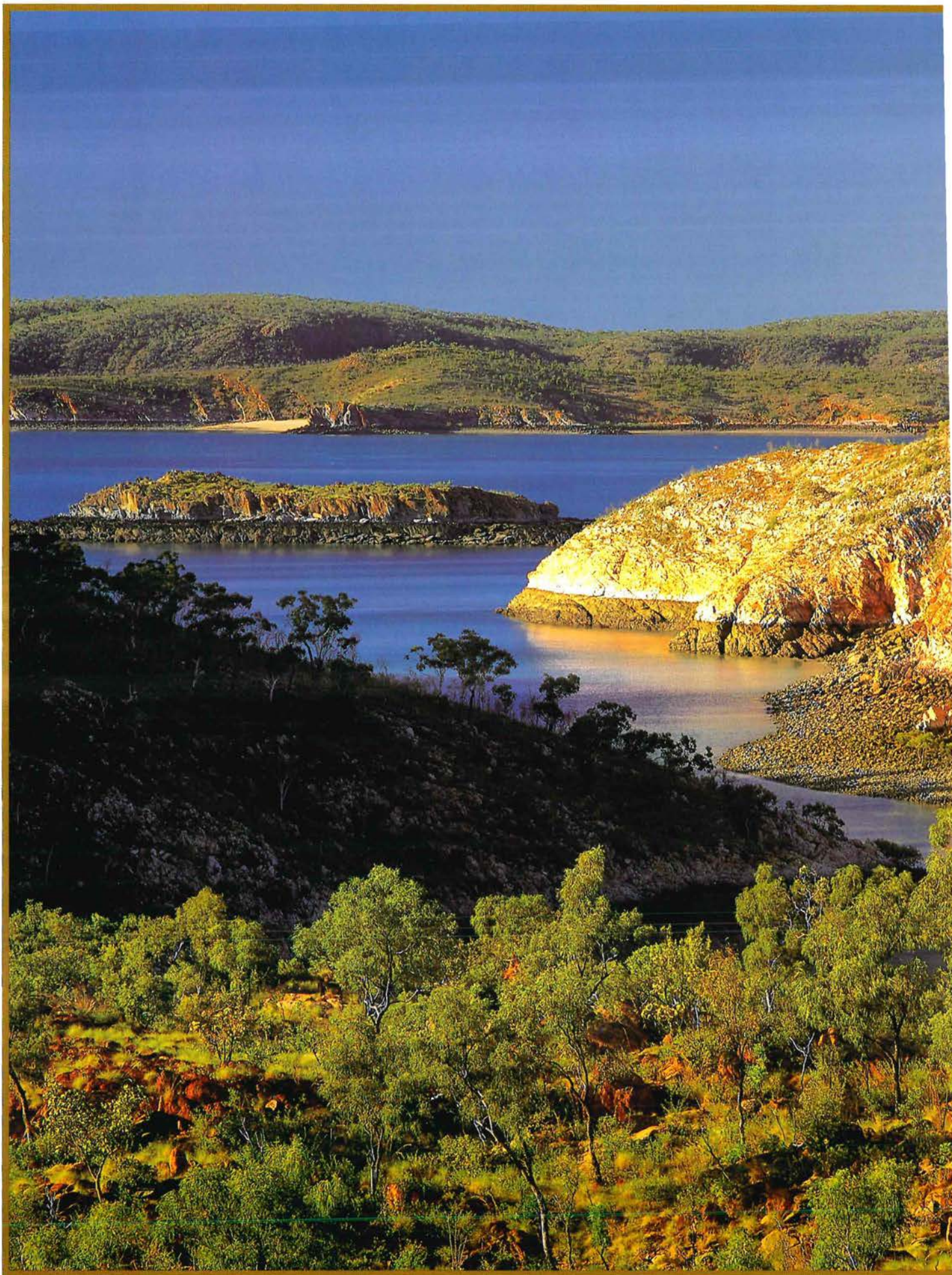
Great Southern has been cleared for agriculture.

Patrick checked the area again in January and evidence at the nest site suggested that all the birds had survived.

Some 300 metres away, a lone adult peregrine quietly surveyed the scientist from atop an old morrel tree, while contemplating a nearby Port Lincoln parrot.

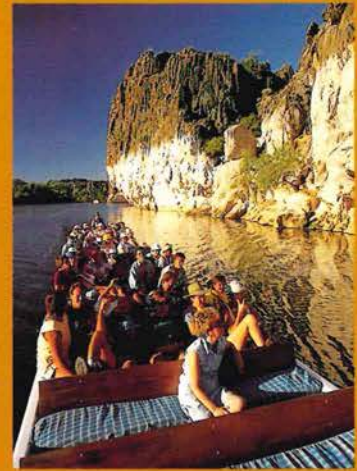
With a little luck and good management, the reserve will continue to produce more of these rare, 'magnificent beasts' next season.







## Our Natural Advantage



**Syd Shea and Jim Sharp**

Worldwide tourism is booming. It is the world's largest and fastest-growing industry. Some estimates indicate an increase of eight per cent per annum. However, nature-based tourism is growing at almost four times that rate, resulting in a growing number of overseas visitors to our vast continent. Syd Shea and Jim Sharp show why Western Australia is well situated to take advantage of this increase.

**R**ecently, there has evolved a new breed of tourist - one who is more interested in what a country has to offer by way of natural experiences, than in simply lying on a beach or staying within the protective shell of a luxury hotel or resort. These nature-based tourists want to venture out into the heart of a country, to experience its sights, sounds and smells, to feel the bare earth beneath their feet, and, in some cases, to sleep under the stars. The number of people who want their holiday experience to be based on the natural environment is growing worldwide at more than 30 per cent per annum. Western Australia already has a significant tourism industry and all the prerequisites for its continued growth, including airports, transport systems, a range of accommodation and skilled friendly people to service the needs of visitors. But there are other tourist destinations throughout the world that have these assets.

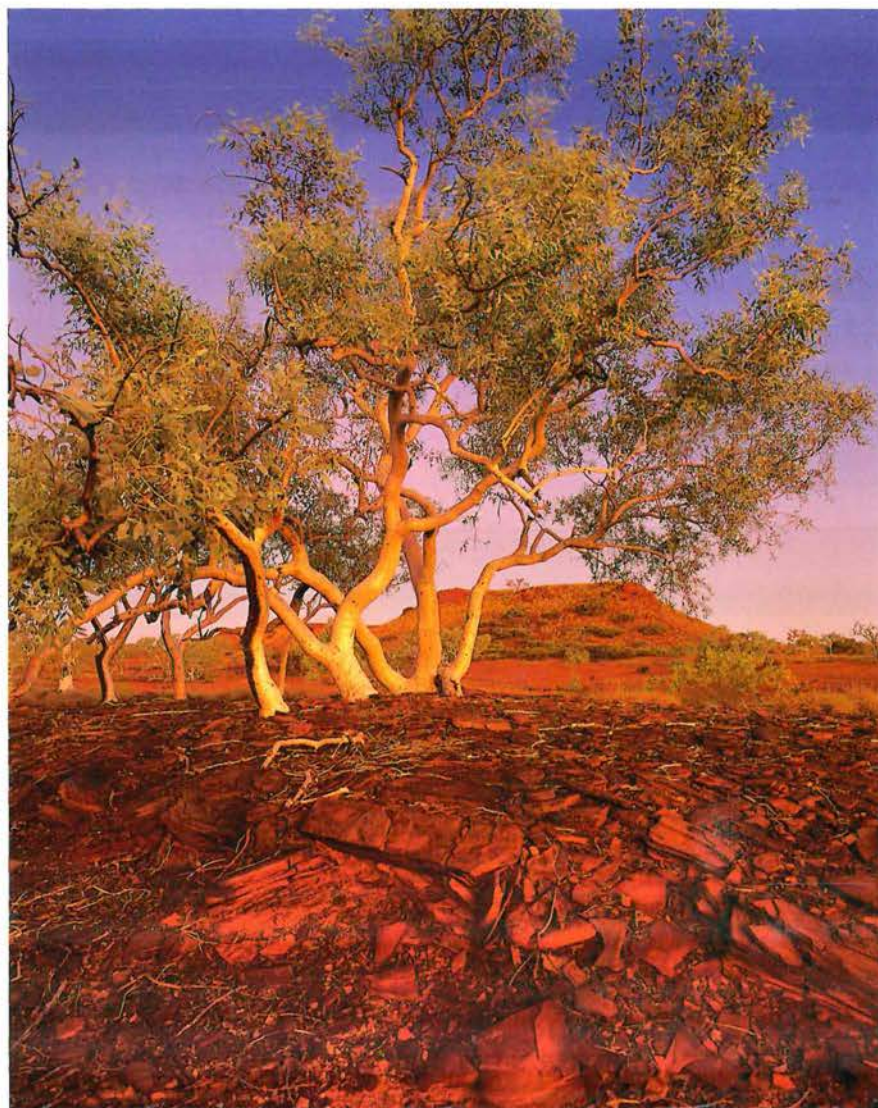
So what makes Western Australia a more appealing tourist destination?

Western Australia's predominant attraction is the uniqueness of its natural environment - its unusual plants and animals; its culture, bizarre and beautiful landscapes and its vastness - which can be packaged into the type of tourist experience that has become the premium tourist product.

## NATURE-BASED TOURISM

There have been various attempts to define this tourist 'product'. For example, ecotourism has been described as a form of tourism that is based on undisturbed natural areas, does not damage or degrade the environment, contributes to protecting and managing the areas being visited, and is subject to appropriate management. More recently, the term 'endemic tourism' has been coined. This recognises that tourists are interested in what is unique to any given place, including the cultural characteristics and values of communities that are linked to the natural environment.

Regardless of how we define the attraction, tourists visiting Australia have made it quite clear what they are seeking. In systematic surveys, more than 70 per cent of visitors have identified the principal reasons for their decision to holiday in Australia as the unusual birds and animals, interesting landscapes and



**Above:** Snappy gum (*Eucalyptus leucophloia*) in Millstream-Chichester National Park.

Photo - Chris Garnett

### Previous page

Yampi Sound, in the far north of WA, is one of the most isolated and scenic parts of the State.

Photo - Bill Bachman

**Inset:** Boat tours, similar to this through Geike Gorge, are being developed by local Aboriginal people.

Photo - Jiri Lochman

the space or 'last frontier atmosphere'. Paradoxically, some surveys have shown that while the natural environment dominates the overseas visitor's perception of Australia, they often do not get the experience they expect because many commercial tours concentrate on urban areas. It is only very recently that there has been an upsurge in outback-type tours.

The nature-based tourist experience can be as simple and as inexpensive as a trip to the bush for billy tea and damper, or as unique as the experience of

**Right:** Mt Nameless, in Karijini National Park.

Photo - Chris Garnett

**Below right:** Boardwalks at Meekadarabee, in Leeuwin-Naturaliste National Park, allow visitors to view the falls without impacting on their natural beauty.

Photo - Chris Garnett

**Far right:** WA's coastline is ideal for recreational snorkelling and diving.

Photo - John & Val Butler/Lochman Transparencies

swimming with whale sharks at the Ningaloo Reef. There is a rainbow of nature-based tourist experiences, with 'ecotourism' or 'endemic' tourism being just two of the colours.

However, nature-based tourism also lends itself to high-value, low-volume tourism. There are worldwide examples where nature-based tourists are willing to pay premium prices for an exclusive or unique activity. Specific segments of the natural tourism product can be designed to cater for relatively small numbers of people having high quality

experience. For example, this year at Ningaloo 1 000 tourists, some travelling from the other side of the world, paid more than half a million dollars over a six week period to experience swimming with whale sharks.

The quality of the nature-based tourist experience is, to a large degree, dependent upon the information and understanding given to the individual. It is not dependent just upon the unique natural feature itself, it is also the interpretation of the natural phenomenon that adds richness to the experience, because the type of tourist who is seeking nature is also inevitably seeking knowledge. We are now seeing significant numbers of tourists willing

to pay for a richer, value-added experience, particularly if they have already paid a great deal to reach their destination.

Increasingly, tourists want a new experience the next time they go on holiday. A nature-based tourist experience, whether it includes watching and interacting with dolphins visiting the shore at Monkey Mia, participating in a night-time possum spotting exercise, or swimming with whale sharks, will provide a 'new' experience no matter how many times it is repeated.

### THE WA EXPERIENCE

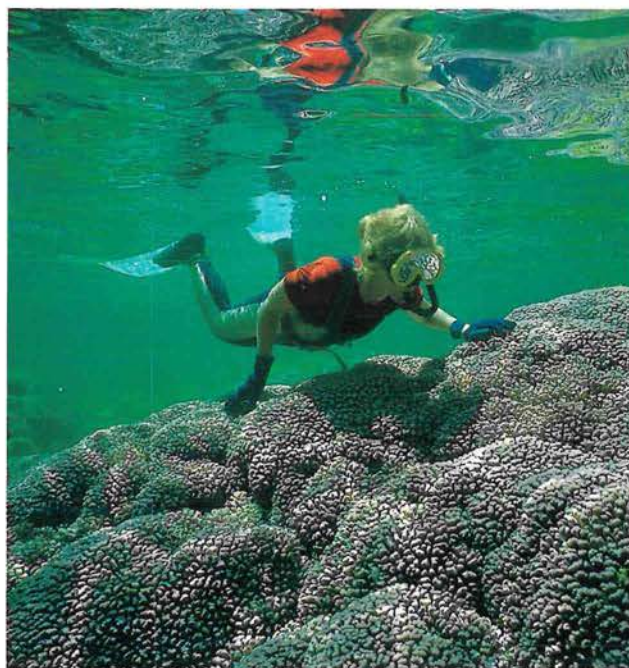
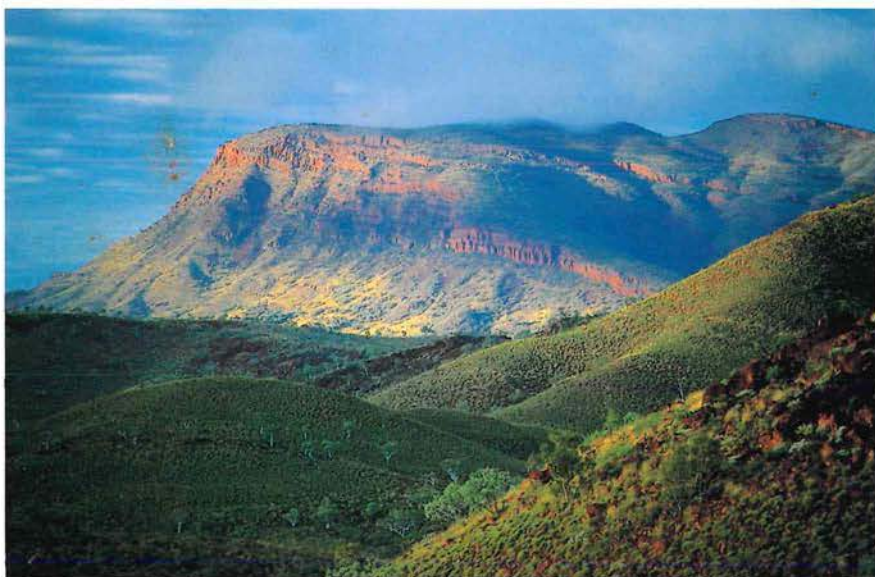
Western Australia covers more than 2.5 million square kilometres - a third

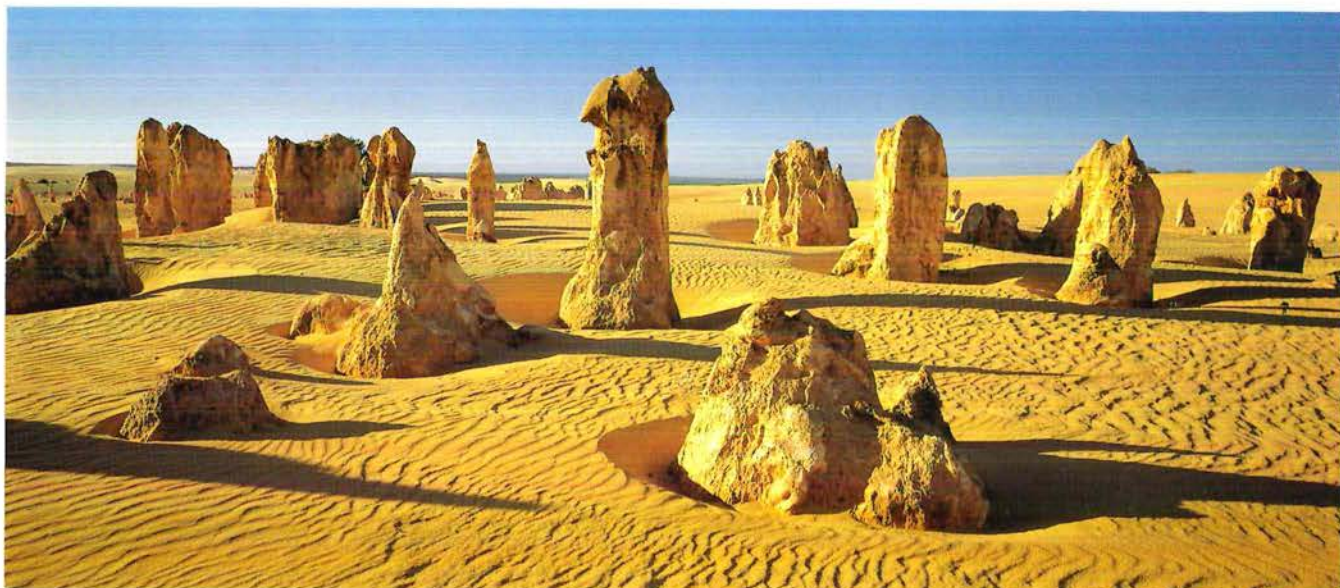
of the continent's land area and coastline. It has one of the oldest landscapes on this planet and is characterised by great diversity in landform, climate and biota.

Of the 25 000 species of flowering plants found in Australia, around 12 000 are found in Western Australia with more than two-thirds of those occurring only in this State. (In the United Kingdom there are approximately 1 400 species, about the same number that occurs in just one of the State's national parks.) Western Australia is one of the few places on earth that exhibits megadiversity, as do rainforests.

The State also has 180 native mammal species (including 37 marine), 480 species of bird, 390 species of reptile, 68 species of amphibian and 1 600 species of fish (CALM 1992). Many of these plants and animals can be seen nowhere else in the world.

Quite apart from the magnificent flora and fauna, Western Australia has a wide range of habitats - remnant rainforests, karri and jarrah forests, mangroves, heathlands, wetlands, coral reefs and deserts. These are combined with bizarre landscapes, beaches and gorges, masses of wildflowers, and features such as the Pinnacles, the striped beehive domes of the Bungle Bungle massif and the meteor crater at Wolf Creek. In addition, there is relatively easy access to rare wild animals. The basic attractions that nature-based tourists are seeking - biodiversity, a high





degree of endemism and unusual landscapes - are abundant in Western Australia and give us a comparative advantage over other nature-based tourism destinations.

There has already been dramatic growth in the number and variety of nature-based tour packages available for visitors to this State. The Western Australian Tourism Commission recently published an excellent guide called *'Western Australia Nature Holidays'*, which illustrates the potential for nature-based tourism, and CALM already has 82 registered tour operators in national parks and other areas it manages. Western Australia has a nature-based product that we believe is second to none in the world.

## CULTURAL-TOURISM

Nature-based tourism is also closely linked to what is sometimes called cultural tourism.

Aboriginal culture has great potential to feature strongly in the nature-based tourism rainbow in Western Australia. Cultural-tourism presents an opportunity for Aboriginal communities to generate income and provide employment for their people at a time when visitors are keen to understand Aboriginal culture and its relationship to the natural environment.

There are several examples in the north of the State where Aboriginal people are responding to the demand from tourists seeking cultural as well as nature-based information and experiences. For example, a traditional owner of the Purnululu National Park is one of three ground tour operators permitted to take fly-in campers to the Park.

CALM is working with Mr Sam Lovell, one of the legends and pioneers of nature-based tourism in the Kimberley, to develop tours that feature Aboriginal culture and involve local Aboriginal communities in developing tourism opportunities for themselves. One program being developed is an Aboriginal cultural tour of Geikie Gorge.

The existing launch cruise tour is led by CALM rangers who explain the biology and geology of the Gorge to as many as 30 000 tourists per year. However, Sam Lovell is developing, in association with local Aboriginal people, a specialised complementary tour that will give the local Aboriginal people an opportunity to incorporate the natural attractions of Geikie Gorge, while emphasising its Aboriginal heritage.

Closer to Perth, CALM wildlife officer Trevor Walley and CALM national park ranger Hardy Derschow have been overwhelmed with bookings for their demonstrations of how south-western Aborigines derived 'tucker' from the bush.

## CONSERVING THE ADVANTAGE

CALM manages more than 19 million hectares of Western Australia - areas that include most of the natural attractions tourists wish to visit. There are strict controls on any tourist activity or development in these areas to ensure that their natural assets are not degraded. However, protection of our unique environment can only be achieved by cooperation with the community and the provision of resources for management. That is why CALM sees the

The Pinnacles, in Nambung National Park north of Perth, attract around 150 000 visitors each year.

Photo - Robert Garvey

*Right:* Crystal clear pools, surrounded by lush vegetation, provide a tranquil and refreshing sight for visitors to the Pilbara's national parks.

Photo - Robert Garvey

*Below right:* Torndirrup National Park is one of several parks and reserves in WA's popular south coast region.

Photo - M & I Morcombe

tourism industry as an essential partner in achieving its conservation objectives.

In a State the size of Western Australia, with its diversity of plants and animals and its often fragile landscapes, it is possible to ensure protection of the environment by regulation and policing. It is more desirable, however, to foster community understanding of our environment and sympathy for it - the inevitable consequence of a nature-based tourist experience, and one of the most powerful forces that can be unleashed to protect the environment.

There is another advantage that tourism brings to conservation, and that is money.

In Western Australia, the most significant threat to our native fauna is not bulldozers, chainsaws or tourists - it is the European fox. CALM research has shown that when this introduced predator is controlled, native animals return in abundance to areas where they previously were extinct. What is required to ensure this major conservation initiative is sustained is more human intervention in the form of funding for management.

We can no longer expect taxpayers to be able to provide the level of funds required for management of lands and wildlife, but the redirection of a small proportion of the extra tourist dollars, generated by quality nature-based experiences, would be sufficient to fund major conservation initiatives.

## CONCLUSION

Australia is an island and has all the mystique that island nations connote; but Western Australia is an island on an island. This, together with the fact that we live on the oldest part of earth, is the reason we have a treasure trove of natural places, plants and animals.

Throughout its history, WA has suffered from isolation and, in places, from the ruggedness of its environment. It is ironic that these very factors now offer us the chance to satisfy the high demand for nature-based tourism and show our visitors the variety and value of what nature has given us.

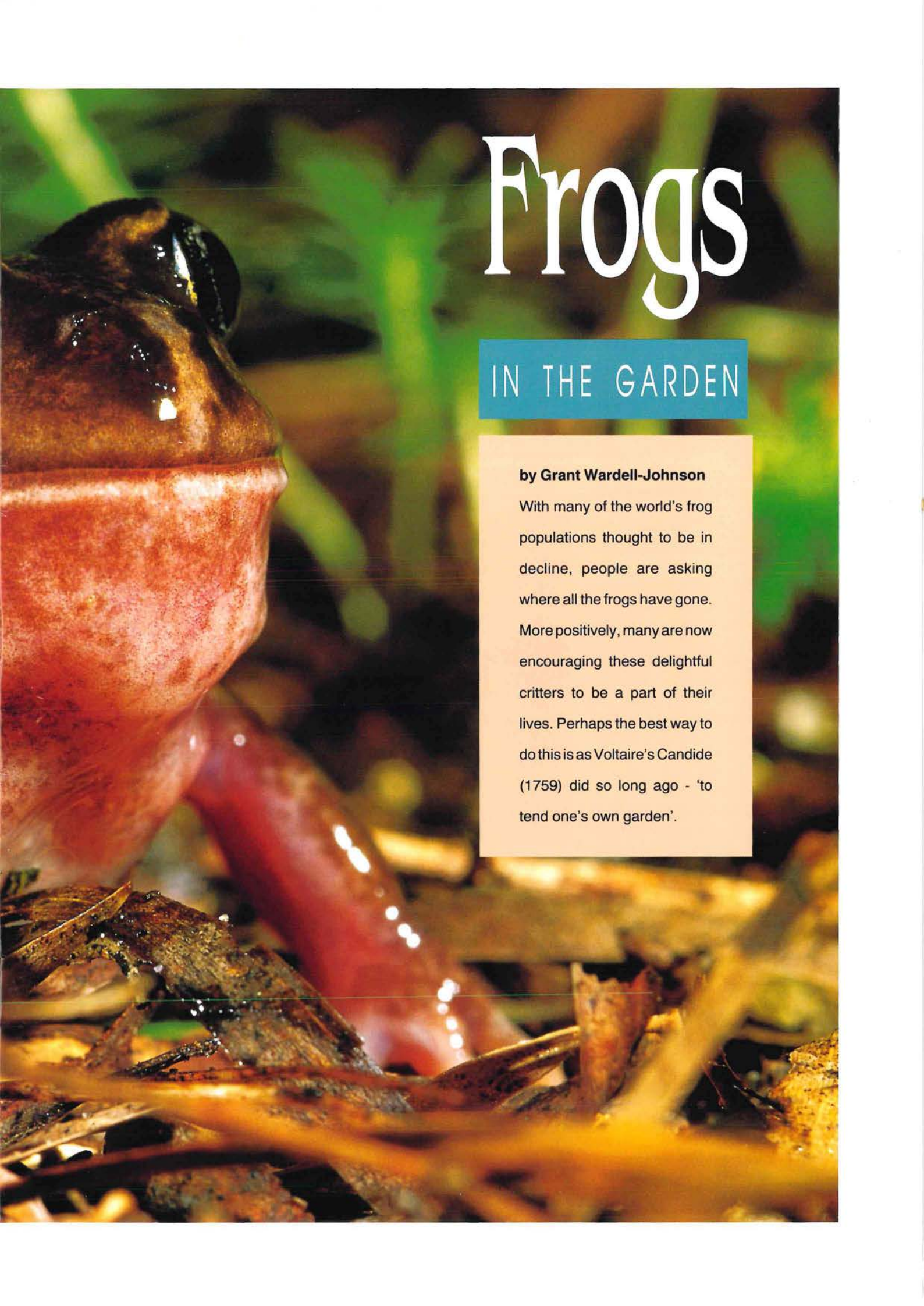
The opportunity to capitalise on our natural advantage will disappear if the natural assets we have are lost or damaged. There is no doubt, evidenced by what has happened in many unique areas throughout the world, that people pressure, if not managed properly, can cause severe environmental degradation. Too many people, too often in the one place, can destroy the very essence of the nature-based experience. But Western Australia is a vast land and it would be possible, with appropriate management, to quadruple current visitor levels without causing damage to the environment or lessening the nature-based tourist experiences.

CALM will continue working in partnership with the tourism industry to develop this exciting and fast-growing tourist product, which will help bring prosperity to the people of Western Australia, increase awareness of the beauty and variety of our environment, and emphasise the need to conserve our unique plants, animals and places.

Syd Shea is Executive Director of CALM and can be contacted on (09) 386 8811. Jim Sharp is Manager of CALM's Policy and Extension Branch and can be contacted on (09) 364 0700.







# Frogs

## IN THE GARDEN

**by Grant Wardell-Johnson**

With many of the world's frog populations thought to be in decline, people are asking where all the frogs have gone. More positively, many are now encouraging these delightful critters to be a part of their lives. Perhaps the best way to do this is as Voltaire's *Candide* (1759) did so long ago - 'to tend one's own garden'.

**F**rogs belong to a class of vertebrates called Amphibia, a name derived from their dual life-cycle, which is usually aquatic during egg and larval stages and terrestrial during adulthood. Despite this dependence on a moist environment, frogs have successfully adapted to a great variety of ecological situations. They occur in deserts and high mountains, in all continents except Antarctica, and on many islands. Australia is blessed with a remarkable number and variety of frogs. More than a third of Australia's total frog fauna occurs in Western Australia, and more than half of these are found only in WA. The 29 species of tree frogs and ground frogs found in the south-west (roughly the area between Esperance and Shark Bay) have a remarkable variety of shapes, sizes, life histories and mating calls.

The call of a frog is perhaps its most distinctive and most easily recognisable feature. Each kind of frog has a different call. In the breeding season, which varies from species to species, male frogs emit a loud advertisement call that, among other things, serves to attract a mate. Female frogs that are ready to mate respond to the calling male and move towards the source of the noise. The biggest and loudest males call from the most suitable places for egg-laying, which differ for each species. When the female locates the male, mating occurs and the eggs are laid.

The advertising call of the male also helps maintain spacing between calling frogs. Breeding males are hostile towards other males of the same species, and the calling acts as a warning to potential intruders to the male's calling site.

A night-time frogging expedition to a dam or creek at any time of the year will be rewarded with the sounds of calling

frogs. A torch will help you to locate calling frogs. If you live in the country or near wetlands, you can also try listening outside your door.

## FROGS IN YOUR GARDEN

Not all of the different species of frog in the south-west occur together and not all are likely to frequent gardens. However, many of the more common and interesting species can and do occur there.

The slender tree frog (*Litoria adelaidensis*) and the bull frog (*Litoria moorei*) are often found in gardens, particularly in greenhouses and ferneries or areas with water such as ponds. As its name suggests, the slender tree frog is a long, slender frog. Ranging in colour

from brown to green, it is often seen on window panes on warm, wet nights. In winter, from reeds up to a metre above water, it calls with a harsh grating screech, incorporating grunts. The bull frog, on the other hand, is a very large green and gold frog with little climbing ability. In spring it calls from water with a sound like a motor bike changing gears. This species is one of the most commonly encountered and has a voracious appetite.

Other frogs likely to be seen and easily distinguished include several of the ground frogs. The banjo frog (*Limnodynastes dorsalis*) is a noble frog indeed. *Limnodynastes* is Latin for 'Lord of the Marshes'. This species has a stripe down its back, hence *dorsalis* for dorsal stripe. It occurs throughout the south-



**Right:** The slender tree frog (*Litoria adelaidensis*) calls with a harsh grating screech and is often found in ferneries or greenhouses.

Photo - Jiri Lochman (Top)

Photo - Grant Wardell-Johnson (Below)

**Previous page:** Frogs are a fascinating and diverse group of creatures that can benefit from good garden planning. The moaning frog (*Heleioporus eyrei*), for example, will thrive in low areas prone to flooding.

Photo - Jiri Lochman

west, is very robust and has a bright crimson groin. It calls from vegetation in swamps and dams in winter and spring. Its loud, deep and explosive 'bonk' is unmistakable. It is often found on roads during wet, summer nights or may be dug up when turning garden soil.

There are five species of moaners (*Heleioporus*) in the south-west. The males call from burrows which become flooded after egg-laying in winter. All are large, stout, burrowing frogs with distinctive calls. The moaning frog (*H. eyrei*) is common around Perth and is widespread in the lower south-west. It tends to make itself unpopular when it calls (a loud, low moan) beneath the houses of people trying to sleep. Its calls are, however, welcome to gardeners in the autumn dry, for they herald the winter rains after the long summer.

The frogs so far mentioned have a free swimming tadpole stage, although the moaners are terrestrial breeders. They lay their spawn in burrows, outside water, as a foam nest. Once the burrows flood with the early winter rains, the tadpoles emerge. One species common around Perth is frequently sent to the museum as an oddity. The turtle frog (*Myobatrachus gouldii*) is an example of extreme ecological specialisation. This large frog has a small head with tiny eyes, and short, muscular limbs. It lives, feeds and breeds entirely underground, but during summer thunderstorms it calls from near the surface of its burrow with abrupt, deep croaks. It is one of many species in the south-west that do not have a free-living tadpole stage. This is known as direct development. Eggs of this species have been found more than a metre below the surface in moist sand.

All the frogs we have looked at so far are easily distinguished from one another without hearing their call. For some other species however, it is necessary to hear the call to identify the frog. The little froglet (*Crinia insignifera*) and Glauert's froglet (*C. glauerti*) are two small variable species that occur in the coastal plain. Both are small, long-limbed frogs with unwebbed fingers and toes and a variety of colours. The former makes a call that has been described as a 'squelch, like drawing a wet finger over a balloon' while the latter has a call like a 'long hollow rattle, rather like a pea in a can'. Both inhabit temporary or



permanent swamps and both are likely to occur in gardens close to lakes and swamps.

All frogs are carnivorous, many catching their prey by means of a sticky extendible tongue attached to the front of the lower jaw. All small frogs have a predominantly insectivorous diet. However, mites, snails, earthworms, spiders and other small animals are also eaten. Larger frogs may eat scorpions, centipedes and lizards. Anyone who has kept frogs in captivity, for even a short time, will know that it is essential to separate large ones from small ones because cannibalism is rife. It is also common in their natural state.

The feeding habits change dramatically during the life cycle. Tadpoles are mostly herbivorous, grazing on algae, while adult frogs are active predators. Most frogs appear to feed indiscriminately on moving animals. Sight is the important sense eliciting feeding behaviour and only moving prey is generally detected. The introduced cane toad (*Bufo marinus*) is an exception. In Queensland it is often an unwelcome guest around the feeding bowls of household pets.

Although frogs are harmless to people and don't bite, kick, scratch or make nuisances of themselves (unless one does not appreciate the melody of their seasonal mating calls), they should, nevertheless, be handled with care. This is not only for the frog's sake. Frogs have moist, glandular skins through which they breathe. They also secrete toxic mucus on to their skin, to help protect them from predators. These toxins may

The bull frog (*Litoria moorei*) is a large frequently encountered frog with a voracious appetite.

Photo - Grant Wardell-Johnson

Below: Gardens can be made more frog friendly with easily constructed ponds, as in this permaculture garden in Bridgetown.

Photos - Grant Wardell-Johnson

prove irritable to people, especially if they contact the eyes or mouth. If toxins do get into your eyes wash them with clean water. The large tree frogs are most likely to cause sensitivity.

## MODIFYING GARDENS

Gardens can easily be made more frog-friendly. Species native to the local area may well make your garden their



home if you provide or conserve suitable habitats. They may also help in pest control and provide a year-round chorus that reflects the changes in season. A garden suitable for frogs will also be suitable for a wide variety of other wildlife. Much is written about making the garden more bird-friendly, but little on frog-friendliness, and it is easy to have both in the garden.

While it is possible to encourage frogs in the garden, they should not, however, be introduced, particularly if found a long distance away. The cane toad, introduced into the Queensland canefields from the Caribbean in an attempt to control a beetle, rapidly escaped from the canefields into the surrounding area. It is now having a severe effect on Queensland's environment. Other, more local, introductions have also led to conservation problems for native species. It is better to ensure that your garden has plenty of shelter sites so that the frogs in the area rapidly realise it is a welcome home.

Some gardens are more likely than others to harbour a large variety and number of frogs. On the whole, frogs prefer damp places, so shade and moisture, which always add to a garden, will encourage many species. A pond will always encourage frogs, particularly the bull frog. A pond is readily built and need not be a breeding site for mosquitoes, particularly if other animals such as frogs are present. An inexpensive but attractive pond can be made from black plastic and old tyres with rocks and reeds at its edge to hide the construction materials. Of course, these should not be taken from the bush, where they are already somebody else's home. Frog habitat will be improved by vegetation and shelter sites, such as small logs and rocks around the edge of ponds. If you live near a swamp, most of the local species will rapidly appear in the garden.

This preference for a damp habitat is associated with their method of breathing. The skin needs to be moist so that oxygen can diffuse throughout it and be picked up by the blood circulating just underneath. If exposed too long to a dry atmosphere, water will evaporate from the body, and the frog will dry out and ultimately die.

Because of the permeable skin of

frogs, they are also particularly susceptible to pesticides and other chemicals in the garden. A healthy garden is most easily achieved by minimal and carefully targeted use of chemicals.

The provision of abundant shelter sites will encourage many species of frogs (and also invertebrates). The more invertebrates the more frogs, and diversity in the system will reduce the need for continued intervention (such as spraying to remove pests). If logs and stones are turned when searching for frogs in the garden or other places, they should be replaced so that their homes will not be destroyed.

Frogs are great friends of the gardener. They will eat most common garden pests. They also add another dimension to a garden. A chorus of frogs around a pond at night ranks with the joy of chattering birds around a grevillea in the early morning, and it is just as easy to achieve with a little planning. Your garden could be a vibrant home for wildlife by day and by night.



There are five species of *Heleioporus*, or moaners, in the south-west. The whooping frog (*H. inornatus*) is found in sandy-peaty sites of the Darling Scarp and Plateau.

Photo - Grant Wardell-Johnson

Below: The banjo frog (*Lymnodynastes dorsalis*) is a very noble frog indeed. *Lymnodynastes* means 'Lord of the Marshes'. Its call is a loud explosive bonk from water.

Photo - Grant Wardell-Johnson

Grant Wardell-Johnson is a CALM senior research scientist studying small vertebrates. He can be contacted on (097) 711 988. A similar article has appeared in the *WA Gardeners Yearbook*.





## SEAGRASS SURF AND SEA LIONS

Within 10 nautical miles of the shore between Dongara and Lancelin lie some 36 small islands that teem with wildlife. From the beautiful lagoon and limestone formations on the west side of South Green Islet to the shell-strewn beaches and colourful reefs of the Fisherman Islands, these islands are a visual feast.

by  
Carolyn Thomson  
and Greg Pobar



**T**he islands, which vary in size from a few square metres to about 25 hectares, are located off the west coast of Western Australia in a narrow chain between 120 and 360 kilometres north of Perth.

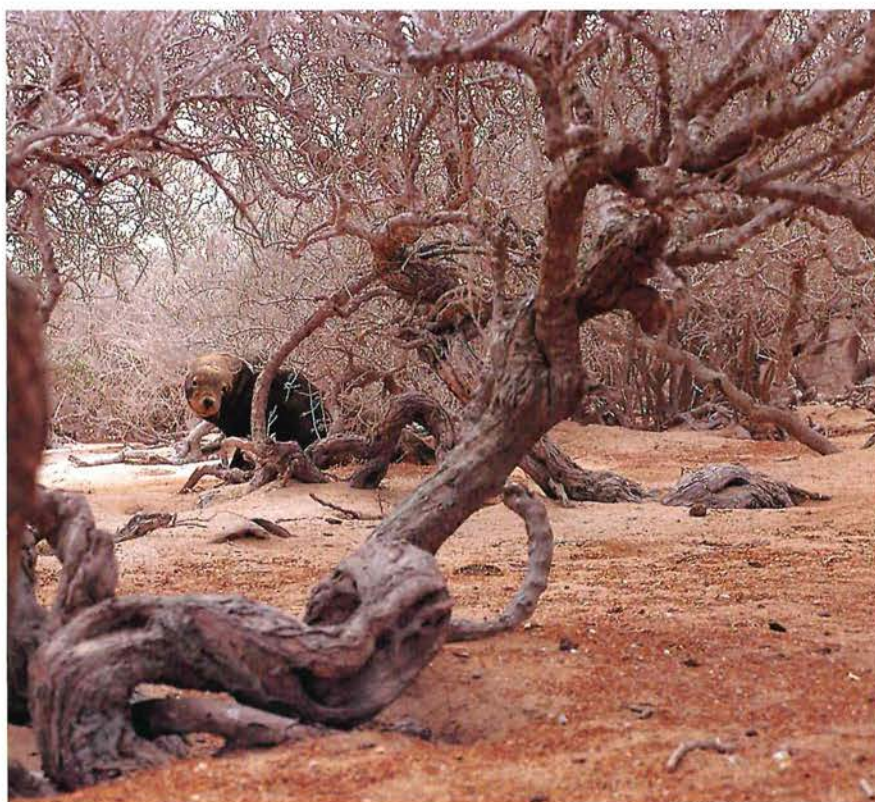
Like most of Western Australia's islands, these are important refuges for plants and animals - sea lions and other mammals, birds and reptiles. All of them are nature reserves managed by the Department of Conservation and Land Management (CALM).

For many years, the ocean surrounding the islands has supported a thriving rock-lobster industry with fishers based at the many small coastal settlements that dot this part of the coastline. Even with modern navigational equipment, the reefs that wind through the islands still present dangers to fishers and the increasing number of boating enthusiasts and holiday makers. But for early navigators this was an extremely hazardous part of the coastline.

## SHIPWRECKS

The islands were first recorded by early Dutch navigators. The *Gilt Dragon*, a Dutch vessel, was wrecked on a reef off Ledge Point, just south of Lancelin, in 1656. A small boat, sent to search for the treasure and remaining survivors, was also lost in a storm. The 13 sailors on the rescue vessel managed to survive the hostile WA coast, sheltering on Lancelin Island for a brief period, and four of them eventually sailed to Batavia. The American whaling barque the *Cervantes* (1844), an Italian-owned barque *Europa* (1897), a passenger steamer *Lubra* (1898) and Australian steamer the *Cambawarra* (1914) were also wrecked along this coast.

More recently, in July 1991, environmental disaster was narrowly averted when the Greek oil tanker *Kirki* began to break up in heavy weather some 20 nautical miles from *Cervantes*. The vessel spilt up to 10 000 tonnes of oil. As the Greek crew were winched off the boat by helicopter in appalling conditions, CALM officers prepared to find out whether local wildlife had been affected and mount a rescue operation if necessary. Fortunately, the islands' marine environments and the dependent industries were spared. Ideal weather conditions broke up the oil before it



Every 18 months, Australian sea lion bulls leave the islands off Perth and swim to the Lancelin-Dongara breeding islands to mate.  
Photo - Carolyn Thomson

**Previous page**  
**Main:** Australian sea lions at Fisherman Islands.

**Inset:** Whittell Island  
Photos - Carolyn Thomson

**Inset:** Ribbon weed, one of the species of seagrass.  
Photo - Clay Bryce/Lochman Transparencies

could cause problems, and salvage vessels towed the crippled ship northward to calmer waters, where the remaining oil was removed from the vessel.

Today, the names of the reefs - Death Valley, the Boomers, Big Break, Big Wave and Coffins Reef - are indicative of the respect with which they are viewed by locals. They should ensure boaters take a cautious and alert approach to the island chain.

## THORNS AND DAISIES

The islands are normally clothed in low heath dominated by coast daisy (*Olearia axillaris*) and thick-leaved fan-flower (*Scaevola crassifolia*) on sandy areas. Herbfields and grasslands grow on very shallow soils over limestone, and soda bush (*Nitraria billardieri*) shrublands are found on the slopes or plateaus of the islands.

The soda bush shrublands, such as those on the Beagle Islands, are prone to invasion by boxthorn (*Lycium ferocissimum*), a South African species believed to have been spread by seabirds. Soda bush plants are relatively open underneath and tend to grow in shallow guano-rich soils (the product of nesting seabirds or resting seals). The birds that spread boxthorn use soda bush for resting or nesting. These are seagulls and rock parrots, both of whom eat the succulent fruits of the boxthorn and soda bush.

CALM officers who visit the islands every few months or so to monitor the wildlife are steadily eradicating the boxthorn. This involves attacking the thorny weeds with a chainsaw, removing and burning the cuttings and, finally, painting the stumps with a herbicide to guard against regeneration. The eradication is being done gradually, to avoid leaving large areas denuded of vegetation. Ironically, the Australian sea lions found on the Beagles don't distinguish between the introduced and native vegetation, and commonly slumber beneath the boxthorn thickets.

## SEALS AND SEA LIONS

The Australian sea lion - the rarest sea lion in the world - breeds on a number of the islands. As well as the Beagles they also breed on North Fisherman and Buller Islands, and are found on many



other islands in this system. Research on the animal's breeding habits by marine biologist Dr Nick Gales has shown that it is the only sea lion in the world with an 18-month breeding cycle. Further monitoring by CALM's Greg Pobar has shown that every 18 months the bulls leave the islands off Perth and swim north to these islands to mate. When mating is over they return to the Perth area, presumably to take the feeding pressure off the females and their young pups.

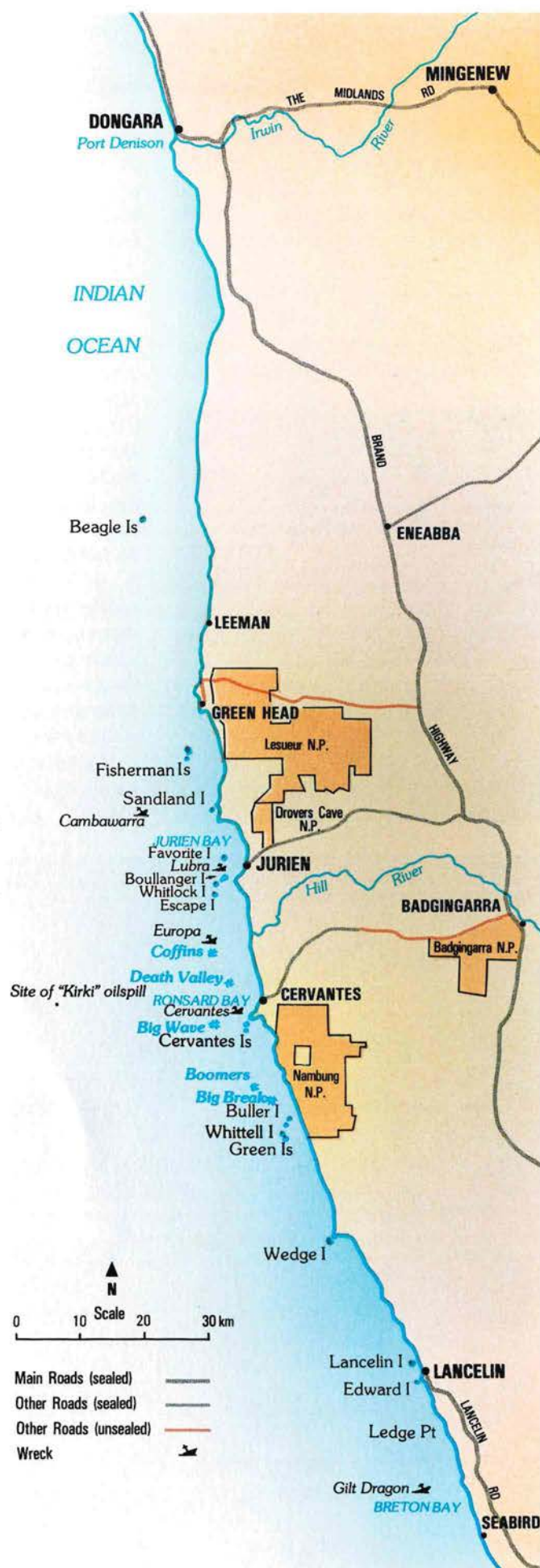
Remarkably, throughout the sea lion's range, breeding and mating on different islands takes place at different times of the year. This is even evident within the relatively small area spanned by the Lancelin-Dongara Islands. The population on Buller Island breeds a few months later than the Fisherman and Beagle Islands populations.

The sea lion population along the State's west coast is probably genetically distinct to Australian sea lion populations elsewhere, including the populations on the south coast of Western Australia. Nick Gales believes there is virtually no genetic exchange between each population. Since the total west coast sea lion population may number only 1 000, the protection and management of these animals is even more vital.

As the islands become more popular, conflict with people will be inevitable.

**Top:** Buller Island is a popular resting spot for sea lions. Photo - Greg Keighery

**Above:** Iceplant (*Mesembryanthemum crystallinum*), an introduced weed, has leaves covered by large, glistening hairs. Photo - Greg Keighery



Sea lions can deliver a savage bite and it is dangerous to approach them, particularly during the breeding season, when the females will do anything to protect their pups. For this reason, the public is encouraged to leave the animals in peace and refrain from visiting the sea lion breeding islands.

Like the Australian sea lion, the New Zealand fur-seal suffered a massive decline from over-hunting last century and now seems to be recovering. As a

result, New Zealand fur-seals are occasionally seen on the islands. Sub-Antarctic fur-seals sometimes stray to these waters. However, they arrive in an emaciated and weak condition, after their long swim from sub-Antarctic waters and usually die.

### DIBBLERS AND DUNNARTS

The rare dibbler, once thought to be extinct, is found on Boullanger and Whitlock Islands. This small carnivorous marsupial was discovered on Boullanger Island when CALM researcher Phil Fuller spotted some unusual tracks in the sand during a research trip in 1985. Dibblers have long, tapering hairy tails and white rings around their eyes. They are nocturnal. Breeding occurs once a year in March. Copulation takes eight to ten hours and the breeding season lasts between ten days and two weeks. One male dibbler on Boullanger was recorded mating with six females in four days. All the male dibblers on Boullanger Island die within one week of the mating season - of stress.

A small dunnart occurs on Boullanger Island. It is closely related to the grey-bellied dunnart (*Sminthopsis*

*griseoventer*); however, research by zoologists Tony Lynam and Dr Chris Dickman has shown that it may be a new species or subspecies.

### SKINKS AND SEABIRDS

Many kinds of geckoes and skinks are found on several of the islands. Attractively patterned kings skinks are often seen on Boullanger, Whitlock, Escape and Favorite Islands. They are thought to form a distinct subspecies. The Lancelin Island skink is even more special. It is found on the 7.6 hectare Lancelin Island and no other place.

A large variety of seabirds use the islands and surrounding waters for



Dibblers (*Parantechinus apicalis*) are found on Boullanger and Whitlock Islands.

Photo - Jiri Lochman

Kings skinks are often seen on Boullanger, Whitlock, Escape and Favorite Islands.

Photo - Jiri Lochman



feeding and breeding. Terns, cormorants, gulls, oystercatchers, shearwaters, sea eagles and ospreys breed there. More than eleven bird species breed on Sandland Island alone, an area of only 1.5 hectares.

It is common to see crested terns crashing into the water to catch small fish, or green moray eels left squirming in the nests of the pied cormorants while they fish for more. The large pacific gull (*Larus pacificus*) snatches the large turban shell (*Turbo torquatus*) from the reef top at low tides and flies over a favoured island outcrop, continuously dropping the shell until it breaks open. The meaty animal is then swallowed

whole. It seems that every island has its own 'bombing' site - evident by the piles of broken shells high up on the limestone faces.

## UNDERWATER PARADISE

Few have explored the island chain below the water. The rich seagrass beds and shallow lagoons favoured by the sea lions are surrounded by limestone reef platforms and are the source of a thriving rock lobster fishery. But there are even

more subtle and fascinating plants and animals to experience. In many of the protected lagoons, tropical, sub-tropical and temperate fish and marine life swim together. These lagoons snare larvae of marine plants and animals, which are driven south from the tropics by the warm Leeuwin Current.

Infestations of *Drupella* have recently been discovered on the reefs south of Fisherman Islands. This small knobbly marine snail strips the living veneer of

The ground on many of the islands is honeycombed with burrows made by wedge-tailed shearwaters.

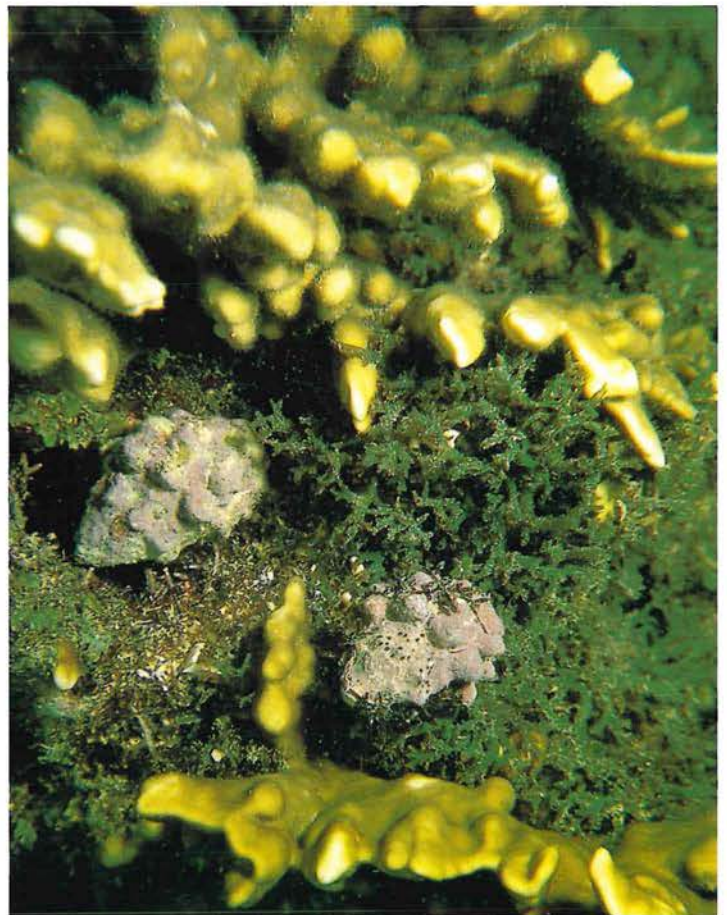
Photo - Jiri Lochman

**Below right:** The coral-eating snail *Drupella* was recently discovered on reefs off Fisherman Islands.

Photo - Greg Pobar

**Below:** Regurgitated eel on a pied cormorant's nest on one of the Beagle Islands.

Photo - Carolyn Thomson





coral from the reef. At Ningaloo Marine Park, off Exmouth, hundreds of millions of the snails have eaten parts of this spectacular reef, leaving large areas of dead coral covered in a green-brown carpet of algae. A recent CALM wildlife monitoring visit to Fisherman Islands confirmed that the snail was still found there and had appeared to spread. Large areas of dead branching coral (*Acropora*) had been eaten out by the snail. Samples of the voracious snail were collected and taken back to *Drupella* researchers in Perth. CALM will continue to monitor the *Drupella* infestation and would like to hear from any divers who have seen the snail along this part of the coast.

Only 30 miles offshore, the continental shelf drops to depths of 1 000 metres, where there are upwellings of

cold sub-Antarctic water. The effect of the cold water is reflected in the marine communities. Small lagoons of tropical corals, parrotfish and trochus shells are often surrounded by seagrass beds supporting marine life more common further south, while larger deep ocean predators and schooling fish swim the back reefs. The marine life is so diverse that you could easily become confused and wonder whether you are snorkelling

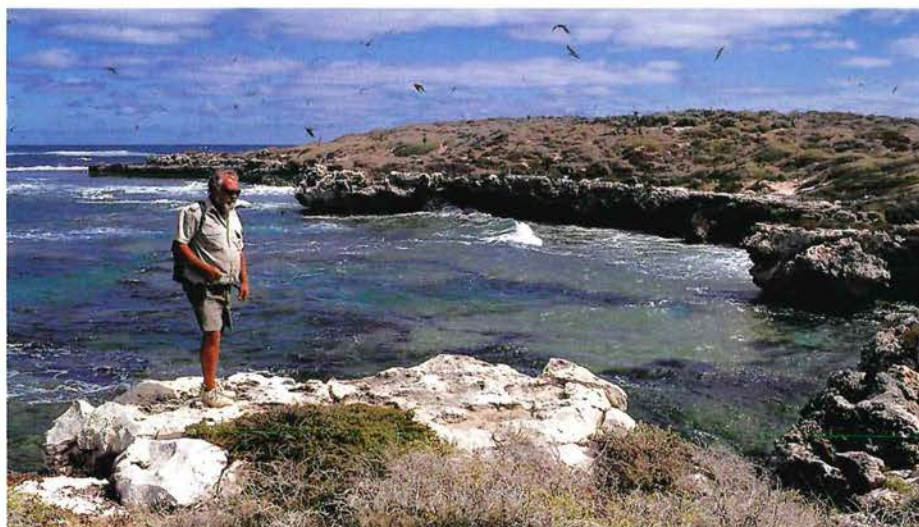
**Above:** Australian sea lions are the rarest sea lions in the world and the State's west coast population is thought to be genetically distinct.  
Photo - Jiri Lochman

**The Green Islets** are a haven for many species of seabird.  
Photo - Carolyn Thomson

the bays of Cape Leeuwin, Rottnest or the Abrolhos.

## CONCLUSION

The dangerous reefs and unpredictable weather along this wild part of the coast have served the islands and their wildlife well by protecting them from over-use. However, it is inevitable that they will be increasingly disturbed by curious people and emergencies such as the *Kirki* oil spill. Already the rediscovery of these islands is providing researchers and managers with many interesting and challenging projects. The reward will be to continue to learn about and manage these islands and reefs so that all uses can be adequately accommodated while safeguarding the seascapes and wildlife.



Carolyn Thomson is a CALM communications officer. She can be contacted on (09) 389 8644.

Greg Pobar is the Swan Region's marine operations manager. He has participated in wildlife surveys on the islands between Dongara and Lancelin for a number of years and can be contacted on (09) 448 5800.

The assistance of CALM botanist Greg Keighery, CALM senior technical officer Phil Fuller and Myra Stanbury of the WA Maritime Museum is gratefully acknowledged.



# ENDANGERED!



## THE SWAMP STARFLOWER: *CALYTRIX BREVISETA* SUBSP. *BREVISETA*

In 1837, Captain James Mangles left the Swan River Colony in Western Australia bound for England. On board his ship, the *Hero*, was a collection of plant specimens from James Drummond, the State's first Government Botanist. In 1839 John Lindley, Professor of Botany at London's University College, named two specimens, including one collected by Drummond, as *Calytrix breviseta*.

In 1987, a subspecies of the starflower *Calytrix breviseta* was recognised and named as the subspecies *stipulosa*. As a result the typical *Calytrix breviseta*, or swamp starflower, became known as *Calytrix breviseta* subsp. *breviseta*. It is distinguished from the other subspecies (*stipulosa*) by its longer, linear leaves and longer petals.

The swamp starflower forms an attractive erect or spreading shrub up to about 40 cm tall. Purple flowers

with numerous stamens are scattered along the branchlets. It is found growing in winter-wet depressions in low heath of featherflowers (*Verticordia acerosa* and *V. plumosa*).

Since the original collections, only a few specimens of the swamp starflower were known to exist, with the last herbarium collection made in 1915. It had been presumed extinct with the likelihood of its rediscovery seeming remote - the known plant sites were from Perth suburbs that have since been largely cleared.

In November 1990, Anne Kelly and Amanda Spooner, consultant botanists with the Flora Conservation Research Program of the Department of Conservation and Land Management (CALM), discovered a population of the plant on private land in one of Perth's eastern suburbs.

In 1991, the swamp starflower was gazetted as "declared rare flora" and a management strategy was

drawn up by CALM to protect it. This involves liaising with the landowners, monitoring the site annually, collecting of seed for long-term storage and, if possible, acquiring the site as a conservation reserve.

The dieback disease caused by *Phytophthora cinnamomi* has since been identified at the site and its long-term ecological impact on the starflower could be significant.

Further surveys in similar areas may reveal other populations, and the development of propagation techniques may allow the cultivation of the swamp starflower. In these ways we may be fortunate to see more of this rare and attractive plant.

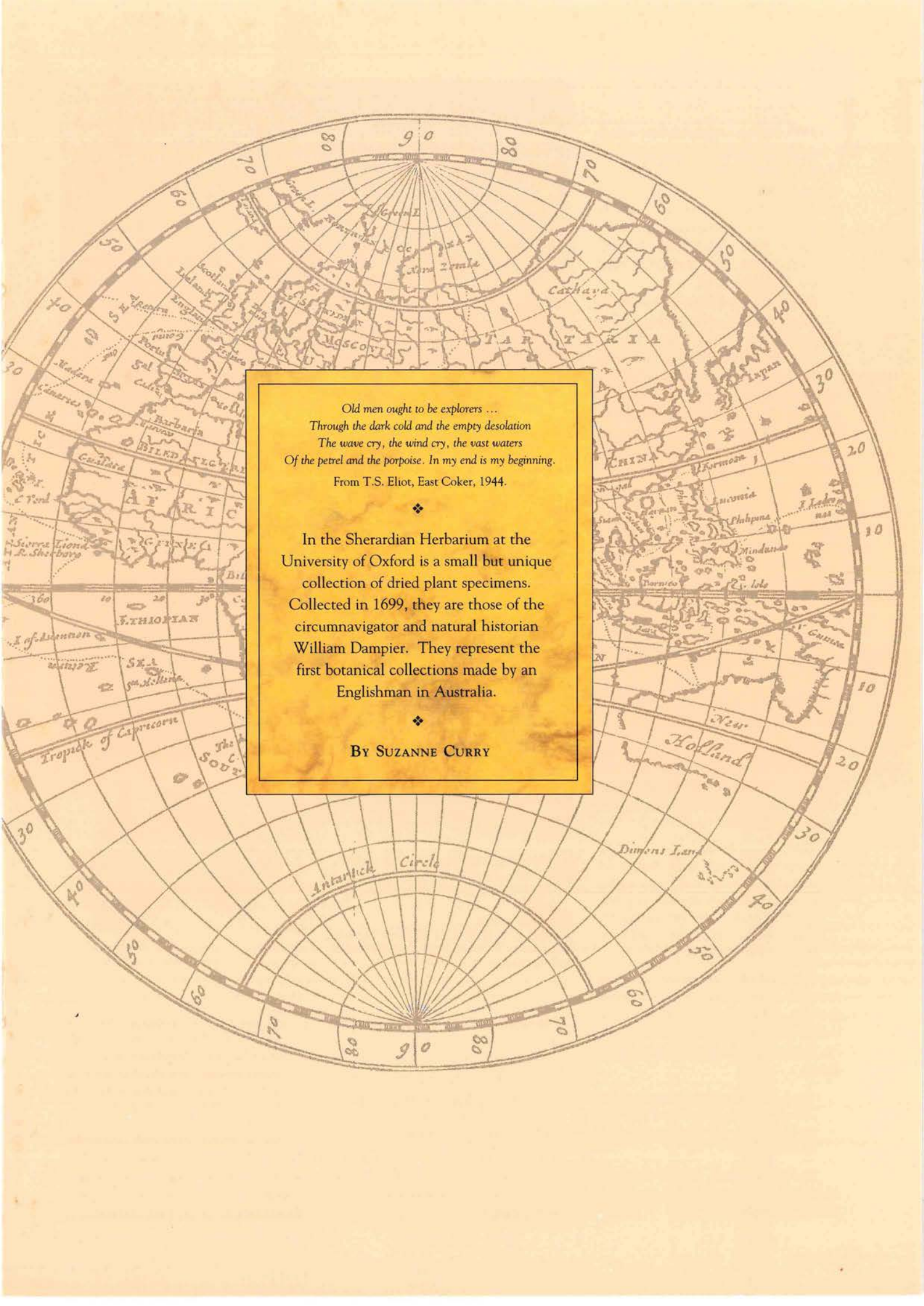
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by Suzanne Curry  
and Anne Kelly  
Photo - David Coates

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WILLIAM DAMPIER  
VOYAGES TO NEW HOLLAND





Old men ought to be explorers ...  
Through the dark cold and the empty desolation  
The wave cry, the wind cry, the vast waters  
Of the petrel and the porpoise. In my end is my beginning.  
From T.S. Eliot, *East Coker*, 1944.

❖

In the Sherardian Herbarium at the University of Oxford is a small but unique collection of dried plant specimens. Collected in 1699, they are those of the circumnavigator and natural historian William Dampier. They represent the first botanical collections made by an Englishman in Australia.

❖

BY SUZANNE CURRY

**I**n 1679, Dampier began his first voyage around the world. It was not a planned, single voyage. Instead, he travelled on various ships, worked in several places and slowly made his way in a westerly direction. It was during one stage of this voyage, in 1688, that Dampier had his first encounter with Australia, then known as New Holland.

Dampier left Spanish America in 1686 to cross the Pacific on the *Cygnnet*, under the command of Captain Swan. He was keen to establish better trade links between England and the Spice Islands and to find safer trade routes while mapping the unknown eastern coast of New Holland. However, the ship followed a more northerly route than was planned, via China and the East Indies, and came upon the north-western coast of what is now Western Australia.

On 15 January 1688, near the islands later known as the Buccaneer Archipelago, the WA coastline was sighted. Extensive studies reveal that the *Cygnnet*, now under the command of Captain Read, probably sailed into Karrakatta Bay at the entrance to King Sound, where she remained until March of the same year.

## DAMPIER'S FIRST ACCOUNT OF WESTERN AUSTRALIA

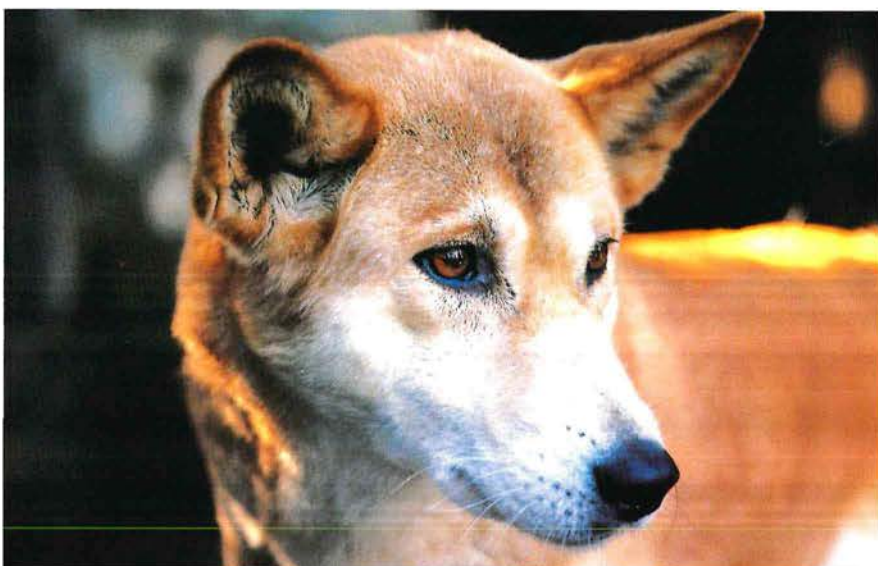
Although no natural history collections were made on this particular voyage, Dampier did make some interesting observations on the country and its inhabitants.

"The Land is of dry sandy Soil, destitute of Water, except you make Wells; yet producing divers sorts of Trees; but the Woods are not thick nor the Trees very big. Most of the Trees that we saw are Dragon-Trees as we supposed; and these too are the largest Trees of any there ..."

The plant observed by Dampier was most likely the screw pine (*Pandanus spiralis*), which is widespread in the tropics of Australia and looks remarkably like the European dragon tree (*Dracaena draco*).

"We saw no sort of Animal, nor any Track of Beast, but once; and that seemed to be the Tread of a Beast as big as a great Mastiff-Dog ..."

The dingo (*Canis familiaris dingo*) or possibly a wallaby or kangaroo could fit this description.



**Top:** Islands of the Buccaneer Archipelago near where the WA coastline was sighted in 1688.  
Photo - Bill Bachman

**Above:** Was a dingo responsible for the mysterious tracks recorded by Dampier?  
Photo - Wade Hughes/Lochman Transparencies

**Previous page**  
**Inset:** Portait of Capt. William Dampier.  
Painted by T. Murray 1698, National Portrait Gallery, London.



Dampier's notes on the Aborigines reveal:

"They have great Bottle-Noses, pretty full Lips, and wide Mouths. The two Fore-teeth of their Upper-jaw are wanting in all of them, Men and Women, old and young; whether they draw them out, I know not: Neither have they any Beards ..."

And that infamous insect, the common bush fly, was obviously very much apparent:

"... they being so troublesome here, that no fanning will keep them from coming to one's Face; and without Assistance of both Hands to keep them off, they will creep into ones Nostrils, and Mouth too, if the Lips are not shut very close ..."

On 23 March 1688, the *Cygnnet* left New Holland for Christmas Island. As Dampier was having difficulties with Captain Read and the crew, who had threatened to leave him marooned in

New Holland, he left the *Cygnets* at the earliest opportunity, at the Nicobar Islands. Later, he joined the *Defense*, from which he disembarked in England on 27 September 1691.

Soon after arriving home, he began writing, *A New Voyage Round the World*, which was eventually finished and published in 1697. The book captured the imagination of all Europe, and revealed Dampier as a competent scientific observer of some literary note. In 1699, he published a supplement to his book, which showed him to be a skilled hydrographer and marine scientist.

### VOYAGE OF THE ROEBUCK

Dampier was by now regarded as an authority on the tropics and the South Seas. On the basis of this reputation, he successfully applied to the British Admiralty for command of a ship to make a voyage to New Holland. He planned to discover the extent of this country and search for economically viable products for Britain.

Dampier, in command of *HMS Roebuck*, left England on 14 January 1699 with provisions for 20 months. Dampier's original intention was to travel by way of Cape Horn and the Pacific to the area of the undiscovered east coast of New Holland. On reaching South America his plans were changed due to the seasons, and he sailed instead for the west coast of New Holland via the Indian Ocean. He still had full intentions of

circumnavigating New Holland, but subsequent events were to prevent him from doing so. The discovery of the east coast was left to fellow-Englishman James Cook.

Dampier reached the west coast of New Holland after a voyage of several months. On 17 August 1699, he sighted an opening in the land where he anchored in seven and a half fathoms. He named this area Shark's Bay (now called Shark Bay) and his anchorage was somewhere between Dirk Hartog Island and Peron Peninsula. The crew went ashore on Dirk Hartog Island in search of water, but to no avail. This search for water continued without success during their entire stay at Shark Bay; however, they were well rewarded with food and wood. During the five days at this anchorage, Dampier made extensive observations on the geography and the plants and animals of the area.

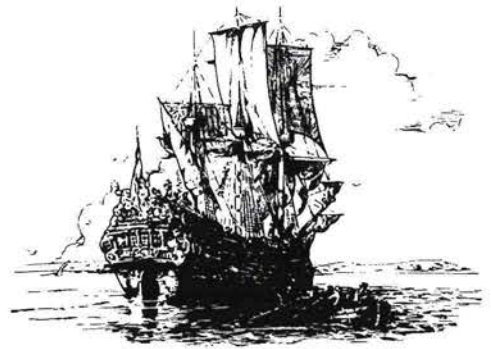
**Top right:** Sketch of *HMS Roebuck* by John Allcot.

**Above right:** Dampier collected *Diplolaena grandiflora* from Shark Bay in August 1699.

Photo - Jiri Lochman

**Below:** *Beaufortia dampieri* was named in honour of Dampier by English botanist Allan Cunningham in 1833.

Photo - Jiri Lochman



He gathered the majority of his botanical collections from Shark Bay, possibly all from the northern end of Dirk Hartog Island. Of the 23 collections still known to exist, 18 can be attributed to Shark Bay. Amongst these are *Beaufortia dampieri* and *Dampiera incana* (both named in honour of Dampier), *Diplolaena grandiflora*, *Melaleuca cardiophylla*, *Myoporum acuminatum*, weeping pittosporum (*Pittosporum phylliraeoides*) and *Solanum orbiculatum*. *Beaufortia dampieri* is a spreading shrub with pale pink to white flowers belonging to the family Myrtaceae. It occurs on sand dunes in tall open-heath on Dirk Hartog Island and on the mainland.

Dampier's collection of *Dampiera incana*, belonging to the family Goodeniaceae, has become the very important 'type' collection, the specimen on which the name of the species is based. It is a perennial herb with deep blue flowers that occurs on sand dunes on Dirk Hartog Island.

Several species of plants, additional to the existing collections, can also be recognised from Dampier's observations:

"The Mould is Sand by the Sea-side, producing a large Sort of Sampier [sic], which bears a white Flower."

This is presumably nitre bush (*Nitraria schoberi*), a succulent-leaved



shrub, which is found growing on the sand dunes.

"Farther in, the Mould is reddish, a Sort of Sand producing some Grass, Plants, and Shrubs. The Grass grows in great Tufts, as big as a Bushel, here and there a Tuft ..."

This could refer to *Spinifex longifolius*, *Triodia plurinervata* or *Plectrachne danthonioides*. The spinifex is common on the coastal dunes, and the other two occur behind the foredunes.

But Dampier's extensive and detailed observations were not confined to botany:

"The Land-Animals that we saw here were only a Sort of Raccoons, ... for these have very short Fore-Legs; but go jumping upon them as the others do ..."

It has been commonly thought Dampier was referring to the banded hare-wallaby (*Lagostrophus fasciatus*), but this may not be the case. It was undoubtedly one of the species of hare-wallaby that once roamed, but is now extinct on Dirk Hartog Island.

Dampier's delightful description of the bobtail skink (*Tiliqua rugosa*) is worthy of mention. How else could such a curiosity be described, but like this:

"And a Sort of Guano's [i.e. iguana],... For these had a larger and uglier Head, and had no Tail: And at the Rump, instead of the Tail there, they had Stump of a Tail, which appear'd like another Head; but not really such, being without Mouth or Eyes

... They were speckled black and yellow like Toads, and had Scales or Knobs on their Backs like those of Crocodiles, plated on to the Skin, ..."

Still in search of water, he moved anchorage to the northern end of Peron Peninsula on 22 August, and again, between 23 and 25 August, to the east of the Dorre and Bernier Islands. He sent a landing party to Bernier Island and records:

"... the Isle produces nothing but a Sort of green, short, hard, prickly Grass, affording neither Wood nor fresh Water ..."

It is very likely this was spinifex (*Spinifex longifolius*) which forms dense tussocks in the sand drifts at the north-eastern end of Bernier Island.

On 25 August, the *Roebuck* departed from Shark Bay, heading north through the Naturaliste Channel. Dampier made frequent observations on marine life, particularly whale activity, along the coastline. On 29 August he recorded:

"... we had in the Night Abundance of Whales about the Ship ... blowing and making a very dismal Noise ... Indeed the Noise made by blowing and dashing of the Sea with their Tails, making it all of a Breach and Foam, was very dreadful to us ..."

This was undoubtedly a pod of humpback whales (*Megaptera novaeangliae*), which are very active in those waters at that time of year. The

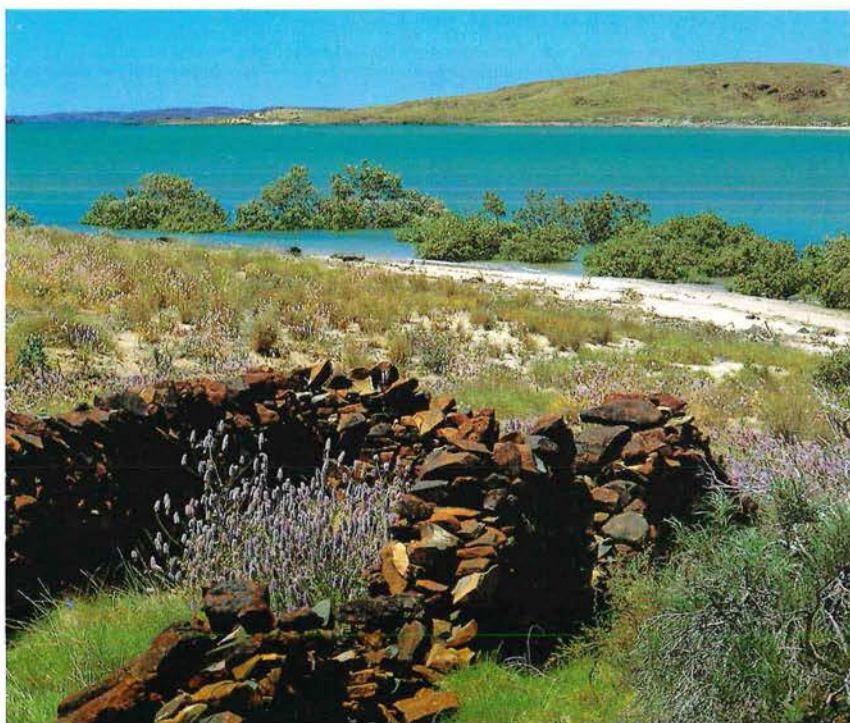
ensuing passage was fairly uneventful until land was sighted on 1 September near the Dampier Archipelago.

## DAMPIER'S ARCHIPELAGO

Included among the botanical specimens at the Sherardian Herbarium is a fragment of plant described and illustrated in Dampier's journal as a *Conyza* from New Holland, with leaves like those of the herb rosemary. Thus the island in the Dampier Archipelago on which this plant was first collected by Dampier was dubbed Rosemary Island. Studies have concluded that his Rosemary Island is most likely East Lewis Island (rather than the island known today as Rosemary Island), and that anchor was dropped at the south-western end of this island on 3 September 1699.

The plant species is commonly thought to have been the familiar coastal daisy (*Olearia axillaris*). However, continuing research on this genus by Nicholas Lander, Principal Research Scientist at CALM's Western Australian Herbarium, has revealed that the specimen is in fact a distinct species of *Olearia* which, despite being amongst the earliest of our plants described by Europeans, still lacks a name, a situation shortly to be remedied.

Dampier also collected a plant with blossoms:





**Above:** Dampier collected Sturt pea (*Clianthus formosus*) from the Dampier Archipelago in September 1699.

Photo - Bill Bachman

**Right:** Brown boobies followed the *Roebuck* as it sailed along the coast.  
Photo - Kevin Kenneally

**Facing page**

**Below left:** Islands of the Dampier Archipelago visited by Dampier in 1699.  
Photo - Carolyn Thomson

**Below right:** The nighttime activities of humpback whales filled the crew with dread.

Photo - Robert Garvey



"... like a Bean Blossom, but much larger, and of a deep red Colour, looking very beautiful."

This is the flower of the beautiful Sturt pea (*Clianthus formosus*). Dampier's collection of the species is housed at the Sherardian Herbarium.

His journal also records the many birds, turtles, shellfish and water-snakes to be found in the area and comments on possible human habitation of nearby islands, because of the smoke which could be seen. Again, no fresh water was to be found so anchor was weighed early next morning and the *Roebuck* departed the Archipelago (later named Dampier Archipelago by Phillip Parker King) through Mermaid Strait.

There are several illustrations in Dampier's journal depicting examples of the flora and fauna seen during this voyage. Among these are birds. One example is a noddy, sighted and recorded a few days after leaving the Archipelago. He records:

"We saw also some Boobies, and Noddy-birds; and in the Night caught one of these last. ... its Tail forked like a Swallow ... the Top or Crown of the Head of this Noddy

was Coal-black ... The Breast, Belly and underpart of the Wings ... were white; and the Back and upper-part of its Wings of a faint black or smoky Colour."

This last species is probably either the sooty tern (*Sterna fuscata*) or the bridled tern (*Sterna anaethetus*). Other birds illustrated include the red-necked avocet (*Recurvirostra novaehollandiae*), the pied oystercatcher (*Haematopus longirostris*) and the common noddy (*Anous stolidus*).

## LAGRANGE BAY

Dampier's third and final survey of our coastline was at a deep bay, where he anchored on 10 September 1699. Studies have shown this was most likely to have been Lagrange Bay, and not Roebuck Bay (named in 1821 by Philip Parker King), which is situated some 80 km to the north.

The crew was now in desperate need of fresh water, but only unpalatable brackish water could be found in the holes dug. The few days spent here gave Dampier time to record, with considerable detail, the Aboriginal people living in the area, his attempts to communicate with them and

comparisons with the people seen on his first visit in 1688.

His botanical observations are also interesting:

"And another sort of small, red, hard Pulse, growing in Cods also, with little black Eyes like Beans. I know not their Names, but have seen them used often in the East-Indies for weighing Gold ... I could not perceive that any of them had been gathered by the Natives; and it might not probably be wholesome Food."

This is crab's eye (*Abrus precatorius*), widespread in tropical regions and often found on northern coastal sands. Dampier did well to avoid eating these highly toxic beans.

The unsuccessful search for water forced the *Roebuck* to depart for Timor on 16 September to restock with supplies. From then until July 1700 Dampier surveyed in the area of Indonesia and New Guinea. His intention to return to New Holland was never fulfilled.

The *Roebuck*, tragically, never made the journey home to England. She foundered and sank off Ascension Island in the South Atlantic Ocean in March 1701.

Dampier managed to salvage his journals and at least some of his specimens. He returned to England and later published *A Voyage to New Holland*. The wreck of the *Roebuck* was located in the early 1970s by Dr Robert Marx, an American archaeologist, but little trace of it remains due to the rocky nature of the area.

## WORK GOES ON

Dampier's work in Western Australia remains invaluable. It provides natural historians with data extending over a period of 300 years: unique in Australia, as the eastern coast was not extensively surveyed until 1770.

Dampier's surveys are particularly interesting as they occurred in areas of the north of Western Australia that are still relatively undisturbed, even today. Comparative studies can be made to see what changes, if any, have occurred in an area and can help scientists establish



the distribution range of some species. Such observations can help CALM formulate strategies to conserve and protect plant and animal species and habitats in these more remote parts of the State.

Dampier did well to avoid eating the beans of crab's eye (*Abrus precatorius*) as they are highly toxic.

Photo - Kevin Kenneally

## WILLIAM DAMPIER - THE MAN

Dampier is believed to have been born in East Coker in Somerset, England on 5 September 1651. Sometime during 1672, the year of his 21st birthday, he joined the Royal Navy and served in the Third Anglo-Dutch War which ended in 1674. In 1676 he sailed for Yucatan on the Spanish Main to begin the profitable but risky occupation of logwood cutting, risky because "Campechea" wood (*Haemotoxylon campechianum*) grew in hostile Spanish territory. Following this, Dampier took up the controversial profession of privateer against Spain, at that time engaged in a (cold) war with England. In 1686 he continued his voyage, briefly visiting New Holland in 1688. After an absence of more than 12 years, Dampier had little to show than his diaries.

In January 1699, Dampier left England in command of *HMS Roebuck*. Unfortunately, disciplinary problems marred the voyage from the beginning. The *Roebuck*, being a commissioned ship, was normally commanded by naval staff, and Dampier, being a civilian, a celebrity of note, of questionable 'pirating' background and with little skill to command, may have been too much for the professional staff to accept. Difficulties arose, particularly with Lieutenant Fisher, whom Dampier left in Brazil. It was on this voyage that Dampier revisited New Holland.

Dampier arrived back in England in August 1701. The War of Spanish Succession had broken out, and in May 1703, he set out on his second voyage of circumnavigation as Commander of the *St George*, operating as a privateer against enemy vessels in the Pacific. He was imprisoned by the Dutch, but managed to reach home in 1707. He again left England in 1708 as pilot for the *Duke* on his third and final circumnavigation. The *Duke* returned in August 1711 with a rich booty.

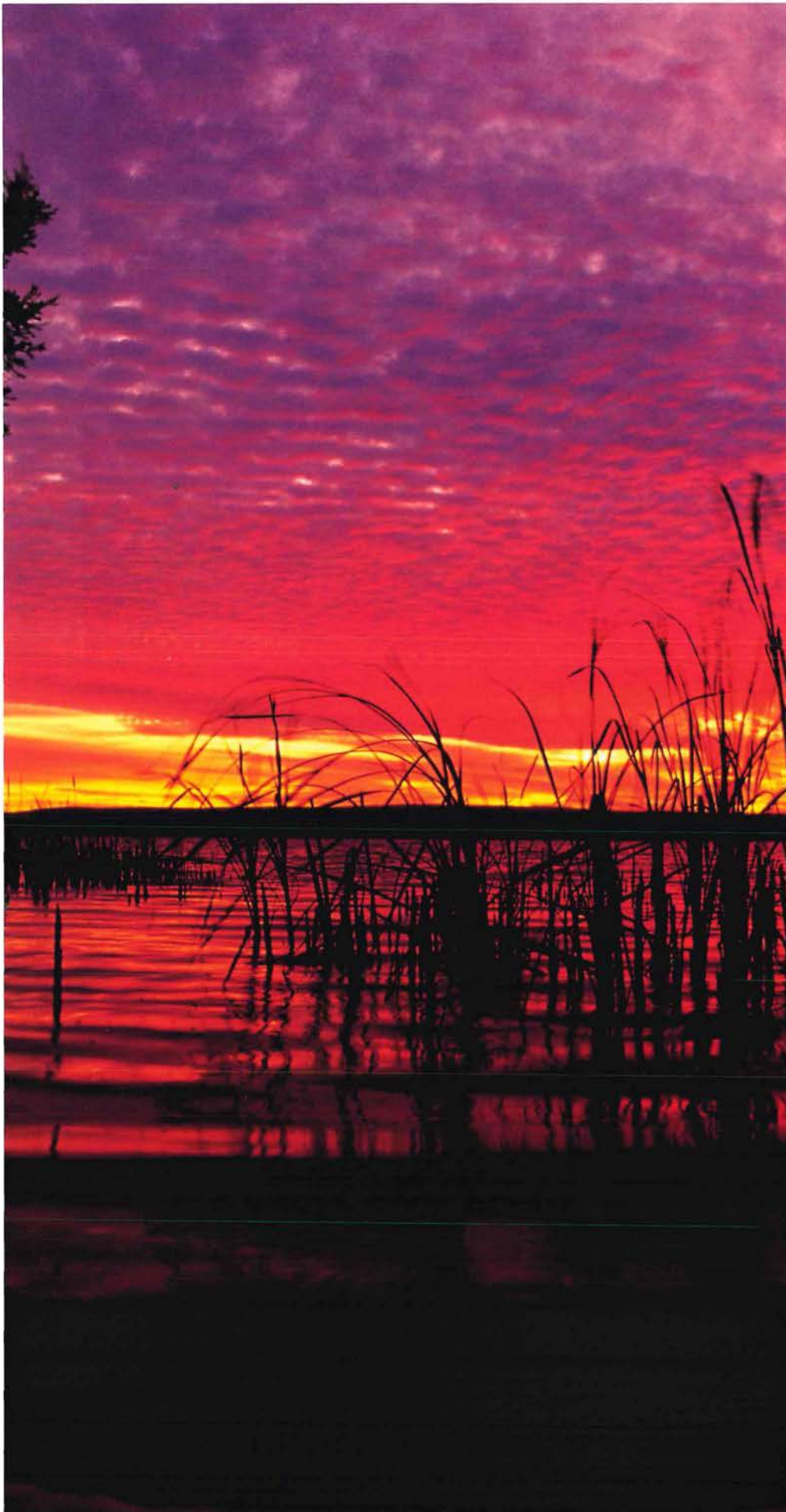
Dampier died in 1715 at the age of 64. His burial place is unrecorded, but just prior to this death he was living in the parish of St Stephens, near Old Jewry in London.

William Dampier has been described as a navigator, hydrographer, naturalist, writer and pirate. He spent almost 42 years away from England and circumnavigated the globe three times. His preliminary scientific studies and remarkable writings paved the way for subsequent voyages, such as those of Samuel Wallis, Thomas Nicolas Baudin, James Cook and Matthew Flinders. His narratives inspired Samuel Taylor Coleridge's famous poem, *The Ancient Mariner* and Jonathon Swift's fantastic story, *Gulliver's Travels*. Few travellers have given such knowledge and inspiration to the world. Emperor Napoleon Bonaparte, with a personal interest in science, held him in such high regard that he placed a bust of Dampier (an Englishman!) in his Gallery of Notables.

Suzanne Curry is a Technical Officer at CALM's Western Australian Herbarium, Science and Information Division. The author gratefully acknowledges the works of Alex George, Leslie Marchant and James Spencer on William Dampier and wishes to thank the many staff of the W.A. Museum, Fremantle Museum and CALM for their assistance.

Extracts are from *A New Voyage Around the World* and *A Voyage to New Holland* by William Dampier

**AUTHOR'S NOTE:** Dampier's works were based on the old Julian Calendar. The specific dates given in this article are calculated using the modern Gregorian Calendar (ie. 11 days later).



# *outer city sanctuary*

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## **FORRESTDALE LAKE**

**by Rod Giblett**

Until recently, Forrestdale Lake was just far enough away from population centres to help ensure its value, as an important waterbird habitat. However, Perth's urban sprawl is slowly enveloping it. Local resident and naturalist Rod Giblett examines the Lake's past, present and future.

**F**orrestdale Lake is one of the most important conservation reserves in Western Australia. It is especially significant as a wetland habitat, regularly supporting more than 10 000 waterbirds. Located on the southern fringes of Perth's metropolitan area, and with the fast-growing City of Armadale to the east, the Reserve will come under further urban pressures over the next few decades. It is a valuable, yet vulnerable, outer city wildlife sanctuary which needs to be carefully managed.

The Forrestdale Lake Nature Reserve covers an area of 245 hectares comprising the near-circular Lake, its narrow belt of fringing vegetation and some surrounding land. At 192 hectares the shallow and semi-permanent Lake is among the larger lakes in the southern metropolitan area. It is largely an expression of groundwater with no natural drainage flowing into it, although two artificial drains enter on the western side. The water quality varies annually as well as seasonally - from very fresh at the end of winter to brackish, if not dry, in summer.

In geological terms, Forrestdale Lake is a basin consisting of clay in the centre, sand on the eastern side and marl (clay mixed with carbonate of lime) on the western side. The geomorphology of the Lake indicates that it began to develop 5 000 to 6 000 years ago, and it is thought to have been part of an ancient river system.

Forrestdale Lake was formerly known as Jandakot Lake. Jandakot means place of the whistling kite (*Haliastur sphenurus*) in the Aboriginal language of the area.

According to tradition the Lake is home to a powerful Waugal (rainbow serpent). Aboriginal tradition warns against disturbance of the native reeds (*Baumea articulata*) around the Lake's edge, as this could unleash the Waugal's destructive power. This indigenous tradition needs to be treated with respect - which can best be given by ensuring the Lake's conservation, and by making visitors aware of its Aboriginal significance to Aborigines.

The Nyungar people used the area as a summering place for thousands of years. The availability of water, the variety and quantity of food, and the open banksia woodlands all provided a comfortable



resting place for the semi-nomadic kinship groups as they moved seasonally between the Darling Range and the coast.

In recognition of its rich heritage value, Forrestdale Lake has been registered as an Aboriginal site of significance by the Western Australian Museum and so comes under the protection of the Western Australian Aboriginal Heritage Act (1972-80). This Act protects all Aboriginal sites and objects from disturbance. Actions which disturb or degrade an Aboriginal wetland site could be regarded as an offence under the Act, and may be followed by prosecution.

## THE COMING OF EUROPEANS

Europeans first settled the area in 1885 when William and Alfred Skeet were granted a 'Special Occupation' licence for 100 acres (about 40 hectares) in the vicinity of the Lake. At that time the Lake was fringed by huge paperbarks, some as big as 10 metres in height and with trunks one metre in diameter. Other families, including the Dumsdays, moved into the area in 1892. The James family have been living on the west side of the Lake since the 1940s, with some family members still actively involved in its conservation.

In 1915, the name of the area was changed to Forrestdale at the request of local residents, to honour the then Premier of Western Australia, Sir John Forrest. Many years later, in 1974, the name of the Lake was also changed from Jandakot Lake to its current name.

During the 1940s the west side of the Lake was heavily grazed by sheep and

cattle, particularly during the drier summers, when land owners used the fringing vegetation to supplement feed from their paddocks. As a result, the west side of the Lake is devoid of most natural understorey species and is infested with weeds and other exotic plants, particularly arum lilies.

## LOCAL AND INTERNATIONAL RECOGNITION

The nature conservation values of the Lake and its immediate surrounds were first recognised in 1957 when it was gazetted as an A-Class Nature Reserve for the conservation of flora and fauna. In recognition of its natural heritage values for the whole of Australia, it was placed on the initial Register of the National Estate in 1978. It was only one of three areas in the City of Armadale to receive such listing.

The regional importance of the Lake to the Swan Coastal Plain was acknowledged in 1983 when it was recommended that it be incorporated into a Regional Park. Some steps have been taken in this direction with the acquisition of land to the south-west of the Nature Reserve by the Department of Planning and Urban Development (DPUD). Once the acquisition program has been completed, this land will become a part of the Nature Reserve.

There is also reserve land to the east of the Lake which is currently vested in the City of Armadale. This reserve is an important heathland with rare flora, including Purdie's donkey orchid (*Diuris purdiei*) and warty hammer orchid (*Drakea elastica*), and threatened fauna.

It is the birdlife that makes

Forrestdale Lake especially noteworthy, both for numbers and for variety of species. More than 17 000 birds were counted there in January 1983.

Seventy-two species of waterbird have been recorded at the Lake, including the rare long-toed stint (*Calidris subminuta*), which migrates from Siberia. Nineteen species of waterbird have been recorded breeding on the Lake. As well as waterbirds, 74 species of bush bird have been sighted in its fringing vegetation, including the splendid fairy wren (*Malurus splendens*). Twenty-three of the bird species found on the Lake are protected under the Japan-Australia and China-Australia Migratory Bird Agreements.

In 1990, in recognition of its value as a waterbird habitat, Forrestdale Lake was jointly nominated with nearby Thomsons Lake for inclusion on the Ramsar Convention on Wetlands of International Importance. It is one of only nine such wetlands to be nominated in Western Australia. By regularly supporting more than 10 000 waterbirds and more than one per cent of the known Australian population of the long-toed stint (*Calidris subminuta*) - 80 have been counted at one time on the Lake - it satisfied two criteria for nomination. It fulfilled a third criterion because it is a particularly good example of the few surviving wetlands of its type.

As the Lake starts to dry up, usually in late summer, thousands of wading birds descend to feast on the abundant



### TOO MUCH OF A GOOD THING

Over recent decades the quantity of nutrients entering Forrestdale Lake has dramatically increased, causing it to become over-enriched (eutrophic). The source of these nutrients may include septic tank leachates from nearby houses, and fertilisers from surrounding paddocks and lawns. The high nutrient levels are responsible for a number of management problems, including algal blooms and nuisance midge swarms, which impact on the well-being of residents in the nearby Forrestdale urban area.

To try to resolve this complex issue, an extensive monitoring program is being undertaken by Jim Goodsell and other CALM staff, with assistance from the WA Water Authority and the Friends of Forrestdale conservation group. This program will enable a better understanding of the sources and destinations of nutrients, and will identify strategies to reduce the quantity of nutrients in the lake system.

The program will involve measuring all exchanges of water between the lake and its surrounds, e.g. groundwater, rainfall and evaporation, as well as surface flows via the artificial drains. Chemical analysis of the water flows will determine the quantity of nutrients in each category.



*Previous page*  
Sunset over Forrestdale Lake  
Photo - Jiri Lochman

*Top left:* Firewood banksia (*Banksia menziesii*)  
Photo - Jiri Lochman

*Left:* Western Australia's bird emblem - the black swan (*Cygnus atratus*)  
Photo - Jiri Lochman

*Above:* Stands of bulrush (*Typha orientalis*) at Forrestdale Lake  
Photo - Jiri Lochman

food found in its shallow waters, thus making it more attractive than the deeper lakes in the metropolitan area. At this time it also becomes a refuge - and an ornithologist's delight - as other, more ephemeral or seasonal wetlands dry up.

## FLORA AND FAUNA

Forrestdale Lake Nature Reserve is noted for other fauna besides its birdlife. The most numerous mammal present is the quenda, or southern brown bandicoot. A survey conducted in July 1992 by officers from the Department of Conservation and Land Management (CALM) and the Friends of Forrestdale found these threatened Western Australian animals plentiful in dense heath, rush and exotic grass species such as Kikuyu grass (*Pennisetum clandestinum*).

Quenda can be difficult to observe as they are generally nocturnal creatures and live under dense vegetation. The best time is at dusk as they move about near open tracks in the Reserve. A good sign of their presence are the small, conical holes they dig in damp soil while searching for insect life.

The Reserve is also home to seven species of frog and fifteen species of reptile, including the long-necked tortoise (*Chelodina oblonga*).

Forrestdale Lake Nature Reserve has a varied flora. Banksia woodland, acacia thickets, low paperbark forest, sedgelands and a small area of clay flats in the eastern section are all representative of the region. Species of banksia include firewood banksia (*Banksia menziesii*) and swamp banksia (*B. littoralis*); tree smokebush (*Conospermum triplinervium*) which is locally uncommon; swamp sheoak (*Casuarina obesa*); several species of melaleuca; globe heath (*Brachyloma preissii*); orchids and fringed lilies are among nearly 160 species of native plant recorded in recent years. Thickets of the swamp regelia (*Regelia ciliata*) are important habitat for the quenda.

## PROTECTING THE RESERVE

Vested in the National Parks and Nature Conservation Authority (NPNCA), Forrestdale Lake Nature Reserve is managed by CALM. To preserve its nature conservation and natural heritage values, a formal management plan was

completed in 1987. It addresses the management issues facing the Reserve, such as controlling access by horses and vehicles, stemming the spread of the introduced bulrush (*Typha orientalis*), and managing midge population explosions. In addition an analysis of the Lake's nutrient cycles is being completed to determine, and then treat, the causes and not the symptoms of the midge problem (see 'Managing the Midge', *LANDSCOPE*, Winter 1992).

The Forrestdale area is popular for horse riding and agistment, and historically owners have had unfettered access to the Reserve. However, the fragile ecosystem of the Reserve is easily damaged by horses (or vehicles) and these needs should be managed in a balanced, environmentally sensitive way. The construction of a fence and bridle trail around the outside of the Reserve is provided for in the management plan. This would regulate access while still providing walkers and riders with a means of enjoying the Lake. A group known as the Forrestdale Reserve Access Group, made up of representatives from the Forrestdale horse-riding community, CALM, the City of Armadale, the Friends of Forrestdale and DPUD, is currently developing a strategy to resolve this sensitive issue.

The management plan also recommended a Friends of Forrestdale volunteer group to liaise with CALM. Such a group was launched in April 1990. The Friends' main aim is to act as informal guardians or honorary wardens.

The Friends meet monthly and are open to anyone with an interest in the conservation of the Lake or its surrounds.

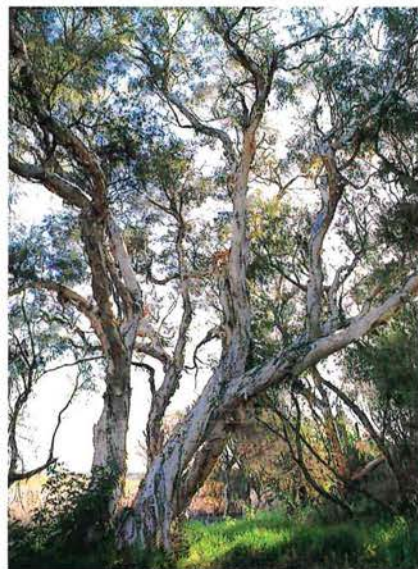
## THE RAMSAR CONVENTION

Convention on Wetlands of International Importance especially as Waterfowl Habitat

This Convention was adopted on 2 February 1971 in Ramsar, Iran. In May 1974, Australia was the first nation to accede to the Convention, which took effect from December 1975. The first nomination of a wetland to the Convention was also from Australia: the Coburg Peninsula in the Northern Territory. Since this initial listing a further 39 areas in Australia have been nominated. These add up to nearly 4.5 million hectares, making Australia second only to Canada in the total area listed, and third to Italy and the United Kingdom in the number of sites listed. Under Article 3, the Convention binds the signatory nations to promote the conservation of the wetlands nominated and the "wise use" of all other wetlands.

The gatherings alternate between hands-on activities (such as bush regeneration), and the formulation of submissions and policy on management issues.

Fringing vegetation of swamp paperbark (*Melaleuca rhaphiophylla*)  
Photo - Jiri Lochman



Rod Giblett is president of the Friends of Forrestdale and a lecturer in the School of Communication and Cultural Studies at Curtin University of Technology, where he is researching the social and cultural aspects of wetlands in Western Australia and western culture.

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# FALSE FLOWERS



The plants of south-western Australia are renowned for their bizarre flower shapes and strong colours. But many of them are not flowers in the true sense. They are clusters of flowers so tightly grouped as to appear like an individual flower.

They are WA's false flowers.

BY NEVILLE MARCHANT

**I**dentification of native plants is often difficult because of their complex flower structures and frequently small flower size. In many cases it is not easy to recognise what is or is not a flower. South-western Australia has approximately 9 000 plant species in more than 150 families. Within these, the flower form varies greatly.

Familiar flowers like those of the common Mangles' kangaroo paw (*Anigozanthos manglesii*) have brightly coloured parts and individual paw-like flowers at the end of a strong stem. The individual flowers of this species and its relatives are quite large, unlike most of our wildflowers. Native hibiscus (*Alyogyne hakeifolia*), the widespread *Hibbertia* species and many of the pea-flowered plants, for example, also have large individual flowers where the calyx, petals and other flower parts are easily distinguishable.

The term 'flower' is often used very loosely to describe a composite structure made up of many individual flower units. A number of very familiar flowers, such as those of the wattles, bottlebrushes and banksias, are not composed of individual flowers, but are aggregations of small flowers grouped into a dense inflorescence (cluster of flowers). In the wattles, for example, each yellow or cream head is made up of a few to many individual flowers closely packed onto a stalk apex. Each individual flower can be recognised easily at the bud stage where, depending on the species, the outer calyx and the inner petals can be seen. At maturity, however, each wattle flower bursts open and the numerous pollen-bearing stamens splay out, making the individual flowers of the head indistinguishable so that the head really appears to be a single unit.

Bottlebrush 'flowers' in the genus *Callistemon* and some species of *Melaleuca*, *Beaufortia* and *Kunzea* are also composed of numerous small flowers borne on one part of the stem. Each may have a calyx and petals and numerous stamens that are often bright red or orange, giving the false flower its colour.

The individual flowers of the banksia family are simple structures that superficially resemble those of the kangaroo paw in their form. Each banksia family flower, such as those of grevillea, consists of an outer floral



**Previous page**  
**Left:** The Mangles' kangaroo paw has individual flowers that mature at different stages. Here, two flowers have opened to show the pale green inner tissues, the stamens and hooked style.  
Photo - Babs and Bert Wells

**Right:** Mulla mullas of *Ptilotus* spp. have bottlebrush-like false flowers. The individual flowers are closely packed on a long axis and clothed in long hairs.  
Photo - Chris Garnett

envelope, the four-lobed calyx that remain joined at their tip until the flower is quite mature. The petals are undeveloped or they are modified to nectar-bearing organs at the base of the ovary. The stamens are borne in a shallow depression on each calyx segment tip and the ovary is capped by a long style that bends sideways through a split in the calyx. The tip is tightly enclosed in the joined ends of the calyx, giving each flower a jug-like appearance. Some species of grevillea, like the Darling Scarp grevillea (*Grevillea bipinnatifida*), have widely spaced flowers forming an open inflorescence. Banksia flowers, like those of the related *Dryandra* genus, are very similar to those of grevillea in their structure.

With banksias, however, hundreds or, in some cases, a thousand or more grevillea-like flowers are borne on a woody spike clothed in dense packing tissues. The whole spike forms what is commonly called a 'banksia cone'. In Menzies' banksia (*Banksia menziesii*) the individual flowers making up the cone may exhibit different stages of maturity on the one cone. The flowers in a wide



**Above left:** *Hibiscus* spp. have the largest flowers of any WA plant. Inside the five large whorled petals are the sexual organs, the yellow stamens and ovary capped with a five-lobed style.  
Photo - Jiri Lochman

**Above right:** In *Hibiscus huegelii* the stalks of the stamens are united into a tube which surrounds the style with its five enlarged lobes.  
Photo - Jiri Lochman

band in the lower part of the cone mature first, each individual flower opening so that the four calyx parts are spread widely. This gives the lower part of the flower a lighter and more tangled appearance. The upper flowers of the cone may remain closed for some time so that the whole cone has an acorn-like appearance.

## FALSE FLOWERS

In the dryandras, close relatives of the banksias, the individual flowers arise from the centre part of a flat disc-like structure, surrounded by large bracts (modified leaves) which are stiff and usually coloured brown. Rows of closely packed bracts surrounding the inflorescence protect the developing flowers. Even when the flowers mature and open, the surrounding bracts are often prominent, so that each inflorescence resembles a large cup-shaped, single false flower.

A number of plant families develop false flowers. These include members of the Asteraceae family, the Apiaceae family, the Myrtaceae family, the Rutaceae family and the Thymelaeaceae family.



**Above:** The buds of the *Acacia extensa* show that each flower head is made up of tiny flowers.

Photo - Marie Lochman



**Centre:** *Malaleuca fulgens*. The lowermost, unopened flowers show the white-margined calyx and petals. The stalks of the stamens are joined into a claw.

Photo - Marie Lochman



**Above right:** *Grevillea bipinnatifida* has loosely packed flowers that have a long, looped style which bursts from the bud.

Photo - Jiri Lochman

**Right:** This daisy, *Waitzia acuminata*, has a compact head surrounded by chaffy bracts. The florets are grouped in the centre and can be recognised as true flowers by their five petals.

Photo - Marie Lochman



## THE ASTERACEAE FAMILY

The daisy 'flower' is a highly developed unit. The individual flowers are so modified and specialised that there are special botanical terms to describe the parts. Each, sometimes minute, flower is called a floret. The florets are usually densely packed on a disc-like receptacle and the whole head of florets is surrounded by a definite layer of chaffy, often brown bracts. As well as protecting the flower head when young, the bracts may also protect the developing seeds after the florets have withered.

## THE APIACEAE FAMILY

The 'flower' of the southern cross (*Xanthosia rotundifolia*), a striking-looking flower seen by visitors to the jarrah forest and Albany district, at first appears complex. On close examination, however, five groups of tiny flowers can

be seen. One group is at the centre of the whole structure and there is one on the end of each of the four arms of the cross. Each group of individual flowers is a false flower, being surrounded by modified petal-like leaves that are creamy white. The whole inflorescence is composed of five false flowers.

## THE MYRTACEAE FAMILY

False flowers are well developed in the mountain bells (*Darwinia* spp.) and the Albany daisies (*Actinodium* spp.)

Some darwinias, such as pom-pom

darwinia (*Darwinia vestita*), have leaves surrounding each small bottle-brush type inflorescence that hardly differ from ordinary stem leaves. Other species, like Oldfield's darwinia (*Darwinia oldfieldii*), have short and obviously modified leaves surrounding flowers that are grouped onto a flat receptacle.

The most spectacular false flowers are found in the Stirling Range mountain bells and their relatives such as the Narrogin bell (*Darwinia carnea*), the Mogumber bell (also *Darwinia carnea*), and the common lemon-scented myrtle

(*Darwinia citriodora*). In these often tulip-like false flowers, the bracts surrounding the true flowers are large and brightly coloured red or yellow, depending on the species. The individual flowers, protected by the bracts, vary in number according to species. In the lemon-scented myrtle, for example, there are usually four individual flowers.

The Albany daisies (*Actinodium* spp.) have bizarre false flowers that, as the common name suggests, so resemble a daisy that even experienced botanists find it hard to believe they are members of the myrtle family. Even within the family, the two known WA endemic species have no close relatives. They occur in the south of WA from Busselton to east of Fitzgerald River. Each flower head has a cone-shaped receptacle upon

which many individual flowers are borne. Each flower has small, petal-like bracts at the base. The outer part of the flower head has rows of outwardly pointing modified branches that have enlarged petal-like bracts on elongated stalks. This gives the whole flower head the appearance of a daisy.

## THE RUTACEAE FAMILY

A few members of the boronia family also develop false flowers. The WA endemic genera *Diplolaena* and *Chorilaena* have pendulous flower heads composed of a number of individual flowers surrounded by a cup-shaped layer of densely packed bracts. Species of *Diplolaena* are found throughout WA forests and the Wheatbelt. One species, commonly called the native rose

(*Diplolaena dampieri*), grows near the west coast on sand dunes.

The karri hazel (*Chorilaena quercifolia*) is widespread through the southern forests and along the south coast. Its flower heads are less compact than those of *Diplolaena*, but they are also surrounded by a definite envelope of modified leaves.

## THE THYMELAEACEAE FAMILY

Banjines (*Pimelea* spp.), belonging to the family Thymelaeaceae, are very common in the south-west. Like darwinias, most species of banjine have their true flowers aggregated into heads that are surrounded by large, usually yellow, modified leaves. Most banjine false flowers have a number of true flowers inside, each of which is easily seen with their long, often hairy, tube-like form and only two protruding stamens.

## TRUE OR FALSE?

The most spectacular banjine is the Qualup bell (*Pimelea physodes*), which occurs in the Fitzgerald River National Park. It has very large inflorescences with reddish yellow modified leaves. This species so closely resembles some species of *Darwinia* that it is often necessary to closely examine the individual flowers to identify the family

**Left:** The true flowers of *Dryandra* spp. are seen standing upright. Some have matured and split into four lobes with pollen being released from the stamens.

Photo - M and I Morcombe

**Below:** The outer bracts of *Dryandra ferruginea* are stiff and leathery and they protect the buds. At maturity they protect the developing seeds.

Photo - Jiri Lochman





correctly. The close resemblance of the Qualup bell to the Mondurup bell (*Darwinia macrostegia*) is an excellent example of the need to examine flowers more closely before attempting to identify the species.

The minute differences in flower forms indicate just how difficult it can be for both professional and amateur botanists to correctly classify individual species and sub-species. Complex flower

structures offer a continuing challenge for botanists at the Department of Conservation and Land Management's (CALM) WA Herbarium who wish to make it easier for amateur wildflower enthusiasts to know more about WA's unique flora.

So next time you go for a walk through the bush, take a closer look at the flowers around you. There may be more to them than first meets the eye.



**Above:** *Diplolaena* spp. have false flowers that are easily mistaken for single flowers. The true flowers are closely packed so that their stamens are almost intertwined at maturity. Close inspection will show a number of styles, each of which indicates an individual flower.

Photo - Jiri Lochman

**Left:** Many *Darwinia* spp. have true flowers that are surrounded by coloured bracts. Each true flower has a long, curved style.

Photo - Jiri Lochman

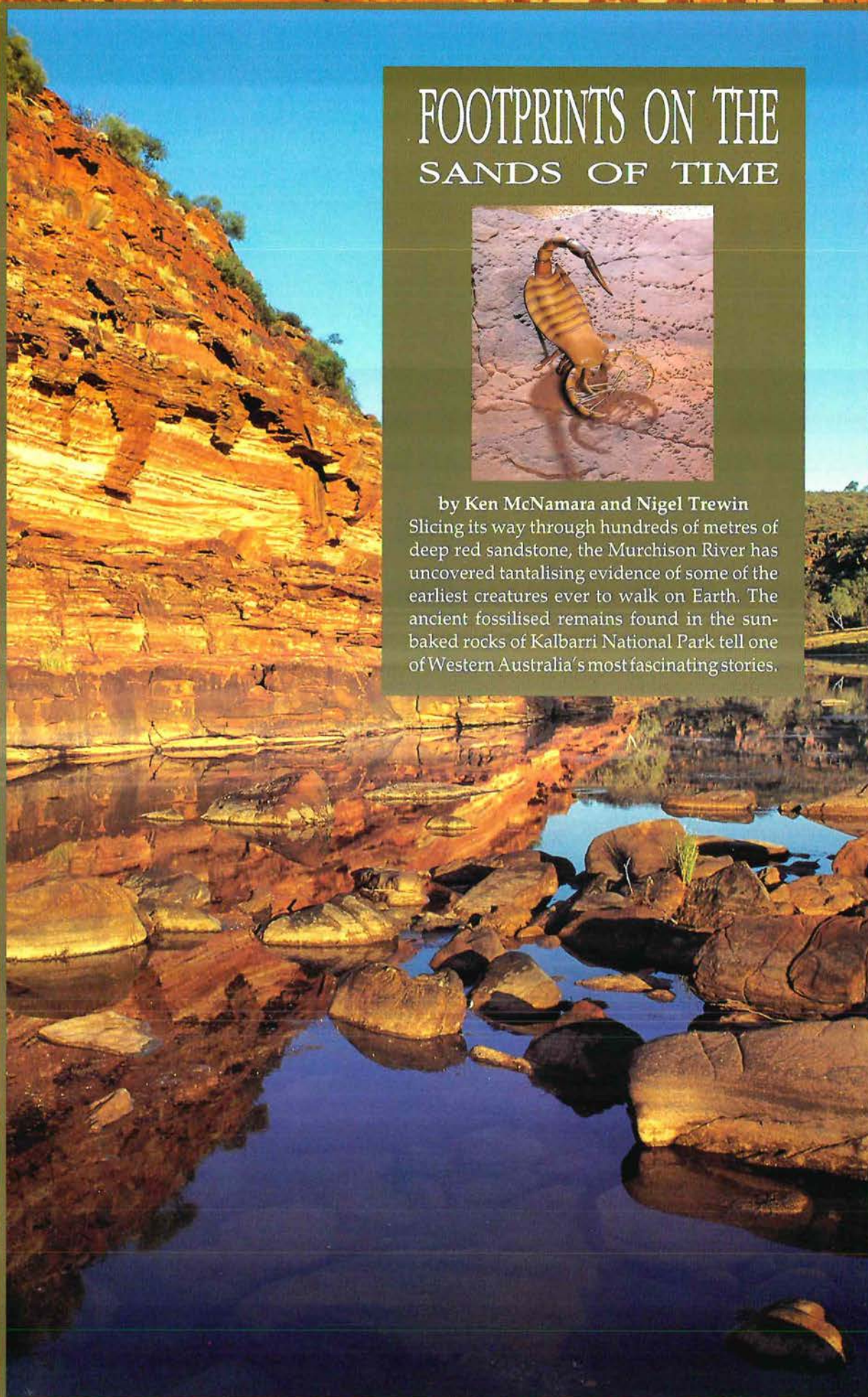
Neville Marchant is Acting Director of CALM's WA Herbarium. He can be contacted on (09) 334 0500.

# FOOTPRINTS ON THE SANDS OF TIME



by Ken McNamara and Nigel Trewin

Slicing its way through hundreds of metres of deep red sandstone, the Murchison River has uncovered tantalising evidence of some of the earliest creatures ever to walk on Earth. The ancient fossilised remains found in the sun-baked rocks of Kalbarri National Park tell one of Western Australia's most fascinating stories.



**T**he layers of sandstone exposed in the Murchison River gorge and in the coastal gorges south of Kalbarri townsite are known as the Tumblagooda Sandstone. They were deposited by a gigantic river system that drained Western Australia and discharged into a shallow sea about 420 million years ago. At that time the southern continents were nestled together as one vast super-continent called Gondwana. Southern Australia lay against Antarctica; moored off Western Australia's south-west coast was the fledgling India; while off the north-west of Australia, parts of present day south-east Asia, like Thailand, were just beginning to break from the clutches of Gondwana and begin their passage north.

Inland from Kalbarri 420 million years ago the Yilgarn Block, comprising the ancient Precambrian heartland of Western Australia that formed between two and three billion years ago, was a towering, naked mountain chain. At this stage in Earth's history plants were only just making their first, tentative attempts to establish on the land. With no plant cover there would have been nothing to temper the tremendous erosive forces of the wind and rain. Billions of tonnes of sand, eroded from the mountain ranges,

was carried by periodic violent floods over sandy floodplains to the sea, through what is now Kalbarri National Park. During storms, sand and dust was swept across the bare sandy plains. Just imagine a badly over-grazed landscape today - massive erosion and choking dust storms. This was the everyday situation on Earth more than 400 million years ago. Rather surprisingly, it was in this hostile environment that animals first left their footprints on land.

## SNAPSHOTS IN TIME

Fossilised remains in the Tumblagooda Sandstone almost invariably occur as enigmatic tracks and burrows known as 'trace fossils'. To a palaeontologist there can be little more fascinating than finding a slab of rock with delicate imprints of tiny feet made by an animal walking across a damp sand flat hundreds of millions of years ago. What we may be looking at here is a snapshot of the activity of a single animal, for perhaps just two minutes of its existence, a very long time ago.

Reverend William Buckland wrote about fossilised tracks in 1836:

"Yet we behold them, stamped upon the rock, distinct as the track of the passing animal upon the recent snow; as if to show

that thousands of years are but as nothing amidst Eternity - and, as it were, in mockery of the fleeting perishable course of the mightiest potentates among mankind."

The trace fossils we have been searching for in the Murchison River gorge, over the last decade, come in a bewildering array of shapes and sizes. Some can easily be interpreted, as tracks or burrows, but others defy a simple explanation, perhaps demonstrating activities by types of animals that have long been extinct. The most easily recognised are tracks made by multi-legged arthropods (the group of segmented invertebrates that today

### Facing page

**Outside:** Patterns in sandstone.

Photo - Bill Bachman

**Middle:** Murchison River Gorge, Kalbarri National Park.

Photo - Marie Lochman

**Inset:** Reconstruction of the eurypterid (*Mixopterus kiaeri*) on fossil tracks.

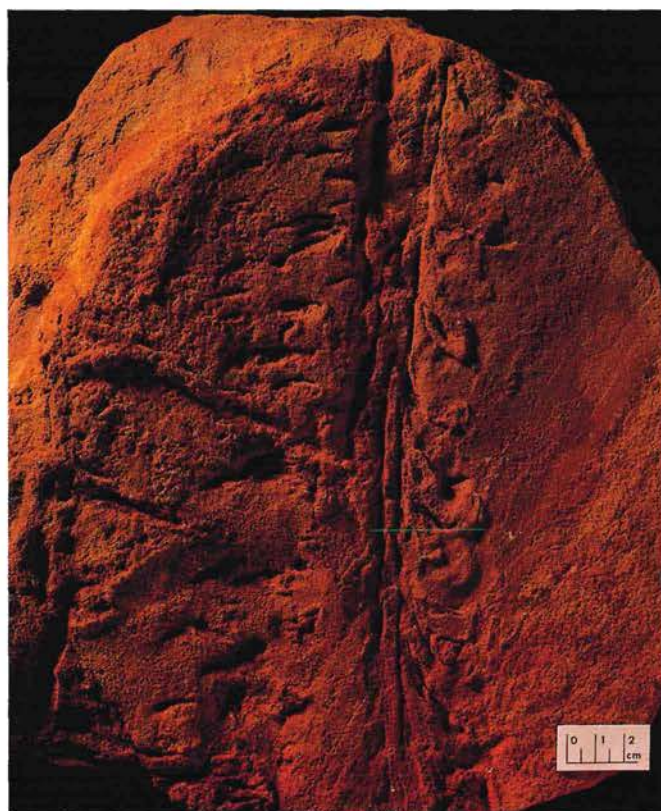
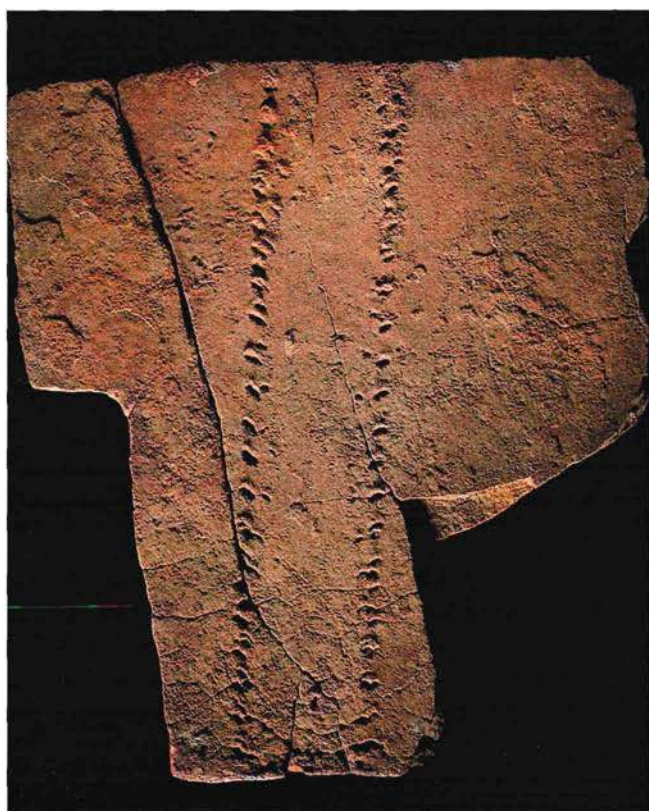
Photo - Douglas Elford/WA Museum

**Below left:** Fossil track of a eurypterid.

Photo - Douglas Elford/WA Museum

**Below right:** Fossil track of eurypterid that floundered through wet sand leaving impressions of its paddle.

Photo - Douglas Elford/WA Museum



includes animals such as insects, spiders and crabs). Some resemble tracks left by a motorbike driving across wet sand. Others, which are better preserved, consist of parallel rows of spaced pits. These pits may cluster together in groups of three, or six, or sometimes eleven, and much of the research in the last few years has focused on trying to identify the perpetrators of the footprints. The work of a palaeontologist is certainly very much like that of a detective - sifting for clues as to who (or what) committed the deed.

The most spectacular site at the base of the gorge consists of a flat, ripple-marked surface covering an area of about

WA Museum scientists making a latex cast of fossil tracks in the gorge.

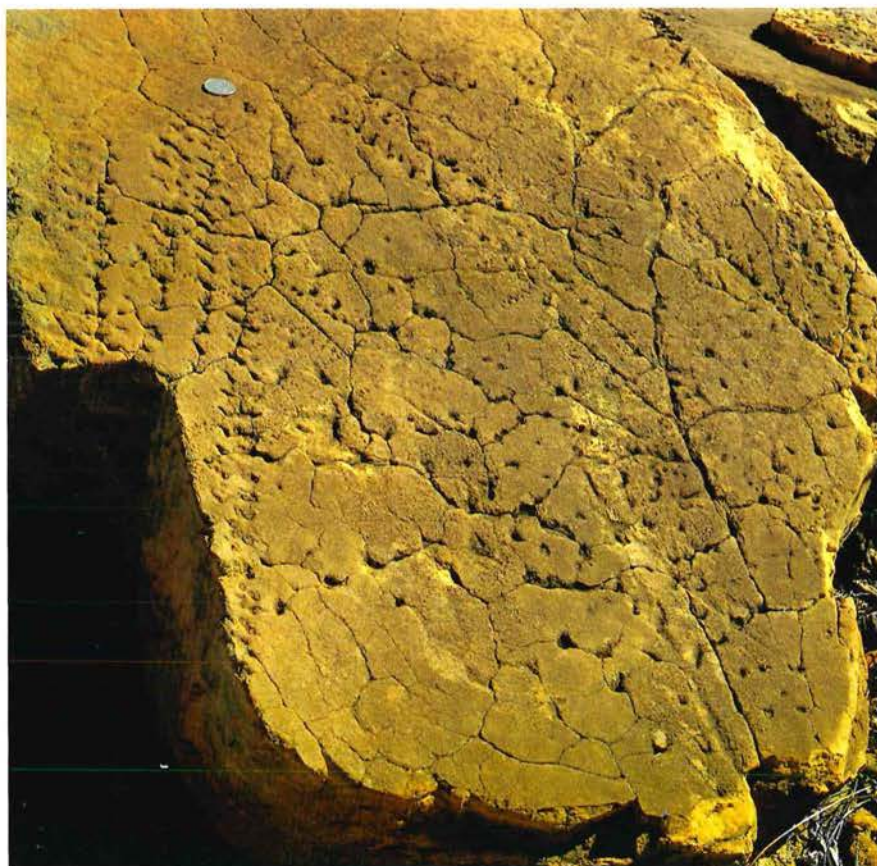
Photo - Ken McNamara/WA Museum

Latex drying prior to applying the first layer of cheesecloth, used to strengthen the final mould. The tracks here covered an area of approximately eight metres by five metres.

Photo - Ken McNamara/WA Museum

Fossil tracks showing where eurypterids emerged from a pool of water (coin marks edge of the pool).

Photo - Ken McNamara/WA Museum



eight by five metres. Crossing this surface are at least six well-defined tracks up to 20 centimetres across, some extending for almost 10 metres in length. While the individual footprints are not well preserved, they do indicate that many large animals were walking across these wet sand flats. No other rocks of this age have yielded such spectacular fossil tracks.

This is the reason why it is imperative to protect this important natural heritage and, since the sites are within the Kalbarri National Park, the job of protection is carried out by the Department of Conservation and Land Management (CALM). The locations of the main sites within the Park are not marked so as to minimise disturbance as much as possible. But according to Roy Harris, CALM's ranger-in-charge at Kalbarri National Park, the public is not excluded from viewing these fascinating fossils. Locally organised tours that take in some of the fossil sites are available from the Kalbarri Tourist Bureau. Park Rangers and tour supervisors stress the importance of these sites and point out sensitive areas so as to help prevent inadvertent damage to the sites and to the fossil tracks themselves.



## FROM OUT OF THE SEA

To identify the animals that made these tracks we trekked across many square kilometres of rocks looking for more well defined footprints. The best were found just metres from the main Kalbarri road and close to one of the popular lookouts. This set of tracks revealed that the large animal had three pairs of walking legs and would have been about one metre long. The only animal that fits this description is the eurypterid, or 'sea scorpion', the dominant predator at the time. Within the group of arthropods known as chelicerates, the eurypterids form a separate family from the scorpions, even though, superficially, they resemble them quite closely. The major difference, apart from the number of legs, is the size - eurypterids grew up to two metres in length!

One of the more important discoveries to come out of our work was the realisation that these animals, thought to be exclusively aquatic, were in fact amphibious. As such, the Kalbarri tracks represent the earliest known direct evidence of animals walking out of water. To arrive at this conclusion we had to look not only at the tracks themselves, but also the nature of the sandstone in which they were fossilised.

The rocks at places such as the Z-Bend and The Loop, appear at first to be a monotonous sequence of layers of sandstone. But by standing at Nature's Window - a natural feature at The Loop - you not only glimpse through a window into the past, you also see that the layers



The recently described euthycarcinoid *Kalbarria brimmellae*.  
Photo - Kris Brimmell/WA Museum

of sandstone in the cliff face opposite vary in form and structure. Some layers are thick and massive, and in these few, if any, trace fossils are found. These layers represent huge quantities of sand dumped by the fast flowing river. The thinner, often ripple marked, layers represent vast sand flats laid down as the flooding river subsided. Other sandstones, made of finer grains, are the remains of wind-blown sand. It is at the junction between these sand flats and wind blown sands that the trace fossils, particularly the tracks, are most often preserved.

## PUTTING A NAME TO A TRACE

The footprints reveal that a range of animals - probably all arthropods, including the eurypterids - staggered

from one pool to another, perhaps as the pools dried up in the harsh sun. Treading with their multi-legged feet over the wet sand, their imprints were preserved by sand storms that dropped fine sand onto the wet surface. The rock, which was eventually exposed by the modern Murchison River carving its way through the ancient layers of sandstone, preferentially split between the water-lain and wind-blown sands to reveal the fossil tracks.

Evidence that the animals were moving from pool to pool can be seen in a number of places where gentle depressions in the rock surface represent shallow pools. Footprints only occur **between** these depressions, where the sand was exposed and wet. At one spectacular site in the gorge, located by Mr Roger Hocking of the Geological Survey of Western Australia, a steep slope from a sand flat into what was once a pool of water has been preserved. Here, tracks wind their way along the sand flat

to the slope. They are then replaced by a pair of deep grooves made by the animal, probably a eurypterid, as it slid down the bank into the pool, crocodile fashion.

Until a couple of years ago we thought we were dealing only with eurypterid tracks, but the discovery of a single body fossil opened a whole new world of strange, extinct arthropods. On one of our field trips in 1990, Kris Brimmell, Technical Officer from the Western Australian Museum, made one of the most important Western Australian palaeontological discoveries.

Walking along a goat track late one afternoon, her eyes were attracted to a peculiar looking fossil. Highlighted by the low angled, raking sunlight, the fossil looked, for all the world, like a trilobite - an extinct group of marine arthropods that lived in the sea between 200 and 540 million years ago. However, closer examination revealed that this was not the case. Looking rather like an enormous cockroach with 11 rather than three pairs of legs, we had no idea what it was. For many years we had hoped to find remains of the eurypterids that we believed had made many of the tracks, but this creature had far too many legs for a eurypterid.

## A SHIFT IN TIME

After weeks of pouring over literature, we excluded all animal groups that were known to have lived 420 million years ago. We then began looking at extinct animals that had lived at other times. Eventually we realised that the only group that the fossil could be placed in was an obscure group of arthropods known as euthycarcinoids, but the oldest examples of euthycarcinoid - found in rocks in France and the United States - were dated at a mere 300 million years old! But the Murchison Gorge rocks where our specimen had been found were 420 million years old.

After showing photographs of the specimen to other palaeontologists around the world who had worked on euthycarcinoids, it was confirmed that we had unearthed the oldest euthycarcinoid by far. We had extended the known range of this subphylum by a staggering 120 million years.

In the early 1980's two palaeontologists had raised the possibility that euthycarcinoids could be the

ancestors of the insects. However, the suggestion gained little acceptance because the oldest fossilised remains of an insect pre-dated the earliest euthycarcinoid known at that time. But with this new evidence that euthycarcinoids did live before the insects, the case is greatly strengthened.

## NEVER ENDING STORY

We returned to Kalbarri in early 1991 in the hope of finding some more specimens. Although we were unsuccessful, what we did find was almost as exciting.

Walking along the edge of the gorge early one morning, the low-angled sun highlighted a slab of sandstone covered by delicate tracks. From the way the animal must have been 'crabbing' along, perhaps being blown sideways by the wind, the repeated pattern of about 11 sets of footprints could be discerned, indicating that a euthycarcinoid made the tracks.

Nearby we found horseshoe-shaped excavations that may have been the feeding burrows of these creatures. The tiny U-shaped burrows, also present in these rocks, even gives an indication of what the euthycarcinoid might have been feeding on.

In his 'Psalm of Life' Longfellow reminded us that :

"We can make our lives sublime, And,  
departing, leave behind us Footprints on  
the sands of time;-"

So too the Murchison River gorge footprints which, having had the good fortune to have been made in wet sand, were not blown away into eternity, but were blessed with an almost immortal existence. The result has been that these ancient footprints, some 420 million years since they were made, are providing us with new insights into the behaviour and early evolution of the land's first inhabitants.

**Box:** Nature's window, above the Murchison River Gorge in Kalbarri National Park.

Photo - Bill Bachman

## THE CARE AND CONSERVATION OF FOSSILS



All fossils and rocks in Western Australia's national parks are protected by law. As such, they must not be removed, broken or otherwise damaged. The benefit is that an important part of our national heritage is protected and many people can see and appreciate the fossils and rocks in their natural state. While the plants and animals of the State are fully protected, fossils, which are a finite resource, are only protected if they occur within a national park or reserve.

Once a fossil has been collected it is effectively lost to the community, unless it is housed in the WA Museum. Many of the fossils in the Kalbarri National Park are of immense scientific importance. Their conservation within the Park, therefore, goes a long way towards protecting an important part of the nation's cultural heritage.

In addition to being the repository for the State's fossil collection, the Western Australian Museum also serves an important function in disseminating information about Earth sciences to the general public. The professional staff in the Department of Earth and Planetary Sciences at the Museum assist the Department of Conservation and Land Management (CALM) by providing information on geological features within national parks, such as the Pinnacles at the Nambung National Park, and for displays at the Milyer Visitor Centre in the Cape Range National Park and at Wolfe Creek Crater. CALM staff actively assist the geological research at the Museum and this has been particularly so with the research at Kalbarri, where Park Rangers have provided invaluable help over the years.

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*oil in the leaves*

*The smell of eucalyptus oil is quintessentially Australian, yet the majority of the oil sold in Australia comes from overseas. Now, Western Australians are exploring new ways to revive this old industry - through research, experiment, and replanting the land.*

BY LIZ BARBOUR AND JOHN BARTLE

PHOTOGRAPHS BY JIRI LOCHMAN

Since World War II the production of eucalyptus oil in Australia has declined as production costs increased, making it uncompetitive with imported eucalypt oil from China, Chile, Spain, Portugal and South Africa.

Eucalyptus oil is presently used for perfumery, medicinal or industrial purposes. Perfumes accounts for only a small fraction of the total market, while medicinal and industrial oils are used in about equal proportions. Medicinal applications include antiseptics, liniments, gargles, lozenges and inhalants, while current industrial use is for scenting disinfectants and cleaners.

Although eucalyptus oil has long been recognised as an excellent solvent, its potential to break into industrial solvent markets has never been seriously investigated. The prospects, however, look very encouraging.

Most industrial solvents are derived from petroleum and subject to increasingly stringent health, safety and disposal regulations. One major solvent, trichloroethane, is likely to be withdrawn from use in Australia by 1996 (and internationally by 2000) under measures to combat ozone depletion. International consumption of this product is estimated to be one million tonnes - some 300 times the present world production of eucalyptus oil.

Providing that it can be competitively priced, the 'natural' credentials of eucalyptus oil, including low toxicity and biodegradability, should give it easy entry into solvent markets. The scale of tree planting required to supply these markets could also be a major force in the treatment of land degradation.

## ORIGINS OF LOCAL INTEREST

Local interest in eucalyptus oil began in the early 1980s when Professor Allan Barton of Murdoch University in Western Australia investigated the use of cineole (the major constituent of eucalyptus oil) as a stabiliser for mixtures of petrol and ethanol ('gasohol'). Although that use did not develop, Professor Barton became convinced of the potential of eucalyptus oil for general industrial use. He screened and selected WA native mallees for oil content and extensively planted trial and demonstration plots throughout the Wheatbelt.

During the late 1980s the Department of Conservation and Land Management (CALM) investigated potential commercial tree crops for the Wheatbelt. The objective was to find economic tree crops that could increase the motivation for the large scale tree planting required to treat land degradation. The economic prospects for eucalyptus oil looked attractive and CALM joined with Professor Barton to continue development. Alcoa of Australia generously supported the investigation of industrial uses.

Several local mallee species have good potential as crop plants. They are native to the Wheatbelt and well adapted to the dry, tough conditions which exclude other commercial species such as bluegum and pine. There are enough species with high oil levels to allow a suitable tree to be found for every site.

Additionally, the mallee's growth habit (to be able to resprout from the 'mallee root') permits a two year harvest cycle thus providing regular income. Being native plants they also serve an important nature conservation function.

At this stage the local mallee species are 'wild' in that they have not been subject to any deliberate selection or breeding to improve their performance as a crop.

Natural oil contents range from half a per cent to five per cent of the fresh weight of leaves. In their difficult natural environment these species tend to be conservative in leaf production, but in the more favourable farmland environment they could be selected to produce a bigger bulk of leaves, consequently there is great scope to increase the amount of oil production by selection and breeding.



*Previous page*  
Main: Seedlings of *Eucalyptus horistes*.  
Inset: Seedling of *Eucalyptus augustissima*.

Left: Degradation of Hermans Lake (near Narrogin) by saline groundwater.

Below: Testing the industrial degreasing value of eucalyptus oil in a workshop at Alcoa's Kwinana Refinery.



## IMPROVING OIL YIELD

CALM has begun a program of genetic improvement of several oil mallee species. The first step in this process is to collect seed from across the natural distribution of the species. The initial collections, made by Professor Barton, have been added to over the past year by CALM staff Tim Birmingham, Wally Edgecombe and Peter White. They scoured the Wheatbelt identifying trees on Crown land and private property, marking their location, collecting leaf samples, and later collecting seed. The large natural variation in leaf oil content allows seed collecting to be biased to favour oil content. Before gathering the seed, the collectors took leaf samples from each of the trees, immediately placed them in alcohol and passed them on for cineole

assessment. This was done by Professor Barton and Ben Tjandra at Murdoch University, using gas chromatography.

The seed from this collection will be sown this winter in specialised breeding trials and seed orchards, as well as in operational scale plantings stretching from Geraldton to Esperance.

## GOING TO SEED

To supply tree farmers with seeds (or the resultant seedlings) which have an improved oil yield, seed production orchards will be established. Seed orchards provide several benefits. By having all the trees in one area, seed

collecting costs will drop dramatically, they overcome the inbreeding inherent in the seed from wild populations, they permit easy selection of superior parent trees, and they can be designed to facilitate maximum crossbreeding. Two types of orchard can be established, an open-pollinated seedling orchard or a clonal orchard.

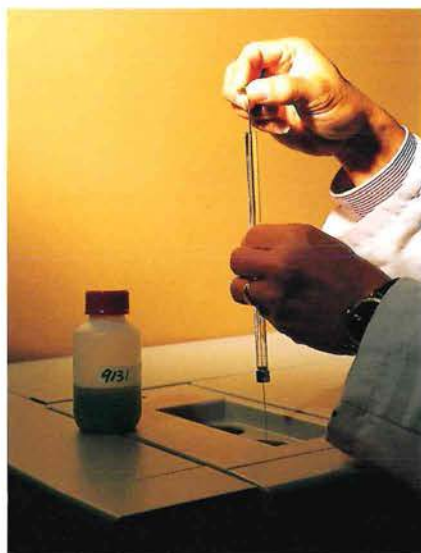
For an open-pollinated seedling orchard, the seedlings from high oil-yielding parents of the same species are planted together. When the orchard trees have reached harvest age, which in the case of the oil mallees is three years, the oil content of each tree is assessed and the

*Below left:* Preparing specimens for oil analysis at Murdoch University.

*Below:* *Eucalyptus kochii*, mature capsules.

*Bottom right:* *Eucalyptus kochii*, canopy of an early seed orchard at Murdoch University.

*Bottom left:* *Eucalyptus kochii*, flowers and buds.



poor producers culled from the orchard. This step ensures that all parent trees are superior oil producers.

The alternative method is to take clones of the very high oil-yielders and plant them together in an orchard. However, some difficulties in cloning remain to be solved before it can be used on the oil mallees. The most promising cloning technique is tissue culture.

## A SLICE OF LIFE

Tissue culture, or micropropagation, is a method of growing material in a container under sterile conditions. Originally a research tool, it is now used extensively in horticulture and floriculture nurseries as a way of multiplying shoots.

Woody tree material has been difficult to adapt to this propagation system. For a number of years Murdoch University has

*Below:* Cultured *Eucalyptus kochii* tissue with emerging shoots.

*Bottom:* Cultures in the growth chamber.



been a major force in developing tissue culture techniques for the cloning of different eucalypt species in Australia (see LANDSCOPE, Winter 1990). One species that showed great potential, as a result of work by Professor Jen McComb and Dr Ian Bennett in the late 1980s, was the oil mallee *Eucalyptus kochii* subsp. *kochii*. Five clones were initiated into tissue culture by Murdoch University. These were taken over by CALM in 1992 and a further six high oil-yielding clones have since been added to the collection.

The process of cloning is complex. Young coppice shoots are collected from stumps and transported to the laboratory, where the leaves are removed. The stem is cut into sections, washed, sterilised and immediately placed in a decontaminated container holding a gelled mix of nutrients and plant hormones (called the medium). The most difficult part of culturing woody tissue is successful sterilisation. The decontamination procedure is a delicate balance between killing the stem tissue and killing the bacteria and fungi (either

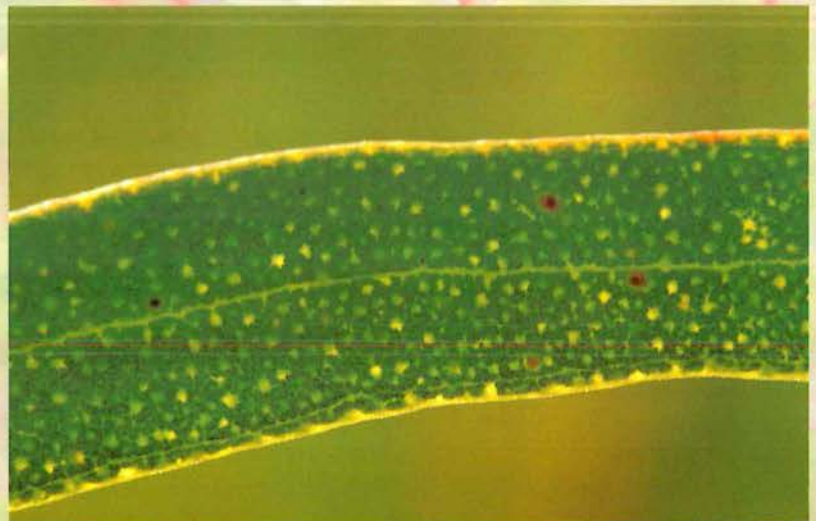
on the surface of the tissue or within the vascular system). If sterilisation is successful, the combination of nutrients in the gelled medium stimulate the tissue to grow, and shoots appear. These are placed in a special room where light and temperature are conducive to growth.

For continued growth the shoots have to be regularly transferred into new medium under sterile conditions. Once established, they are placed in a medium containing a rooting hormone, which stimulates root development. From here they are prepared for planting.

These 'plantlets' are very different from seedlings. Having existed in a perfect environment they rarely form the water-protective coating, or cuticle, vital for survival outside the laboratory. Additionally, the plantlets depend on the medium and need to become photosynthetically self-sufficient before they can be moved into the nursery.

If tissue culture of oil mallees turns out to be easy and efficient, it could be used to produce stock for full scale

## OIL-BEARING EUCALYPTS



Oil occurs in the leaves of all eucalypt species in differing amounts. Of the 700 species and varieties of eucalypts, fewer than 20 have enough oil to be commercially exploited.

The original eucalyptus oil industry was based on species from the eastern States of Australia - blue mallee (*Eucalyptus polybractea*) and the peppermints (*E. radiata* and *E. dives*).

Western Australia has its own oil mallees, which occur widely as remnants on farmland in the Wheatbelt and also in pastoral areas east of the agricultural zone. The species that are of greatest interest are *E. kochii* subsp. *kochii*, *E. kochii* subsp. *plenissima*, *E. horistes*, *E. angustissima*, York gum (*E. loxophleba*) and swamp mallet (*E. spathulata*).

Photo - Oil mallee leaf showing leaf glands.

operational planting, not just stock for clonal seed orchards. However, there is an interesting complication. For operational planting the tissue cultured plantlet must be able to produce a 'lignotuber'. This is the well-known 'mallee root' which, when fully grown, is the underground root mass from which new shoots emerge after harvest (or fire). The tissue culture process may alter the development of the lignotuber. If so, the technique may need to be restricted to gathering the best material for future seed orchards. During this winter CALM will establish field trials to test the field performance of tissue cultured plantlets.

## OIL FOR THE FUTURE

Breeding and propagation is just one part of developing a major new industry for rural Western Australia. If each of the parts are carefully researched and developed, Western Australia should be able to build an efficient eucalyptus oil industry based on providing new environmentally safe industrial solvents. Furthermore, the revival of this traditional industry would help to reduce, as well as prevent, land degradation.

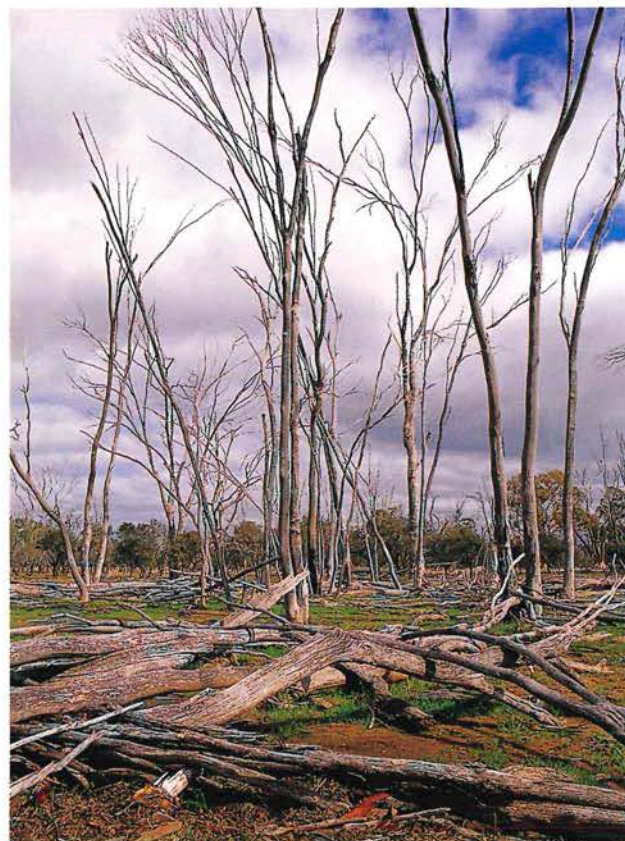


**Right:** Saline groundwater inundation causing tree death in a valley bottom near Woodanilling.

**Below right:** *Eucalyptus kochii* showing mallee root with numerous shoots.

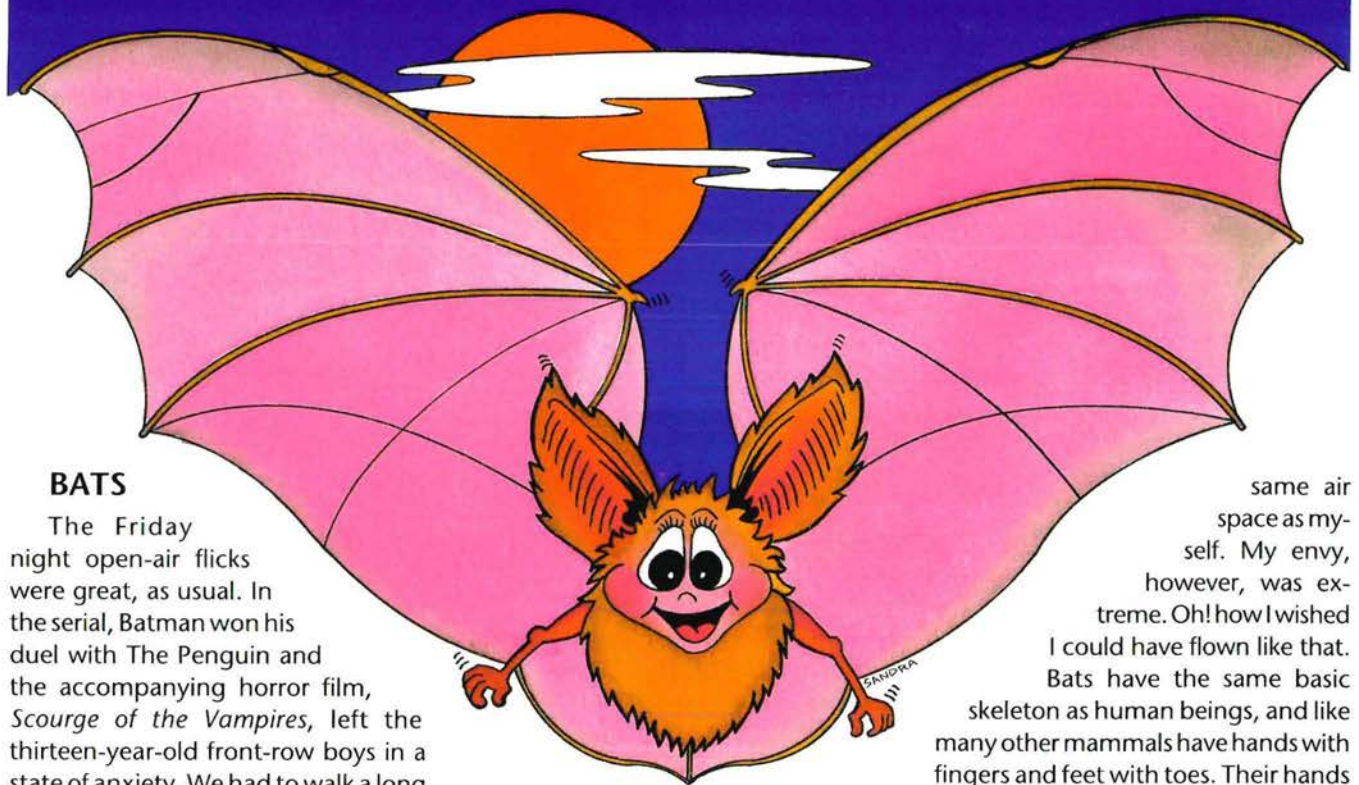
**Below:** Oil mallee species being raised for plantation in 1993 at CALM's Narrogin tree nursery.

**Bottom:** Initial field scale plantings in 1992 near Woodanilling.



Liz Barbour is a research scientist with CALM. She is in charge of tree propagation and can be contacted on (09) 334 0302. John Bartle is manager of CALM's Vegetation and Tree Planting Advisory Service and can be contacted on (09) 334 0321.

# URBAN ANTICS!



## BATS

The Friday night open-air flicks were great, as usual. In the serial, Batman won his duel with The Penguin and the accompanying horror film, *Scourge of the Vampires*, left the thirteen-year-old front-row boys in a state of anxiety. We had to walk a long way home - in the dark.

We marched in a pack, loud-voiced, wide-eyed and whistling (to keep the boogymen and his bats away). The dim lit streets and back lanes seemed to harbour a multitude of shapes and shadows which resembled the cloaked wings of ugly, saliva-dripping, bloodthirsty, giant bats. Like snakes, frogs and spiders, bats have always been unjustly associated with evil. However, research has helped to dispel the myths that are perpetuated in story books and films.

Bats are the only mammals that have the power of true flight and they also make up a quarter of all the species of Australian terrestrial mammals.

They belong to the order Chiroptera (meaning "hand-wing" in Greek), which is divided into two sub-orders, the Megachiroptera (larger fruit and blossom bats) and Microchiroptera (smaller insectivorous and carnivorous animals).

In Perth, our temperate and dry climate does not continuously produce the numbers and types of blossoms or fruit to sustain fruit bats (flying foxes). Consequently, they are found only in the north of the state. The insectivorous bats, however, do frequent the city

and suburbs.

Here you can find the white-striped mastiff-bat, Gould's wattled bat and two or three species of smaller bats.

Large groups of bats can be observed in late spring, when females band together in maternal colonies. The young are left in a communal creche while the females go out hunting.

To most Perthites, bats are things seen in books, on exotic holidays, in horror movies and the occasional TV documentary. When you first sight one, especially where you live, like I did one evening at football practice at a Scarborough oval in 1957, you may never forget it.

What attracted my attention that evening was either an albino or a light brown-grey coloured animal. The fluttering short wings seemed to pat the air, and the tiny body rose and fell like a tumbling leaf caught in a small willy-willy. It was a bat alright. The typical angular wings and stubby, seemingly tailless body, was just like those in the movie a year before.

Instantly, my thoughts of revulsion and horror were dispelled. Here in the half-light, some 10 metres above was a frail, harmless mammal living in the

same air space as myself. My envy, however, was extreme. Oh! how I wished I could have flown like that.

Bats have the same basic skeleton as human beings, and like many other mammals have hands with fingers and feet with toes. Their hands serve as wings, with long fingers supporting flexible skin, which is also joined to forearms, legs and tail.

Contrary to belief, their eyes are quite good and, with their ability to use vocal sound as sonar to track insects on the wing, they are truly among the Earth's most fascinating creatures.

## JOHN HUNTER

### DID YOU KNOW?

- *Insectivorous bats eat up to half of their body weight in insects each night and some become torpid in the winter and hibernate. To disturb them in this condition could cause death through loss of body heat and critical energy reserves.*
- *Of the 900 plus species of bat worldwide, one flying-fox has a wingspan of one and a half metres, while Kitt's hog-nosed bat of Thailand is about the size of a bumble bee.*
- *Unusual places where bats have been found roosting include old tractor exhausts, disused bird nests, water pipes from tanks, under stones, cracks in wooden fence posts and even tin cans.*

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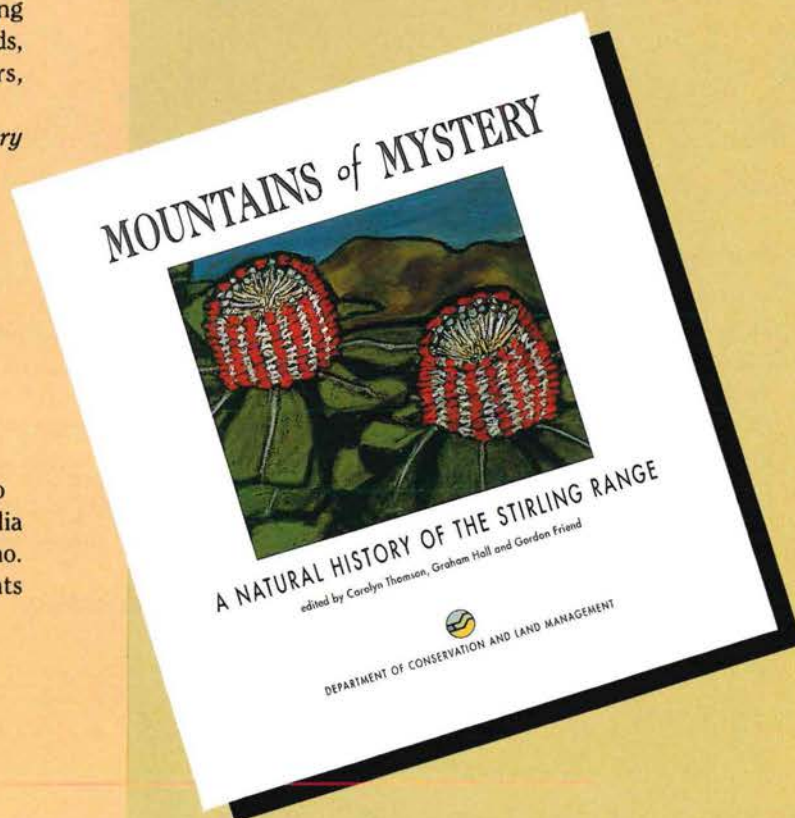
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A CALM publication  
Department of Conservation  
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*Western Australia has spectacular scenery, magnificent wildflowers and unusual animals, all of which give us a natural advantage. Here, tourists are enjoying the breathtaking view of the Murchison River Gorge in Kalbarri National Park.*

*Photo - Robert Garvey*

