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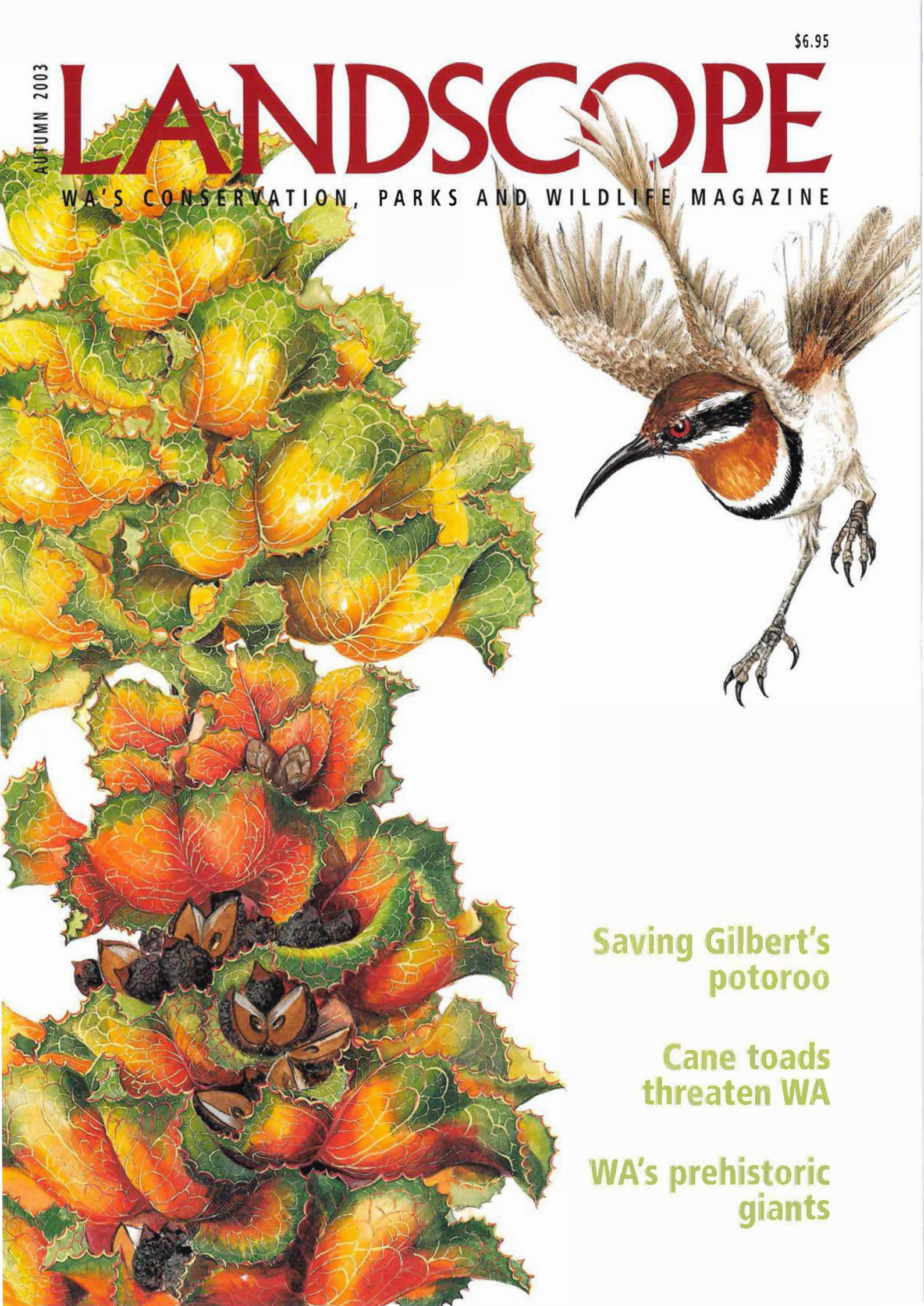
AUTUMN 2003

LANDSCOPE

WA'S CONSERVATION, PARKS AND WILDLIFE MAGAZINE



Saving Gilbert's potoroo

Cane toads threaten WA

WA's prehistoric giants

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Kimberley coast, Western Australia. Photo – Kevin Kenneally

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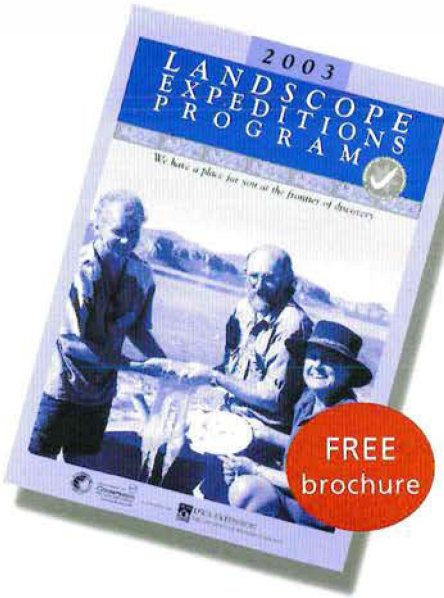

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Department of Conservation and Land Management
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THE UNIVERSITY OF WESTERN AUSTRALIA

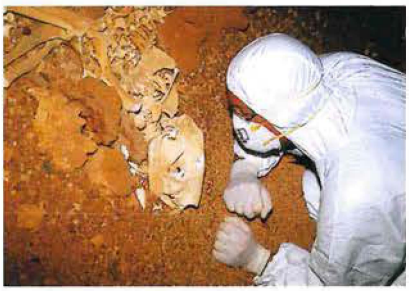
Winner of the 1998 Alex Harris Medal for excellence in science and environment reporting.

LANDSCOPE

VOLUME EIGHTEEN, NUMBER 3, AUTUMN 2003

Once thought to be extinct, Gilbert's potoroo has overcome many obstacles. What is being done to improve its chances of survival? See page 28.

Cane toads are poisonous, prolific breeders and are getting closer to the WA border. Hop to page 10.



Discover some of the prehistoric megafauna that once roamed the State in 'Walking with WA giants' on page 23.

The tuart once typified the coastal strip north and south of Perth. Why should we cherish this majestic tree? See page 16.

Lichens decorate Lake Muir, near Manjimup, with varying colours and shapes. Turn to page 43 to learn more about these fascinating life forms.

FEATURES

REGULARS

COVER

Royal hakea rises above the surrounding heath, straight and column-like. When sunlit from above or below, its unusual large variegated leaves appear to glow like lanterns, so the shrub is also known as the Chinese lantern bush. Among the birds that obtain nectar from its flowers (hidden at the base of the leaves) is the western spinebill.

Royal hakea grows almost exclusively in Fitzgerald River National Park, an area that was reserved on the recommendation of then Government Botanist Charles Gardner (see 'Botanic Guardian' on page 36).

Cover illustration by Philippa Nikulinsky

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PARTNERING WITH NATURE

Writing about the need for hands-on conservation management, pioneering conservationist Aldo Leopold wrote "the hope of the future lies not in curbing the influence of human occupancy—it is already too late for that—but in creating a better understanding of the extent of that influence and a new ethic for its governance."

Often referred to as the father of wildlife conservation in America, Leopold wrote those words in 1933.

It is therefore not exactly a new idea that any policy of hands-off management of natural areas or individual species, based on the attractive but flawed notion that nature, if left alone and freed from human influence, produces a state of harmony, balance and beauty, is, in Leopold's words, "good taste but poor insight."

In his thoughtful and provoking book, Nature's Keeper—The new science of nature management, *science and environment writer Stephen Budiansky picks up where Leopold left off and argues that it is necessary to work alongside nature and intervene in the management of natural areas, including, but not limited to, counteracting disturbances like feral animals we have let loose on the landscape, creating disturbances like prescribed fire we may have suppressed in the past or "circumscribed by the artificiality of park boundaries", regulating populations of species during eruptions or crashes and so on.*

In this edition of LANDSCOPE, *we take a look at several issues requiring very active and careful management.*

Western Australians have long feared that cane toads will one day cross our border and wreak havoc on our indigenous wildlife. In 'Poison in Paradise', Tony Start and Chris Done chronicle the westward hop of this poisonous pest released in Queensland 70 years ago to control cane beetles, outline the threats posed to the State's frog species and detail the work being done to monitor and control this amphibious bulldozer.

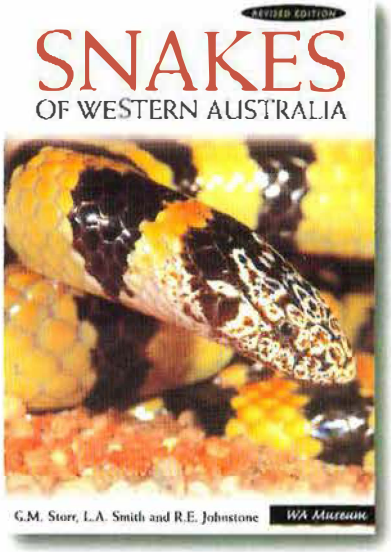
The tuart tree, which originally grew on the narrow coastal strip between Jurien and Busselton, now occupies only a small fraction of its former distribution, largely because of clearing for agriculture or housing. In 'Cherish the Tuart', Robert Powell and Bronwen Keighery provide an insight into the nature and biological value of tuarts, outline the causes of the decline of this species, and set the scene for a future LANDSCOPE *article to deal with action underway to conserve and protect these trees and their ecosystems.*

This is just a sample of what's in LANDSCOPE *this time around. Enjoy the read and we'll see you again in winter.*

Ron Kawalilak
Executive Editor

P.S. Thank you to all the LANDSCOPE *readers and supporters who responded to my request in our last issue for feedback on what you especially like about* LANDSCOPE, *what you think could be improved, and what may be currently missing that you'd like to see in the magazine in the future. You make me feel that we have an editorial committee of thousands and the magazine is the better for it. Your views will help guide us as we work to make* LANDSCOPE *a "must read" concerning conservation, land management, parks and wildlife in Western Australia.*

WATCH OUT FOR SNAKES OF WESTERN AUSTRALIA



"Snakes"... even the word sends a chill through some people. It almost certainly did when early settlers first encountered them, probably prompting the response to try to kill them—even the harmless ones. This reaction is understandable because it would have been difficult for Europeans to differentiate between a harmless and dangerous species. Fortunately, we have the revised edition of *Snakes of Western Australia* to guide us.

The new field guide, published by the Western Australian Museum, contains just about everything anyone would need to know about local snakes, including descriptions, distribution maps, illustrations and colour photographs for accurate identification. It also includes useful advice on how to avoid trouble with snakes, and what to do in the event of a snakebite. The information is comprehensive and easily understood by the reader.

Dangerous and harmless snakes alike perform a useful service by keeping rat and mice populations down, particularly in areas where they have access to wheat and feed for farm animals. This service also extends to areas where feed is kept for chickens and goats that are bred in the outer suburbs.

Arguably, snakes have more to fear than we do, particularly when they are young. Usually, only one or two of some 30 young will survive to become adults. Snakes have to avoid becoming a meal for predators such as kookaburras, magpies, goshawks and butcherbirds. They are also affected by habitat destruction, which pushes them into areas where they come into contact with people.

Generally, snakes are inactive creatures, with most only coming out of their hiding places to feed and search for a mate. *Snakes of Western Australia* profiles death adders and tells of how they feed only once or twice a year, and search for a mate when the weather warms up, before resuming an inactive life.

First published in 1986, this revised edition of *Snakes of Western Australia* will help readers to identify more than 100 species found in WA and the surrounding seas. Written by G M Storr, L A Smith and R E Johnstone, the guide is available for $39.95 at all major bookshops and all branches of the Western Australian Museum.

ECOEDUCATION: BREEDING CONSERVATION CONSCIOUSNESS

Launched in 1993, the Department of Conservation and Land Management's EcoEducation programs for school students are producing a new generation with sound conservation values. The programs have catered for more than 110,000 participants and have influenced children, their teachers and families.

The profound success of the programs is largely owed to their ability to appeal to students of all ages, and encourage them to look at nature in a new light. As well as learning from their hands-on bush experiences about how people depend on natural systems, children are also empowered to contribute personally to nature conservation. This augurs well for the future management of the environment, by encouraging recognition of the need for all sections of the community to share responsibility in conserving Western Australia's natural heritage.

The programs are based at the department's Hills Forest Discovery Centre in Mundaring and offer students practical, hands-on lessons through excursions and camp activities. They also provide teachers with professional development, and schools with curriculum-linked resources.

In 2001, EcoEducation programs were launched at the Wellington Discovery Forest, and through the programs, students from the Bunbury, Collie and Harvey areas have developed a sense of ownership of Wellington National Park and the jarrah forest. To date, more than 3000 students, teachers and other adults have been involved.

Meanwhile, other EcoEducation initiatives continue to grow, with schools from all over the State taking part in the CALM Bush Rangers cadet program and the Western Shield schools program, which involves them in the department's wildlife recovery program. Through this program, more than 67,000 students and teachers have been made aware of the plight of our small mammal species and they have been shown how they can each help to save threatened species.

Many schools have participated year after year in the EcoEducation programs and deserve acknowledgement for their assistance in the development of the programs. These include Applecross Primary School—which has raised $6000 over the past six years for conservation projects—and Walliston, Willetton and Falls Road primary schools; Penrhos College and Helena College; Perth Modern School; and John Forrest and Lynwood senior high schools.

Kanyana Wildlife Rehabilitation Centre managers and volunteers have provided animal encounters that are integral to the programs and also deserve thanks. Volunteers and small businesses from the Mundaring community have also made an important contribution to all the programs, facilities and resources at The Hills Forest Discovery Centre.

Students Sarah Zuzzolo and Rhys Sharrett measure evidence to help solve a mystery on the 'forest detective trail'.

Photo – Tony Nathan

Invaluable partnerships have also been forged with the Department of Education's Aboriginal Education section, the Water Corporation and Alcoa World Alumina Australia. These partnerships have generously sponsored the programs for four years.

For further information about EcoEducation programs contact the department's Senior EcoEducation Officer, Liz Moore, by phone (08) 9334 0387, fax (08) 9334 0498 or by email (lizm@calm.wa.gov.au).

SALT FLATS PROVIDE CLUES ABOUT SALINITY

A tract of seemingly uninteresting samphire flats, running along the northern side of Great Eastern Highway between Meckering and Tammin, has proved to be a treasure trove of biological diversity that could help landowners unlock further strategies in the bid to counter salinity.

Recent surveys by the Department of Conservation and Land Management have found that the Mortlock salt flats represent one of the most extensive and biodiverse, naturally saline braided drainage lines in this part of the Wheatbelt. The flats extend over 6300 hectares, and were documented during the recent five-year biological survey of the Wheatbelt.

Further survey work by the department's WA Threatened Species and Communities Unit (WATSCU), funded under the State Salinity Strategy, has revealed that many of the salt flats are teeming with life and are home to more than 80 plant species.

These species include a recently rediscovered plant not seen since the 19th century—Drummond's frankenia (*Frankenia parvula*)—and a number of other rare plants, including Royce's saltmat (*Roycea pycnophylloides*), Hopkins's salt rush (*Hopkinsia anoctocolea*) and purple samphire (*Sarcocornia globosa*). A variety of microscopic animals also live in the lakes and temporary pools dotting the flats.

An interesting feature of the area is that, while many trees and larger shrubs had obviously declined, other species—also thought to be intolerant of flooding and high salinity—have survived on the sandy islands and banks within the flats.

The department is now investigating how the vegetation of the flats is surviving, when many other areas have succumbed to salinity and rising groundwater. It is not yet clear if the area will remain intact, due to the presence of complex water properties and its movement in relation to the land (hydrology), or if the vegetation of the area will collapse within the next few years.

The department is currently preparing a plan to work with neighbouring landowners to allow them to study the hydrological processes of the system. It is hoped that the study may lead to new strategies to help landowners combat salinity on their farms and in other parts of the catchment. There may also be implications for other naturally saline systems elsewhere in the Wheatbelt.

The Wheatbelt biological survey revealed that as many as 450 native plant species were at risk from rising water tables and resulting salinity.

If researchers and landowners can gain a better understanding of how salinity is impacting on native vegetation and ecological communities, then there is a greater chance that strategies to combat salinity will have broad ranging benefits economically, socially and environmentally.

People in the Meckering-Tammin area who are interested in the department's work at the Mortlock salt flats can contact Jill Pryde at WATSCU on (08) 9405 5128 or by email (jillp@calm.wa.gov.au).

Right: Purple samphire is found from Meckering to Lake King.

Photo – Bindy Dotson

Below: Mortlock salt flats in the Wheatbelt.

Photo – Sheila Hamilton-Brown

SAMPHIRES—LIFE FROM SALT

A new book, *Samphires in Western Australia*, suggests that samphires—hardy, salt tolerant plant species—may hold the key to breeding new crops in Western Australia's marginal areas. Environmental consultant and author of the book, Bindy Datson, suggests that the ability of samphires to live in harsh environments could lead to the use of the shrub's genetic material to breed food crop plants.

The succulent, leafless shrubs are remarkably durable and can cling to claypans through frost, drought and floods. They are already proving their worth in projects to rehabilitate mine sites. Seeds of some samphire species have long been an important food source for Aboriginal people, who traditionally used them to make flour for damper. A wide variety of samphire species are also found across the world, and in some countries they are either pickled or boiled.

Bindy's book was published as part of a range of activities involving the Department of Conservation and Land Management. The projects aim to develop and encourage the use of native plants to meet economic goals, as well as those of biodiversity and land and water conservation.

"Few studies have been conducted into the State's samphires. Experimental planting of different species has, however, been carried out in Victoria, and overseas in the Middle East, Mexico and America's west coast, where fresh water is scarce," Department of Conservation and Land Management Consultant Botanist Paul Wilson said.

"In many of the overseas trials, samphires have been planted in fields of rice and irrigated with sea water. The whole plant is harvested for hay, sometimes by being threshed, and the seed is crushed for its oil. In making hay, the salt is removed by roller-pressing before the crop has dried.

"The easy-to-read book, *Samphires in Western Australia* is the first field guide to identify the shrubs frequently found in saline wetlands, and hasn't come a moment too soon. Western Australia's salinity problem is worsening and we have to look at ways of managing and manipulating the problem with innovation."

The guide—designed for landcare officers, farm advisors, horticulturalists and botanists—outlines the environmental and aesthetic value of 30 species found variously in conditions ranging from waterlogged saline soils to hard-baked clay.

Beautifully illustrated with colour photographs, *Samphires in Western Australia* costs $25.95. It is available from bookshops, camping shops, visitor centres and Department of Conservation and Land Management offices.

A THORNY PROBLEM

Prickly acacia (*Acacia nilotica*) was introduced to Queensland in the 1890s as an ornamental tree. Since then, cattle have consumed the pods and spread the seed throughout Queensland and parts of the Northern Territory. It is now estimated that seven million hectares are covered in prickly thickets of this registered 'weed of national significance'. The cost to biodiversity has yet to be calculated, but primary industry losses are estimated at $4 million per year. The bad news is that prickly acacia is still spreading.

"This is why there was a stir when it was reported to be growing on the roadside in the east Kimberley near Halls Creek," said Tony Start, a Department of Conservation and Land Management principal research scientist.

"Fortunately, the one young tree was destroyed, but it highlighted the importance of people keeping a sharp eye out for it occurring anywhere else," he said.

While departmental officers are vigilant, people should watch out for prickly acacia—particularly on roadsides anywhere in the north of Western Australia. The seeds (which remain dormant for long periods) can grow to maturity after falling off an interstate vehicle.

What do you need to look for? Young plants are shrub-like and often form dense, prickly thickets, but mature trees have an umbrella shape, similar to the ones seen in pictures of the African savannah (even though the Australian variety came from Pakistan). Pairs of ridged thorns—up to five centimetres long—protect fine, feathery leaves and round yellow flowers, just like many Australian acacias. The 15 centimetre (or more) greyish pods, deeply constricted between each seed, look like pendulous strings of flattened beads.

"Young prickly acacia plants look similar to the mimosa bush (*Acacia farnesiana*). People must be careful not to confuse the two," says Tony.

"The mimosa bush is common in the Pilbara and Kimberley, where it is sometimes also called prickly acacia. The bark on the twigs of the mimosa bush is dark and rough, with tiny pale spots, whereas the prickly acacia's twigs are smooth and green. Mimosa bush pods are dark, not much more than six centimetres long and are shaped like slightly curved cigars."

People should remember that when visiting northern Australia, they can help protect our heritage and economy by taking a small sample of anything they suspect to be the prickly acacia weed to their nearest Department of Conservation and Land Management or Department of Agriculture office.

The prickly acacia's thorns are up to five centimetres long.
Photo – Colin Wilson

DRYANDRA ECOLOGY COURSE

Radio-tracking, trapping and spotlighting native animals such as possums, woylies and tiny red-tailed phascogales are just a few of the activities planned for the Dryandra Woodland Ecology Course to be held in May 2003. Participants can also expect to gain an insight into some of the challenges found when managing remnant bushland, and learn something of the natural and cultural history of Dryandra.

While not part of the Ecology Course, time will be set aside for participants to enjoy a brief viewing of the new Barna Mia native animal enclosure, which opened in December 2002. Barna Mia is already proving popular with visitors to Dryandra.

Winner of the 2001 Heartlands Tourism Association Award, the Dryandra Woodland Ecology Courses are held twice each year, usually in May and October or November. Activities are mostly field based and provide participants with a close-up experience of the astonishing diversity of Wheatbelt plants and animals. Participants will also see some of the research techniques used in the urgent quest to conserve the region's important inhabitants.

Far left: Field officer Clare Anthony with a juvenile mala.

Left: The hands-on courses involve mostly field-based activities.

Photos – Kate MacGregor

These residential courses are organised by the Department of Conservation and Land Management's Narrogin District staff, and take place between Friday evening and Sunday afternoon in the tranquil setting of Dryandra Woodland—only a two-hour drive from Perth. For further information, including the dates, times and cost of the May 2003 course, please contact the department's Visitor Services Officer Kate MacGregor on (08) 9881 9207, or by email (katemac@calm.wa.gov.au).

Poison in paradise:
cane toads hop west

Western Australians have long feared that cane toads will one day cross their border. As that day draws near, work is being done to monitor and document their progress, and the implications to the State's frog species.

by Tony Start and Chris Done

The time: August 2000.
The place: Elsey Station, near Katherine (in the Northern Territory).
The scene: A bunch of scientists, loafing ducks, lotus flowers and a billabong.

While conference delegates discussed ponderous problems of pasture management, a few of us 'birdos' slipped over to the billabong. Close up, it had its share of blemishes, particularly a shoreline churned by cattle and pigs, but there were lots of birds and lotus flowers, and waterlilies too. As I picked my way between muddy holes made by sinking hooves, I spotted a strange little black frog sitting motionless in a particularly deep pig-print. Intrigued, I caught it. But, as I peered at the tiny amphibian in my hands, curiosity turned to horror. I'd caught my first 'wild' cane toad. Then we saw more, lots of them: juvenile toads and a few bigger ones too!

WESTWARD HOP

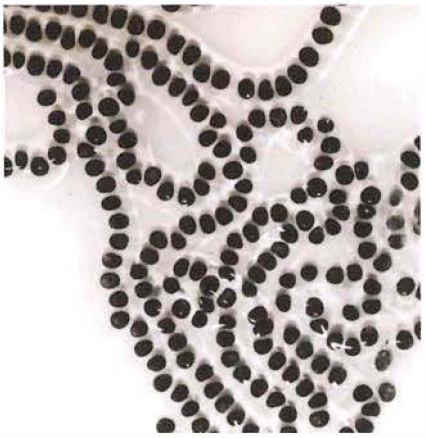
So . . . they were this far west. The billabong was in the catchment of the Roper River, which flowed east to the Gulf of Carpentaria. For Western Australians, however, the concern was that the Katherine River, just a few kilometres up the road, joined the Daly River, which emptied into Bonaparte Gulf off the Kimberley coast. Reality sank in. Cane toads had all but reached the watershed that separated the rivers that flowed east, from those that flowed towards Western Australia, towards home.

Two wet seasons later, in March 2002, national park ranger Lindsay Brown confirmed the rumours we'd heard. The toads were well west of Katherine. Indeed, he'd seen masses of them sitting on the road at most creek crossings in the first 75 kilometres travelling west from the town. Thereafter, numbers had thinned and the last cane toad he saw that night was 100 kilometres down the highway. Since then, there has been news that they have reached the Victoria River Bridge. The lead toads are now less than 300 kilometres from Kununurra and the Ord River.

Cane toads travel fast, following roads as well as rivers. On average they travel about 25 kilometres per year, but in some years they do much more. They are also adept at hitching rides. In fact, the first cane toad we saw in the Kimberley had come from Queensland in caravan comfort, snugly concealed in a flowerpot. Its cover was blown when quarantine officers pulled the illegally imported plant out of its container at the border checkpoint.

Previous page
Main: An aerial view of the lower Ord River, Kununurra.
Photo – Col Roberts/Lochman Transparencies
Inset: Cane toad (*Bufo marinus*).
Photo – Dennis Sarson/Lochman Transparencies

Above: Cane toads mate in still or slow moving waters and are sexually mature at one to two years.
Photo – Stephen Richards/Nature Focus



Above: Large females may lay more than 50,000 eggs at a time in distinct bead-like strings.
Photo – Deborah Pergolotti

POISON PIONEERS

It doesn't take long for pioneers to populate new territory. A cane toad can lay thousands of eggs in long threads of mucous, which drift like tangled strings of black beads. While most frogspawn is the target of predatory fish and other creatures, cane toad eggs are safe. They are toxic. The tadpoles and the mature toads are poisonous. Merely mouthing toads is sufficient to kill dogs and quolls. There is only one short window in their lives when they can be safely eaten. That is the brief time it takes, after metamorphosing from tadpoles, for the poison glands to develop on their necks. It is a rare and sad irony that, in Australia, cane toads kill their would-be predators (fish, northern quolls, goannas, crocodiles and birds of prey, for example) as well as their prey. No wonder there were masses of tiny toads at the billabong on Elsey Station or that they had travelled so much further west in just two short years.

While there are many accounts of the diet of cane toads, and of the susceptibility of carnivores to their poison, information on their effect on native wildlife is mostly anecdotal. No doubt there is truth in observations of frogs, goannas and quolls becoming rare following the arrival of toads in new areas, particularly in the first years. However, there are no proven accounts of extinctions (except locally) as a direct consequence of cane toads eating or poisoning indigenous animals. In fact, there are accounts of species becoming rare and, some years later, recovering to varying degrees. It seems that some species learn to avoid cane toads and a few—some birds of prey for example—even learn to roll toads over so that they can feed off the soft underside while avoiding the poison glands on the back of the toad's neck.

People in the Kimberley are understandably concerned. Questions range from conservation issues to the effect that toads may have on bush tucker, domestic pets, fish stocks and wildlife. Last year, many people brought frogs to the Department of Conservation and Land Management's office in Kununurra, mistaking them for cane toads. So far, besides the one from the quarantine checkpoint, they have all been false alarms. Most of the suspects were giant frogs (*Cyclorana australis*). But it seems inevitable that in a year or two there will be toads in town and in the extensive habitats offered by Lake Argyle and Lake Kununurra, as well as the irrigated farm area.

WHAT ARE CANE TOADS?

Cane toads (*Bufo marinus*) are members of the family *Bufonidae*, the true toads. No toads are native to Australia despite the (misleading) use of names such as 'toadlet' for some of our native species. Toads occur naturally on every other continent—where one species or another can be found in tropical rainforests, temperate forests, savannas and even deserts—but the ancestral home of cane toads is Central and South America, where they live in fairly arid scrub forests and savannas.

Cane toads exude a poisonous secretion from the glands on their neck.
Photo – Jiri Lochman

Unlike all our native frog species, cane toads have:

- a very warty skin that is usually dark brown to black;
- a very short nose (the distance from the front of their eyes to the tip of their nose is less than the diameter of their eyes); and
- large, elongated swellings on either side of the neck at the back of their heads. These are the poison glands, from which they exude a milky toxic fluid if handled. DO NOT LICK YOUR FINGERS OR RUB YOUR EYES AFTER TOUCHING THEM!

They are tough!

- Adults can lose more than 50 per cent of their body water and absorb replenishment through their skin from damp soil or humid atmospheres.
- They tolerate temperatures between 6° and 41 °C, although they are not very active at the extremes.
- They eat almost any animal, provided it's not more than half their own length (in Australia they'll eat mice, birds, lizards, frogs, crabs, earthworms and spiders, but beetles and ants are the staple items).

They are prolific breeders!

- A large female may lay more than 50,000 eggs at a time.
- Tadpoles can live in permanent lakes, temporary ponds and even brackish water (up to 15 per cent seawater).
- Provided they can get to water, they can breed all year round in northern Australia.
- In optimal conditions, eggs can hatch in two days and tadpoles can metamorphose into tiny toads, only six millimetres long, in 16 days. Thereafter, they can grow up to two millimetres per day and they are sexually mature within one to two years. (These growth rates depend on the availability of warm water and abundant food. In less perfect habitats, everything takes longer, but they still grow.)

Will we ever learn?

- On 22 June 1935, 101 cane toads were released in Queensland to control grey-backed cane beetles, despite the fact that the beetles lived on the cane stems and their larvae in the soil, where they were inaccessible to toads, and despite a long history of their ineffectiveness as bio-control agents.
- There is a long history of introductions, which started in Jamaica in the 1850s and other Caribbean Islands soon afterwards. Cane toads are now established in the Philippines, Japan, Hawaii (where the first toads to arrive in Australia came from), Fiji, New Guinea and other Pacific nations.
- Despite so many well-intentioned introductions, all attempts to use cane toads for controlling pests have been dismal failures that have invariably backfired. Here's just one more example. In the Philippines, cane toads were expected to kill rats. Instead, they poisoned the village cats and rat numbers soared.

KUNUNURRA FROG WATCH RESULTS

Frogs recorded by Save Endangered East Kimberley Species (SEEKS) near Kununurra on 20 January 2002

The recordings were made at five sites: Lake Kununurra (site 1); a garden (site 2); seasonally flooded grassland (site 3); a flooded gravel pit (site 4); and a rocky creek line (site 5). The results show the total number of species recorded at each site and (in brackets) the number of species found only at that site.

Frog species	Site 1	Site 2	Site 3	Site 4	Site 5
bilingual frog (*Crinia bilingua*)					•
giant frog (*Cyclorana australis*)			•	•	
long-footed frog (*Cyclorana longipes*)			•		
Daly Waters frog (*Cyclorana maculosus*)			•		
marbled frog (*Limnodynastes convexiusculus*)	•		•	•	•
ornate burrowing frog (*Limnodynastes ornatus*)			•		
flat-headed frog (*Limnodynastes depressus*)			•		
green tree frog (*Litoria caerulea*)		•			
Copland's rock frog (*Litoria coplandi*)					•
Peter's frog (*Litoria inermis*)				•	
rocket frog (*Litoria nasuta*)			•	•	
pale frog (*Litoria pallida*)				•	•
Roth's tree frog (*Litoria rothii*)			•	•	
desert tree frog (*Litoria rubella*)			•		
Wotjulum frog (*Litoria wotjulumensis*)					•
northern toadlet (*Uperoleia borealis*)				•	•
stonemason toadlet (*Uperoleia lithomoda*)				•	
Total	1 (0)	1 (1)	9 (5)	8 (2)	6 (4)

- The marbled frog was the most widespread, and the hardest to catch. It kept hidden under the grass.
- Only six of the 15 species were recorded at more than one site.
- Lake Kununurra was remarkable for the lack of frogs.
- The flooded grassland had the greatest diversity (nine species; five found only there).
- The gravel pit had nearly as many (eight species) but only two that were not seen elsewhere. It was the prime site for toadlets.
- Rock holes in Mirima National Park were home to some sandstone specialists.

Lily Creek lagoon, Lake Kununurra.
Photo – Marie Lochman

FROGWATCH

If you'd like to keep track of the westward hop of cane toads, you can visit the Frogwatch website at www.frogwatch.org.au, where new sightings are recorded on an accessible database. In fact, the website contains information on the identity, habitat and distribution of all frogs found in the Kimberley or Top End. You will find maps and photos, and can even play recordings of the calls of all species.

If you visit the Kimberley or Top End and wish to record the frogs around your campsite, the calls will be particularly useful for identification, because each species has its own distinctive 'croak' or 'plonk'. One only has to look at the common names of frogs to see that. In Western Australia, we have (among others) banjo frogs, bell frogs, bleating frogs, moaning frogs and motorbike frogs. We even have humming frogs, wailing frogs and quacking frogs! Because frogs tend to be most active at night, and many live in dense vegetation or burrows where they're hard to find (they invoke an understandable but irritating code of silence as you approach!), it is much easier to listen for frog calls than to catch the animals themselves. If you're sure of your identifications, you can have your data added to the Frogwatch database (to find out how to do that, visit the site).

Frog-watching adds to our knowledge of the status and distribution of frogs (and the spread of cane toads). It can be great fun too. Last year, Ian Morris and Graeme Sawyer—the people behind the Frogwatch website—visited Kununurra. Ian and Graeme, together with members of our local naturalist group, Save Endangered East Kimberley Species (SEEKS), listened and hunted for frogs on the banks of Lake Kununurra, in flooded gravel pits, in rock holes and in seasonally flooded grasslands. Their results? Pretty good. They found 15 species, which is all but one of those known from the area (see the table above).

Left: The giant frog (*Cyclorana australis*) is sometimes mistaken for the cane toad.
Photo – Greg Harold

Although it was the wet season, when most frogs were out and about, there hadn't been rain for a week. Each habitat had its own suite of frogs. Surprisingly, Lake Kununurra—with its abundant water—had fewest species, while the flooded grassland was the richest site, closely followed by the gravel pit. Numbers were probably good because the frogs had large areas of shallow water, and damp banks with patches of open ground and dense vegetation.

CALLING ALL FROGS

SEEKS hopes to repeat the survey each year, so that—when cane toads arrive—members will be able to record any impacts on local frog communities. There have been other attempts to document the effects of the cane toad's arrival in new areas, but they have to overcome considerable difficulties. For one thing, frogs and toads are most active in northern Australian savannas during the summer (wet season), when roads become impassable and fieldwork is most difficult. For another, it is difficult to document exactly when the first toads arrive.

Gordon Grigg, a Professor at The University of Queensland, and his colleagues have come up with a particularly clever approach, which they are using on the Roper River. They have developed computer software that compares frog calls detected through microphones against a library of recorded calls of every species in the region and those of cane toads. Solar panels, batteries, microphones and data-loggers have been set up on poles at 'froggy' places along the river (except in the lowest reaches in which cane toads have already arrived) to record the identity and abundance of all frogs calling between eight o'clock and midnight each night. With this equipment, they can determine exactly when cane toads arrive, and also measure changes in the abundance of each frog species before and after cane toads get to each of their monitoring sites.

Above left: (left to right) Gordon Grigg and Les Fletcher from The University of Queensland, and Andrew Taylor from from The University of New South Wales with the frog call monitoring equipment behind Nourlangie Rock in Kakadu National Park.
Photo – Marcos Coutinho

Above: Wotjulum frog (*Litoria wotjulumensis*).

Right: Green tree frog (*Litoria caerulea*).
Photos – Greg Harold

So what is in store for the Kimberley wildlife? We can be sure that cane toads will arrive, probably in the next two to three years. As no-one has been able to stop them in 70 years of dispersal from the canefields of coastal Queensland, it seems there is little we can do about it. We can't be sure how fast they will move through the landscape, because much of the Kimberley is rugged and harsh. Nor can we be sure how severely they will affect our native wildlife. There is good reason to expect that many species will be severely affected, but history elsewhere suggests that most, if not all, will be spared extinction. Finally, scientists are still looking for biological control mechanisms for this pest. We must hope that they are successful and that our wildlife will ultimately recover.

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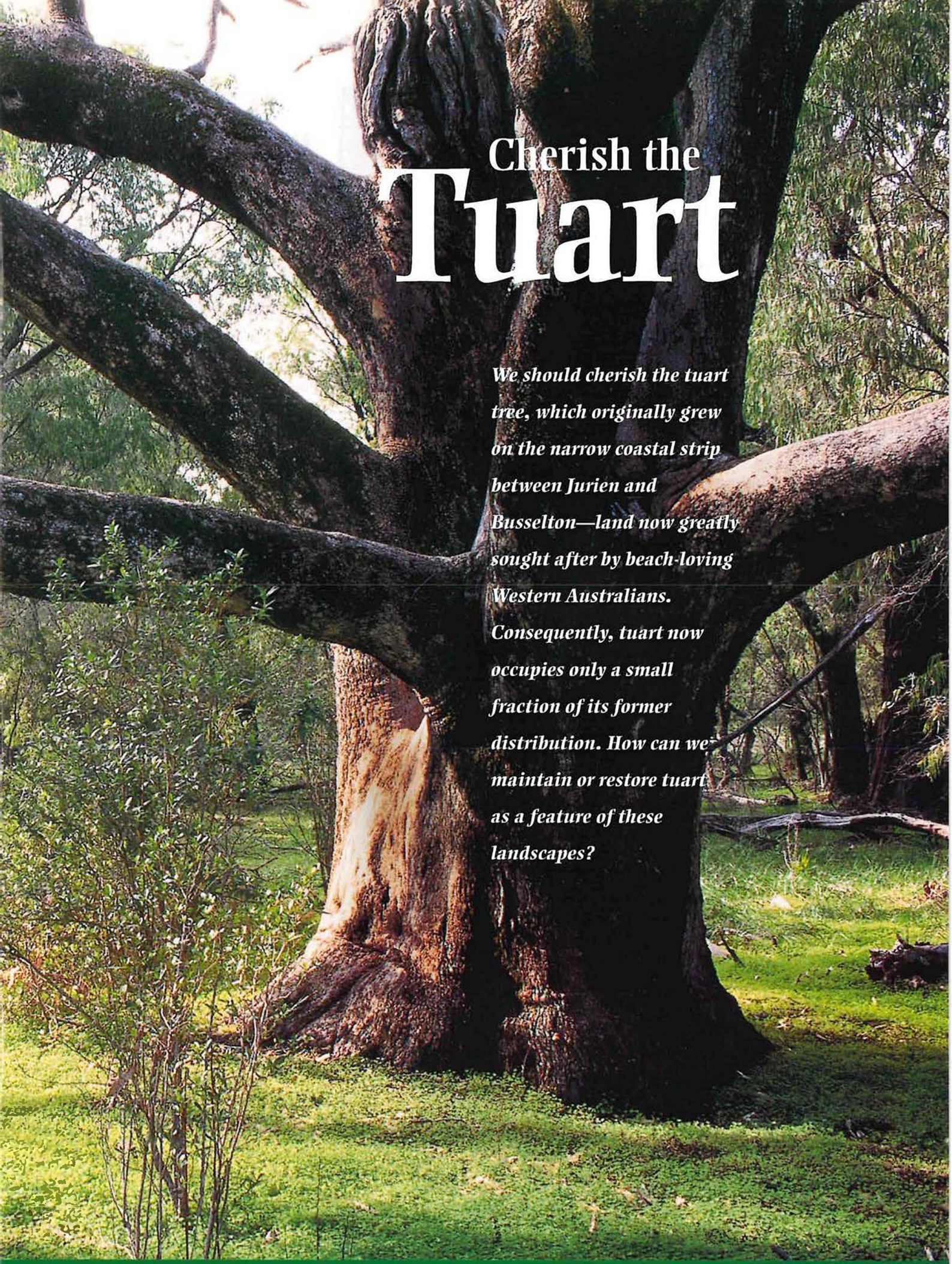


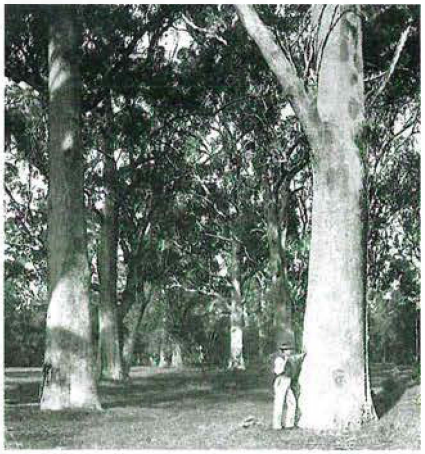
Cherish the Tuart

We should cherish the tuart tree, which originally grew on the narrow coastal strip between Jurien and Busselton—land now greatly sought after by beach-loving Western Australians. Consequently, tuart now occupies only a small fraction of its former distribution. How can we maintain or restore tuart as a feature of these landscapes?

by Robert Powell and Bronwen Keighery

Tuart occurs in a coastal strip from near Jurien to the Sabina River, near Busselton, and dominates the landscape in many places within this range. These include the otherwise cleared sandy flats from Ludlow to Mandurah, and the dune country from Bunbury to the Moore River.

Although mostly confined to a coastal strip five to 10 kilometres wide, tuart does extend further inland along the margins of our rivers and estuaries. The western block of the Lowlands property, on the Serpentine, and remnant trees on the flats at Ravenswood, on the Murray River, and in the Perth suburb of Ferndale, near Bannister Creek, illustrate these landscapes. A distinctive variety was known to occur at Guildford. Some of the interdunal wetlands are typified by tuart groves; significant locations are Manning Lake, where they grow into the lake, and the Perry Lakes, where they grow on the sandy flats around the lakes.



Previous page
Tuart tree on Leschenault Peninsula.
Photo – Rob Oiver

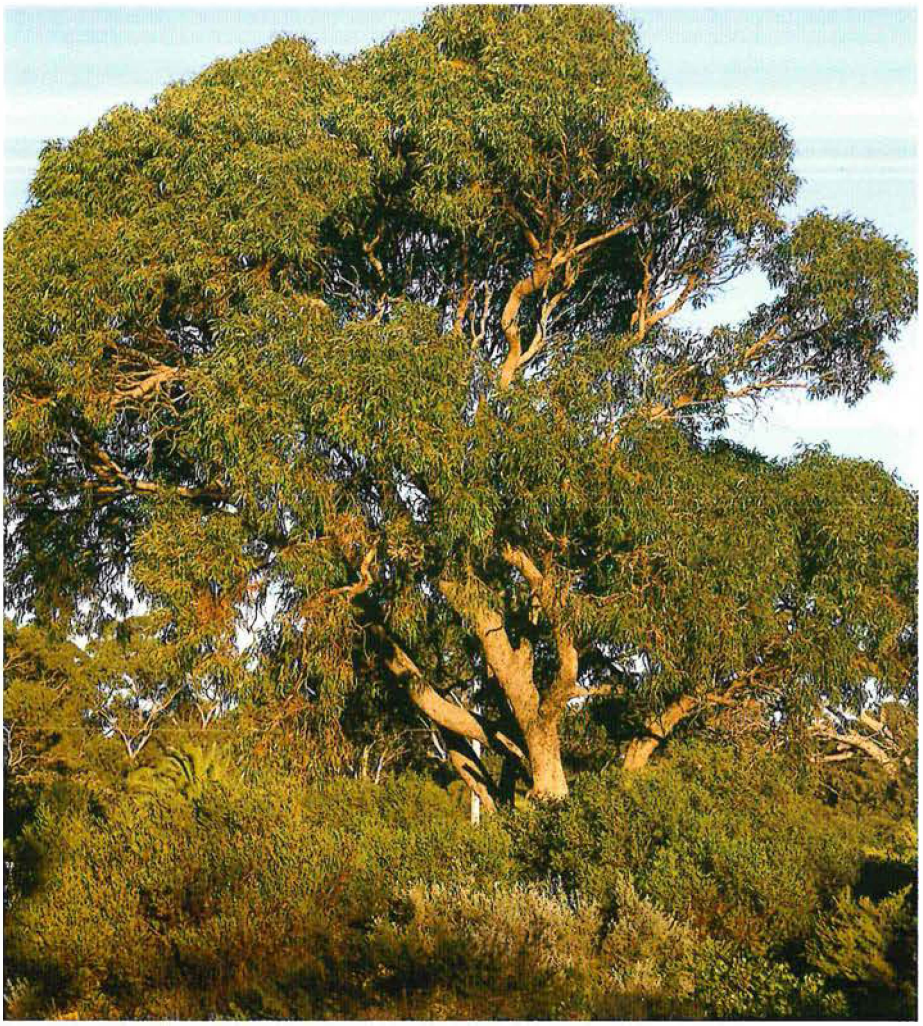
Left: Tuart forest, probably near Ludlow, in 1896.
Photo – Government Printing Office, A4264

Below left: Tuarts at City Beach with low, broad, dense canopies, in response to very salty sea winds.
Photo – Robert Powell

REMAINING OCCURRENCES

Most of the area where the tuart occurs has been cleared, or largely cleared, for agriculture or housing. A number of places, however, are preserved for conservation. The best known is the Tuart Forest National Park, at Ludlow, near Busselton. Well-known conservation reserves south of Perth containing tuart include Yalgorup National Park and Leschenault Peninsula Conservation Park. North of Perth are Southern Beekeepers Reserve, Nambung National Park and Bashford Nature Reserve. Within the Perth metropolitan region are Yanchep and Neerabup national parks, Woodman Point and Thomsons Lake nature reserves, Kings Park, Bold Park, Star Swamp and Trigg bushlands, and Blackwall Reach Reserve.

In suburban Perth, tuart has largely been destroyed. Isolated old specimens, however, still occur in such Perth suburbs as Nedlands, Floreat Park, Scarborough, Applecross and suburbs east and south of Fremantle. Further out, parks in Wanneroo and Joondalup, sadly cleared of most of their original vegetation, remain dominated by tuart.



SIZE, COLOUR AND FORM

Tuart, through its size, colouring and form, gives an identity to the landscapes of the Swan Coastal Plain.

Tuart is the largest naturally occurring tree on the Swan Coastal Plain, growing in places to more than 35 metres, with trunks two metres thick near the base (other local eucalypts such as jarrah and marri grow tall on the Darling Range, but smaller on the coastal plain). Combined with this majesty is its grace—the result of its flowing and well-spaced branches.

Tuart's colour scheme of greyish-green foliage and off-white trunks is not matched by any other eucalypt natural to the plain. The near-white colour of the trunks, particularly in mature specimens, gives rise to the tree's alternative common name, 'white gum'. One of the earliest land grants in the Perth area records the name 'White Gum Block' for a part of the farm dominated by tuart. Although preserved in the name of the suburb White Gum Valley, nowadays only old-timers use the name white gum for the tree—its

Right: Tuarts shed more bark than most rough-barked eucalypts, leaving paler patches. Shedding may be so extensive that the new, pale bark dominates, hence the name 'white gum'. In flower at the bottom of the picture is cockies' tongues (*Templetonia retusa*).
Photo – Bernhard Bischoff

Aboriginal name dooart (hence 'tuart') has prevailed.

Tuart typically adopts a 'splitting' habit of growth. Rather than having a dominant central trunk, with side branches coming off it (the 'shaft' habit), as many forest trees do, tuart tends to split into several nearly equal spreading branches. That habit is well suited to tuart's occurrence near the coast. Salt carried by the frequent onshore winds is very damaging to foliage. The broad, rounded canopy that results from tuart's habit, together with a greater mass of foliage than is found in most eucalypts, tends to deflect these salt winds, reducing their effect.

Tuart is not the only eucalypt on the plain to adopt a splitting habit. Flooded gum does so very typically. Jarrah, which has more of a shaft habit in the Darling Range, has a splitting habit on the plain. But tuart's form is nonetheless distinctive. Its branches are more flowing and upwards-tending than those of jarrah, and sturdier and more widely spaced apart than those of most specimens of flooded gum. Its foliage is also thicker and more clumped than that of flooded gum.

Tuart varies greatly in size and shape over its range. Although it is often a tall tree, it is of low to medium height in the northern parts of its range, or on very shallow soils, or close to the ocean. Near the ocean, where it is more affected by salt winds, it is asymmetrical in shape, much broader than it is tall, and has a more closed canopy than it does elsewhere. In several near-coastal locations, north of Pipidinny Road in the Perth metropolitan area and on the coast at Dalyellup, south of Bunbury, it forms a mallee.

NATURAL HERITAGE

The type of vegetation formation it creates varies greatly too. In some places, it forms a forest, in others a woodland or open woodland. Or the trees may be spread still further apart, as isolated specimens, or clumped together in small groves. Thus tuart contributes much towards the variety of landscapes on the plain. The remaining tuart groves and individual trees in otherwise mostly cleared areas of the plain are important landscape features and a significant part of our natural heritage. The conservation of these tuarts is vital in maintaining the distinctive landscape of the near-coastal lands on the plain.

In Perth, tuart provides a link with history through the occurrence of specimens that were part of the vegetation before it was cleared for urban development. Even in Subiaco, one of Perth's oldest and most highly cleared suburbs, three specimens still survive in the gardens of Subiaco School and the Theatre Centre. They have been pruned in past years, but two of them have regained something of their previous majesty.

BIOLOGICAL VALUE

Tuart is one of the most biologically valuable trees in Perth. The older trees provide hollows for many bird species, possums and bats. Tuart's value to insects is especially important.

TUART RESPONSE GROUP

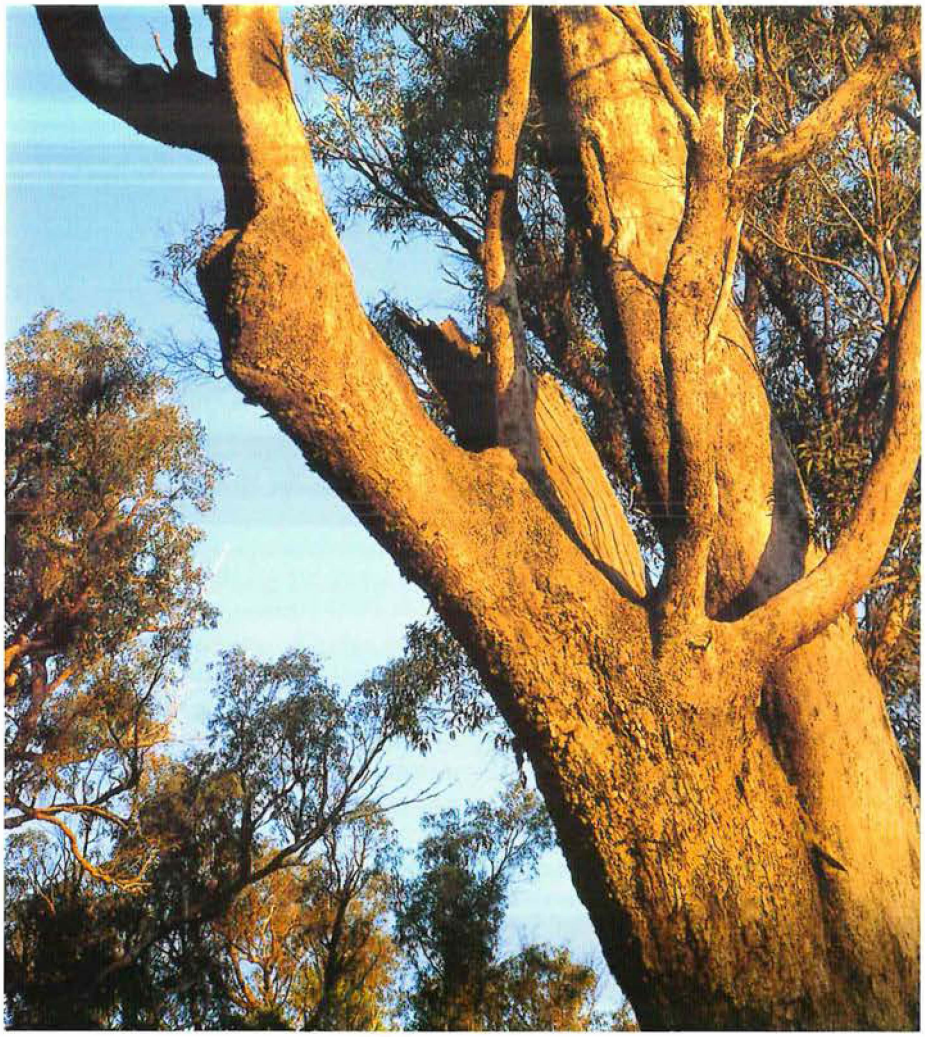
Since the late 1990s, there has been increased community concern about the future of tuart and its associated vegetation. In recent years, tuart woodlands between Mandurah and Preston Beach have suffered a severe decline, linked with a heavy infestation by wood-boring insects. The underlying reasons are not yet clear but may include:

- ongoing reductions in winter rainfall;
- hydrological and salinity factors near wetlands;
- changes to the soil or its nutrients;
- altered fire regimes;
- competition with understorey species;
- changes in the ecological balance between insects and their predators;
- adjacent clearing; and
- roadworks.

In the face of tuart's decline in health, a comprehensive conservation and protection strategy is needed.

Consequently, the Minister for the Environment, Dr Judy Edwards, has set up the Tuart Response Group to establish a partnership with local communities to plan and manage the conservation and protection of tuart trees and ecosystems, and to investigate the causes of their decline.

The Tuart Response Group has produced a Status Report on the Conservation and Protection of Tuart, which summarises the current information. It includes the findings of a Hydrology Workshop, held in May 2002, and the Tuart Science Workshop, held in July 2002. Future possible directions for conserving and managing tuart are outlined in the report. Copies of the report can be viewed on the Department of Conservation and Land Management's website (www.naturebase.net.au).



Recent studies are beginning to show what a high number of insects and other invertebrate animals are associated with naturally occurring eucalypts. For example, probably more than 750 invertebrate species are associated with jarrah or marri, of which well over 400 occur in just the foliage alone. These studies also show that eucalypts of the more fertile soils tend to support more insects than those of less fertile soils. Since tuart occurs on more fertile soils than either jarrah or marri, it is likely to support even more insect species. Insects and other invertebrates comprise most of the diversity of terrestrial ecosystems, and are also extremely important in the ecology. They pollinate plants, recycle plant materials, regulate each other's numbers and provide food for birds, lizards, frogs and small mammals.

That tuart supports many insect species can readily be seen by examining the foliage of specimens growing in the tuart belt. All sorts of different marks can be seen, evidence of the ways of life of many different insects. One can thus appreciate that such trees are part of a living ecosystem. Sydney naturalist Densey Clyne writes in her book *More Wildlife in the Suburbs:*

> 'Much of the fascination of a tree lies in its relationship with insects, birds and mammals. Their comings and goings leave signs behind on stems and bark and leaves, so a tree without such blemishes is like a friendless stranger in a foreign land.'

By contrast with tuart, most of the non-local trees planted in Perth tend to be largely free of blemishes; these are Clyne's 'friendless strangers'.

In addition to its other values, tuart can be established with no or minimal watering, and needs no watering or fertilising once established. Moreover, it is more resistant than almost all other eucalypts to the salt winds and limy soils of sites close to the ocean.

DECLINE OF TUART

Like most plants and animals today, tuart is suffering from the direct and

Left: Branches of an old tuart at Tuart Forest National Park.
Photo – Rob Olver

Right: Tuart trees contribute to the scenery along a bushland walk at Lake Joondalup.
Photo – Rob Olver

Below right: Urban sprawl encroaching on bush viewed from Neerabup National Park.
Photo – Jiri Lochman

indirect effects of human activities. An obvious direct effect is clearing. Indirect effects include changes to fire patterns and the introduction of weeds and canker fungi. Although possibly caused directly by the larvae of a native beetle, the recent severe decline of many tuarts over a wide area south of Mandurah has no doubt been triggered by stresses or ecological imbalances brought about by human activities, together with a significant decline in rainfall associated with climate change.

The natural distribution of tuart, the coastal strip from near Busselton to north of Guilderton, corresponds closely with the places where today's Western Australians most like to live. Consequently, the effect of people on tuarts has been severe: much of the land formerly occupied by tuart has been cleared for houses or other human uses, and many of the bushland reserves containing tuart have been greatly affected by weeds and frequent or severe fires.

The human population of this coastal strip continues to increase. Urban areas are expanding, alongside an increase in the density of buildings within established suburbs, in both housing lands and grassed parklands. The change in density is mirrored in rural areas in the expansion of horticulture into grazing lands and the subdivision of large blocks into smaller lots in special rural subdivisions. These changes in density bode ill for the remnant tuarts of the plain. Tuart is a large tree and not perceived by many as being compatible with housing, even though trees have persisted and graced urban yards since housing was established.

Many local municipalities have policies on retaining trees and in some cases replacing them. Unfortunately, these often focus on planted non-local trees rather than the local species, and there is a need to catalogue these significant local remnant trees and act to preserve and replace them. Much of this replacement could be achieved by using tuart in coastal suburbs when landscape plans allow tall trees. The currently favoured landscape trees in Perth and other urban areas include plane trees (a hybrid variety from the northern hemisphere), spotted gums and Norfolk Island pines. These are grown to about two metres tall and planted to create an instant treed suburb.

Thousands of these, and many other, non-local tree species have been, and continue to be, planted in urban areas within the tuart belt, competing visually with those tuart trees that do remain in parks and gardens. Many parks in the newer suburbs begin with a very visible group of tuart trees, but the tuarts soon become less visible as planted non-local trees distract attention away from them, or ultimately hide them from view. It is now non-local trees that are visually dominant in our urban areas, not only because of their numbers, but also because many are large and vigorous species. They are all the more large and

Above left: Tuart trunk, Tuart Forest National Park.
Photo – Rob Olver

Top: Larva of tuart longhorn.
Photo – Robert Powell

Above: Anthelid moth, one of a great many insects supported by tuart.
Photo – Robert Powell

vigorous because they support fewer insects than the local species, and fewer than they themselves would in their local environment. Tuart today is prominent in very few places in Perth apart from some bushlands, where there is less visual interference from non-local trees. Numerous natural landscapes dominated by tuart are slowly being eroded in this way—including some of national significance.

THE FUTURE

What can be done if we wish tuart to remain, or be restored as, a feature of our landscape? We need to do this directly—by preserving those tuarts that remain, and, where necessary, increasing their numbers or visibility—and also indirectly—by encouraging the community to be aware of and value tuart.

To preserve those tuart trees that remain, there is a need to catalogue these significant local remnant trees and act for their preservation or replacement. Much of the replacement of trees that cannot be preserved could be achieved by using tuart in coastal suburbs when landscape plans allow for tall trees. Tuarts have been and continue to be planted in many public parks; the recent plantings at the southern entrance of the Floreat Forum are just one example.

In many cases, unfortunately, too little attention is paid to where trees are sited. Many of the spots chosen for them do not allow for their full height or spread when mature. On sites close to the ocean, they are often placed without regard to the asymmetrical shape they will develop as a result of salt-laden westerly winds, and therefore will grow too close to obstacles to their east. To get the best out of tuarts as a landscape feature, the establishment of trees should where possible aim for a result that looks natural. Copying the natural groupings of trees, and including some of the natural understorey will help, as will making use of natural regeneration wherever possible.

Improving the visibility of tuart in this way should help to encourage the community to be aware of and value tuart.

Tuart, once the dominant tree of much of the coastal strip north and south of Perth, still gives a distinctive character to our natural landscapes, with its colour and habit, its variety, its vigour, its majesty and its grace. Despite land clearing and ecological pressures, it is possible to retain and restore something of this distinctive landscape, if people can be brought to understand and value tuart's natural qualities.

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This article was condensed from a paper by Robert Powell and Bronwen Keighery entitled "Tuart in the Landscape", which was published by the Wildflower Society of Western Australia in June 2002 in the book *Tuart and Tuart Communities*, edited by B J Keighery and V M Longman. The book is based on a workshop on tuart and its associated vegetation, organised by the Wildflower Society in conjunction with the Department of Conservation and Land Management and the then Department of Environmental Protection, and held in March 1998. It incorporates papers given and matters raised at the workshop, expanded by further research and collaboration since that time. It can be obtained from the Wildflower Society, phone (08) 9383 7979.

A subsequent *LANDSCOPE* article will look at the Tuart Response Group and its work (see box on page 20).

Walking with WA giants

by John Long

When we think of prehistoric times, images of giant woolly mammoths and sabre tooth tigers spring to mind. Yet here in Western Australia, in the last few hundred thousand years, a great variety of giant mammals once roamed the countryside.

The term megafauna generally applies to giant animals (weighing more than 45 kilograms) that became extinct around 50,000 years ago. Many palaeontological sites in Western Australia have already provided us with a general picture of the kinds of creatures that once roamed our forests and open plains. But recent finds of well-preserved skeletons of megafauna from caves on the Nullarbor Plain will provide new insights into the lives and deaths of our ancient megafauna.

Australia's largest land animals, since the demise of the dinosaurs 65 million years ago, lived during the Pleistocene epoch (from 10,000 years ago to 1.75 million years ago). In Western Australia, the prehistoric mammals from the last million years included a variety of these giants, such as the largest monotremes (egg-laying mammals) that ever lived, huge diprotodontoids (extinct diprotodontines and zygomaturines that were the size of rhinos), giant wombats up to 1.5 metres long, huge kangaroos three metres high, leopard-sized predatory marsupial lions, Tasmanian tigers and devils, koalas, possums, and a wide variety of smaller bandicoots, phascogales and rodents.

At the turn of the last century, John Sharp and William Poynton collected fossil mammal bones at a granite soak near Balladonia, on the western edge of the Nullarbor. They gave the specimens to the Western Australian Museum, where Ludwig Glauert described them in 1912. Glauert recorded a number of species of extinct large mammals, such as the huge, lumbering *Diprotodon* and the marsupial lion *Thylacoleo*, which had previously only been known from the eastern half of Australia.

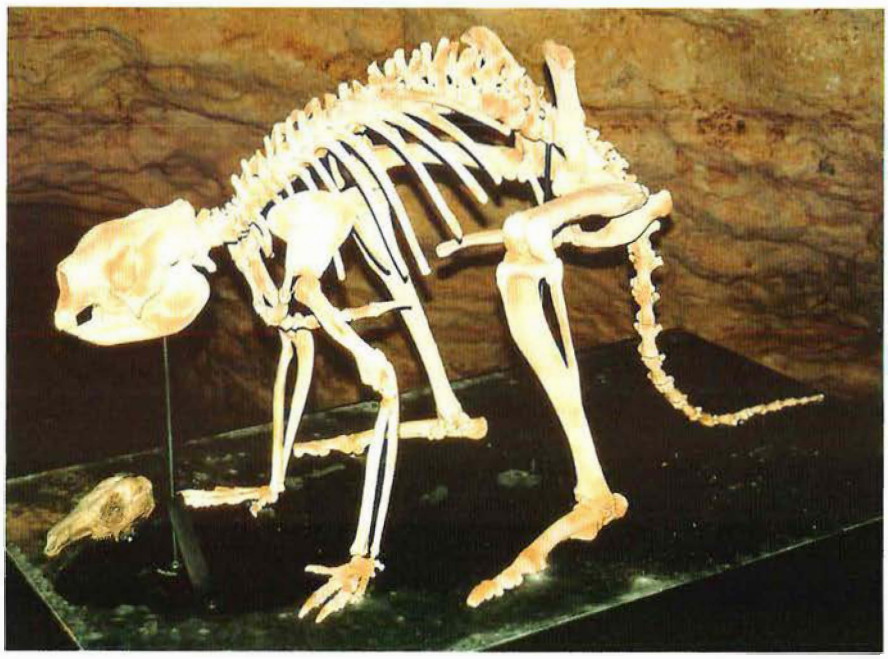
EARLY FINDS

However, the first truly significant discoveries of prehistoric mammals in WA were made in 1904, during the construction of a path inside Mammoth Cave, near Margaret River. Five years later, Glauert began to excavate the site and found a great diversity of prehistoric mammals. To his surprise, the number of fossil species far exceeded the number of species of mammals that currently inhabited the region.

Glauert's finds included a giant marsupial, *Zygomaturus trilobus*, which was the size of a small hippo. Recent studies of this animal suggest that it may have lived much like a marsupial version of a hippopotamus, inhabiting swampy regions and feeding on plants. Glauert also discovered the partial skeleton of a monotreme—a giant echidna, which he compared to the living New Guinean form *Zaglossus* and named *Zaglossus hacketti*. This anteater was about a metre long and, to date, is the largest known monotreme ever discovered.

The fauna of Mammoth Cave was later studied by Duncan Merrilees of the WA Museum. He named two new species of the extinct short-faced kangaroo, *Sthenurus*, from the material found there. The complete fauna provided an accurate representation of the range of animals that lived in south-west environments of WA from about 44,000 to 60,000 years ago, based on recent new dates provided by Richard Roberts of the University of Woolongong. Similar dates obtained from a nearby cave, called Devils' Lair, indicated that human occupation in Western Australia could be traced as far back as 50,000 years (see 'History from the Caves', *LANDSCOPE*, Spring 2001). Some of the giant kangaroo bones found at Mammoth Cave bore notches that appeared to be carved by humans.

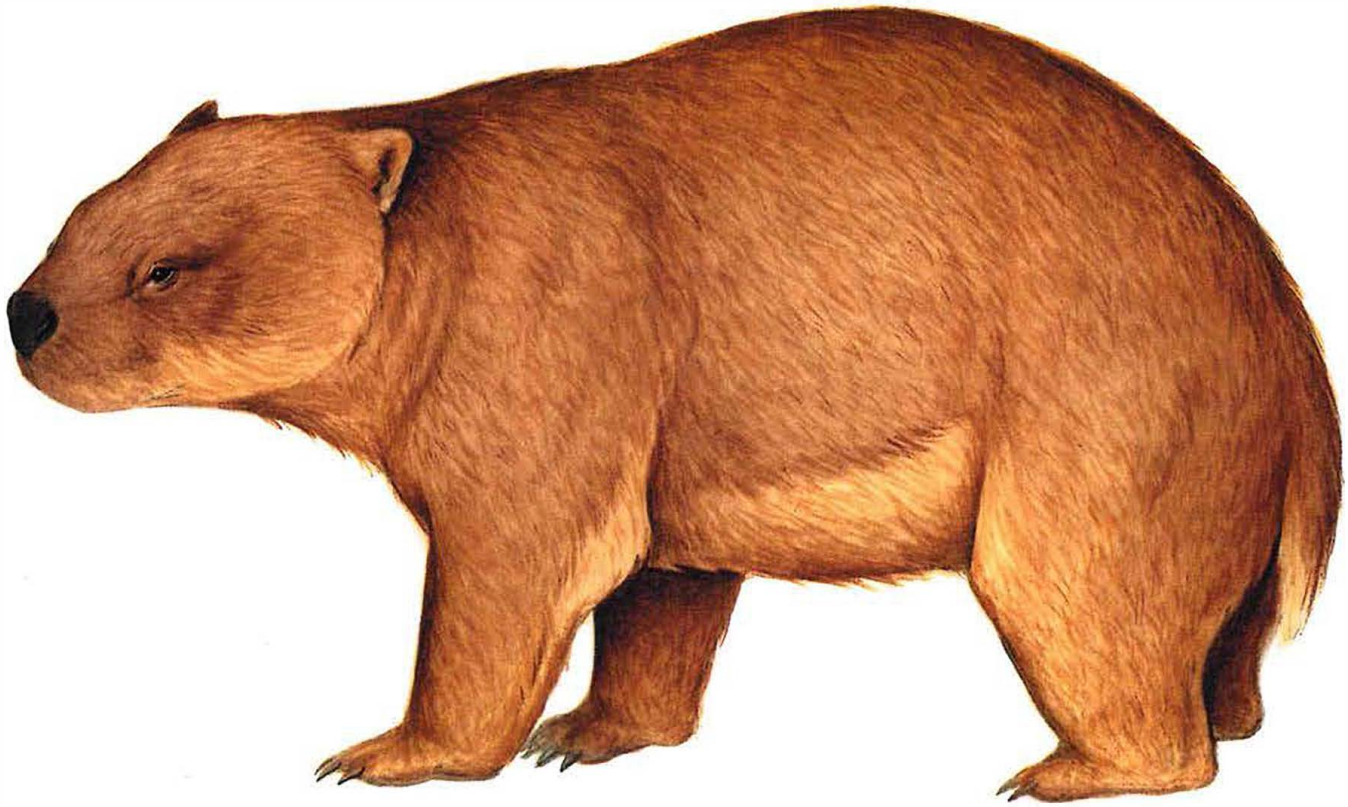
The small mammal fauna of Mammoth Cave included a great variety



Previous page
Reconstructive illustration of the marsupial lion *Thylacoleo carnifex*.
Illustration – Martin Thompson

Above: Reconstructive illustration of a diprotodontid marsupial.
Illustration – Anne Musser/ Naturefocus.com.au

Right: Skeleton of the short-faced kangaroo, *Sthenurus*.
Photo – Kris Brimmell/WA Museum



of species found living in the area in recent times, such as quokkas, woylies, long-nosed bandicoots, bilbies or dalgytes (see also 'Remembering the Dalgyte', *LANDSCOPE*, Summer 2002–03), southern quolls and many varieties of rodents and bats. There were also remains of living marsupial species, such as the koala, that no longer occur naturally in Western Australia.

Many other caves from the Augusta-Margaret River region have yielded remains of fossil mammals; all contributing to the picture of the animal life that once lived in the densely forested habitats of the south-west. But what of the north of the State, and its far east?

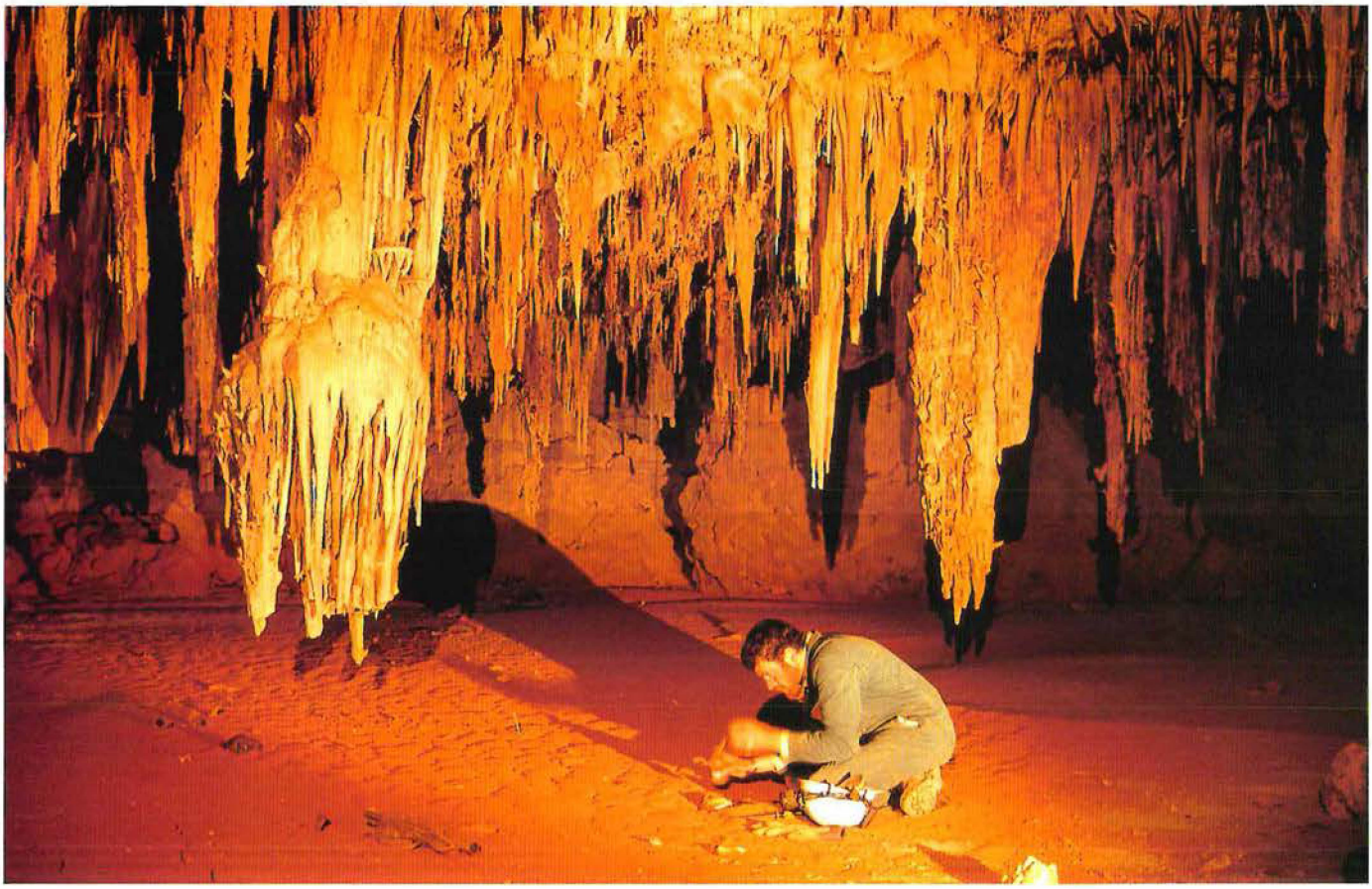
Top: Reconstructive illustration of the giant wombat *Phascolonus gigas*.
Illustration – Anne Musser/Naturefocus.com.au

Above: The jaw of *Zygomaturus* sp. found at the Murchison River.
Photo – Kris Brimmell/WA Museum

MEGAFAUNA FROM THE NORTH

Fossils from a range of prehistoric mammals and reptiles were excavated from a dark muddy layer encountered when building a dam at Quanbun Downs Station, near Fitzroy Crossing. These were described by Ludwig Glauert in 1921 and studied in further detail by Tim Flannery in 1984. Flannery concluded that, on the basis of the extinct kangaroo *Macropus pan* being present at Quanbun, these finds must have been much older than any of the other mammals from the cave sites, possibly as old as the Pliocene epoch (1.75–5.3 million years old). The fossils and other material found at Quanbun included remains of the giant wombat *Phascolonus gigas* and the extinct giant wallaby *Protemnodon*. They also contained the teeth of a very large crocodile, which could either be the living saltwater crocodile or an extinct form known as *Pallimnarchus*.

Other isolated finds included bones of *Diprotodon* along the Oakover River in the Pilbara and also south of Karratha near the mouth of the Fortescue River, where a whole skeleton was excavated over two field seasons in 1992–93. Windjana Gorge, in the southern Kimberley, has yielded bones of *Diprotodon*, the teeth of a giant extinct crocodile and scant remains of



the Tasmanian tiger. A set of lower jaws of *Zygomaturus* was also found near the Ord River at Kununurra.

NULLARBOR DISCOVERIES

The Nullarbor Plain is a vast limestone plateau along the State's south-east coast that is riddled with many caves. During the last 30 years, occasional finds of prehistoric mammals had been made in some of these caves. A mummified thylacine was discovered at Thylacine Hole in 1966. This specimen was dated at 4500 years old and is still the only complete example of the mainland thylacine (with skin colouration and muscle tissue preserved) known to science. A cave near Madura, studied by Professor Ernie Lundelius in the 1970s, yielded the remains of extinct megafauna. During the 1990s, a cave in the western Nullarbor produced the fossil remains of megafauna, which included a partial skeleton of a marsupial lion, bones of the giant echidna, various extinct forms of sthenurine kangaroos and other animals. But it wasn't until last year that really exciting discoveries—of extremely well-preserved fossil remains of mammals—were made in the region.

In May 2002, members of the Cave Exploration Group of South Australia and the Victorian Speleological Group, headed by Ken Boland, Ray Gibbons, Peter Ackroyd and Paul Devine, used an ultralight aircraft to discover a number of new karst features on the western Nullarbor. Some of these caves contained very well-preserved articulated skeletons of extinct

Above: Dr Gavin Prideaux from Flinders University examining a fossil in a cave in the Nullarbor Plain.

Left: The fossil of the giant kangaroo, *Procoptodon goliah*.
Photos – Clay Bryce/WA Museum

mammals. The cavers notified museum specialists in Victoria and South Australia, who in turn notified palaeontologists at the WA Museum, as the caves were on WA Crown land.

Our expedition, in July 2002, recovered several complete skeletons of the marsupial lion *Thylacoleo carnifex*, skeletons of three species of sthenurine kangaroo, bones of the giant wombat *Phascolonus gigas*, the giant kangaroo *Procoptodon goliah*, extinct species of *Wallabia* and the remains of unidentified species of macropodine kangaroos.

The time that elapses between the initial discovery of such fossils and the actual recovery of the specimens is a crucial period in the preservation of valuable scientific information. In this instance, correct procedures were followed to the letter, enabling uncontaminated skeletal specimens to be collected under sterile conditions for extraction of ancient DNA, and adding to the scientific value of the discovery. It is a credit to the discoverers that this occurred.

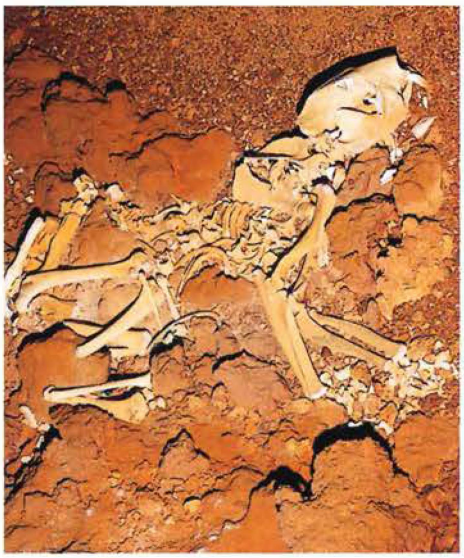
IMPORTANCE

The Nullarbor discoveries are immeasurably important. They provide the first complete, articulated skeletons of megafauna from the Pleistocene epoch from anywhere in Australia. Samples are currently being tested for ancient DNA, and the ages of the fossils are being dated using OSL (optical stimulation luminescence) and ESR (electron spin resonance) techniques. It is likely that the unique preservation of the fossil material was the result of a long period of constant dry conditions within the caves, which, in some cases, may have been sealed off shortly after the animals accidentally fell in.

If the *Thylacoleo* skeletons have any trace of ancient DNA left in them, it will be a useful tool to interpret the evolutionary history of the group. There are two main schools of thought about the origin of marsupial lions. Some workers believe that they are closely related to the possums, whereas other scientists think that they evolved from wombat-like ancestors. Ancient DNA in a marsupial lion would enable comparison between these groups, and hopefully resolve the matter once and for all.

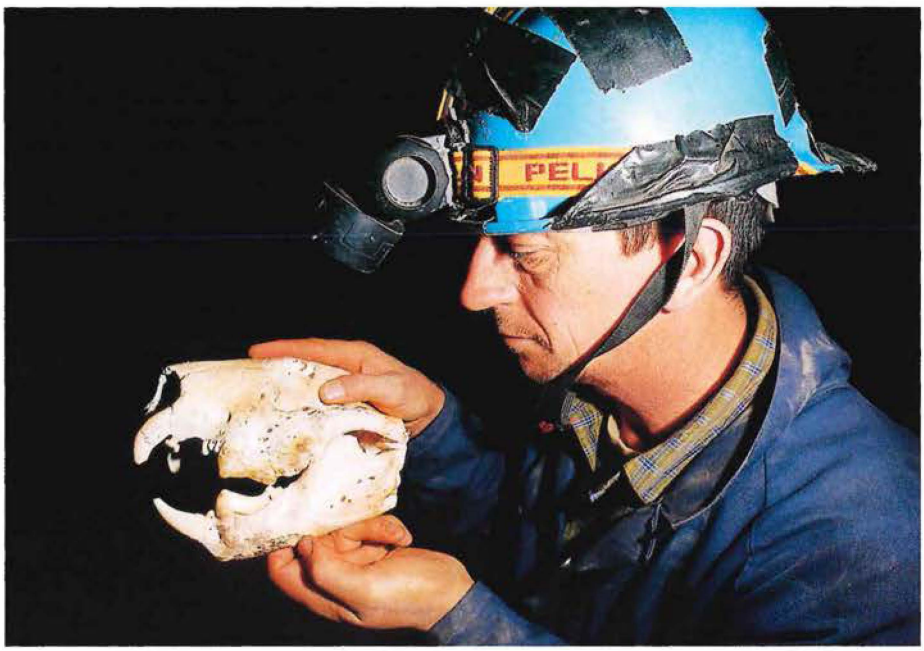
Right: The fossil of the marsupial lion *Thylacoleo*.

Below: John Long with the fossil head of the marsupial lion *Thylacoleo*.
Photos – Clay Bryce/WA Museum



Similar debate exists over the lifestyles of the marsupial lion. Some have argued that they must have been skilled tree-climbers, using their powerful opposable thumb hand for pulling themselves up trees, but others think they were too massively built to be comfortable in a tree. As the new material represents the first complete skeleton of *Thylacoleo* ever found, it will enable us to study the bones and try to answer these questions through analysis of the bones' internal structure. However *Thylacoleo* lived, one thing is for sure—it was a voracious predator. Its teeth bear silent witness to a lifestyle that involved a lot of killing.

Over the coming months, even more information will be gleaned from these important finds and we shall learn more about the lifestyles of the huge, extinct inhabitants of this ancient land.



John Long is Curator of Vertebrate Palaeontology at the Western Australian Museum. He can be contacted by email (john.long@museum.wa.gov.au). John has written or co-written many books on prehistoric animals of Australia including *Dinosaurs of Australia* (Reed Books, 1991, 1993), *The Rise of Fishes* (University of New South Wales Press, 1995), *Dinosaur Dealers* (Allen & Unwin, 2002) and *Prehistoric Mammals of Australia and New Guinea – 100 Million Years of Evolution* (UNSW Press, 2002, coauthored with M Archer, T Flannery and S Hand).

Younger readers may enjoy John's new fiction book *Journey to the Dawn of Time* (Fremantle Arts Centre Press, 2003) which takes the reader back to the ice age world of Australian megafauna.

The Western Australian Museum gratefully acknowledges its partnership with the Rio Tinto Futures Fund in support of Operation Leo.

Gilbert's potoroo
eight years on

With only 20 to 40 individuals known in the wild, Gilbert's potoroo is the rarest mammal in Australia. What is being done to save these marsupials from extinction?

by Tony Friend

There was great excitement in the zoological world in December 1994, with the announcement that an 'extinct' species had been rediscovered (see 'Lost & Found', *LANDSCOPE*, Autumn 1995). Elizabeth Sinclair had been trying to catch quokkas for her doctoral study of their genetics. She and volunteer Adrian Wayne found some unidentified, bandicoot-sized mammals in the large cage traps they had set in Two Peoples Bay Nature Reserve, near Albany. Elizabeth and Adrian took two of the animals back to the Two Peoples Bay Research Station and alerted Alan Danks, the nature reserve manager. The animals were identified as Gilbert's potoroos (*Potorous gilbertii*). The species was discovered in 1840 and recorded from the Albany area up until 1879. It then vanished from the scientific record.

Potoroos and bettongs belong to the rat-kangaroo family (the Potoroidae). Family members share a liking for underground fungi, or truffles, and a tendency to become endangered or extinct. Four different potoroo species are recognised. The broad-faced potoroo is thought to be extinct, Gilbert's potoroo was thought to be extinct until its rediscovery, and the long-footed potoroo is endangered and only known from a small area of Victoria. Only the long-nosed potoroo from Tasmania and Victoria is reasonably common and secure. A similar situation exists among the bettongs.

Gilbert's potoroo looks very similar to the long-nosed potoroo and, in 1970, a book on Australian mammals decreed that they were one and the same. According to the author, the early records of potoroos around Albany represented merely a western population of the long-nosed potoroo. This decision had been made from studying dried skins and skulls, without the benefit of modern DNA techniques. After the excitement of making the discovery of a lifetime, Elizabeth continued her study of quokkas, but incorporated an investigation of the potoroos. Working with another geneticist, Mike Westerman, she showed that Gilbert's potoroo was indeed a distinct species, as genetically different from the long-nosed potoroo as was the much larger long-footed potoroo.

Previous page
Its slightly protruding eyes scanning for danger overhead, a Gilbert's potoroo pauses from its search for underground fungi.
Photo – Jiri Lochman

Left: The first live Gilbert's potoroo examined by scientists in 115 years sits quietly in the hands of Two Peoples Bay reserve manager Alan Danks, December 1994.
Photo – Tony Friend

Below: A female Gilbert's potoroo with her young in the captive colony at Two Peoples Bay.
Photo – Jiri Lochman

SEARCHING FOR POTOROOS

As soon as potoroos were discovered on the slopes of Mount Gardner, in Two Peoples Bay Nature Reserve, researchers began looking for other populations. Very little of the large tracts of uncleared rugged land along the south coast had been searched thoroughly. If Gilbert's potoroos had remained undetected at Two Peoples Bay, where years of detailed biological fieldwork had been carried out, it was quite possible that other populations might exist in less well-known areas. Mount Gardner is a special area, having escaped extensive fire for many years. Natural firebreaks have been created by the lakes and sand patches on the isthmus and the large areas of granite on the slopes of the mountainous headland. The long-unburnt vegetation on the slopes and in the gullies provided a haven for the noisy scrub-bird, rediscovered there in 1962, and other threatened birds such as the western bristlebird and western whipbird. Since the 1960s, fire had been deliberately excluded by careful management, mainly to preserve the noisy scrub-bird.

Searches since 1994 for other potoroo colonies concentrated on areas nearby, particularly on and around Mount Manypeaks, an imposing peak across Two Peoples Bay from Mount Gardner. Although much of the mountain was burnt in 1978, moist gullies on the southern side escaped the fire and are now inhabited by noisy scrub-birds—reintroduced to the area from Two Peoples Bay in 1983.

Surveying for potoroos requires special techniques. Although they make many small diggings to obtain underground fungi, these are difficult to distinguish from those of quendas (bandicoots) that also occupy the coastal heathlands. Setting cage traps to find potoroos is very labour intensive, and covers very small areas at a time, as every trap needs to be checked early each morning to ensure the welfare of the animals. However, potoroos can be detected in other ways, due to their habit of moving along recognisable runways through the dense scrub, and their fondness for peanut butter and pistachio essence.

Top: Since the discovery of Gilbert's potoroos at Two Peoples Bay, nearby Mount Manypeaks has been the site of intensive searches for additional populations.
Photo – Tony Friend

Above: Over the years, large granite outcrops have helped to reduce the spread of wildfires on the slopes of Mount Gardner, allowing the development of the long-unburnt heathlands favoured by Gilbert's potoroos.
Photo – Jiri Lochman

UNDERNEATH THE ARCHES

Small arches of flexible plastic sheeting are held in shape by bent fencing wire, and double-sided sticky-tape inside the arches takes small samples of hair from the backs of animals moving through them (quokka and potoroo hairs are very similar to the naked eye, but can be readily distinguished under the microscope). Scattering bait underneath the arches increases the chance of movement through them. Hence, if numerous arches are set up within runways in likely potoroo habitat—for one to three weeks at a time—they are very likely to pick up evidence of any colony that exists there.

Left: Tony Friend (centre) and Jackie Courtenay (right) measure a Gilbert's potoroo in the wild, assisted by Cathy Jenkison (left) and Vinh Nguyen.
Photo – David Broadhurst

Below: Mount Manypeaks, from Two Peoples Bay Nature Reserve.
Photo – Marie Lochman

A possible potoroo hair was collected from a different type of hair-tube near the top of Mount Manypeaks in 1996 by Department of Conservation and Land Management researcher Sarah Barrett. A subsequent survey by Jackie Courtenay, Sarah Vetten and Kelly Gillen using hair arches detected another suspect hair in the same place. A trapping survey, involving 100 cage traps, six people and a helicopter, was carried out in November 1998. Much effort carrying and setting traps in dense bush down each side of the mountain turned up possums, quendas and many bush rats—but no potoroos! However, vast areas of Mount Manypeaks remained unsurveyed. The question of whether or not a small potoroo colony was still hidden in the scrub around Mount Manypeaks and the adjacent Waychinicup National Park had to be answered. Such a find would provide the opportunity to combine gene pools in captive breeding or translocations, and hence give this little marsupial a more secure future than is provided by the limited genetic resource of the Two Peoples Bay population.

NOT TURNING A HAIR

Many more short surveys with hair arches and cage traps were carried out over the following three years, without result. In 2002, the Department of Conservation and Land Management funded a four-month search of coastal bushland between Cheyne Beach and Gull Rock, just east of Albany. Jennifer Trouchet undertook this survey, carrying plastic hair arches for kilometres through rugged terrain and dense scrub in search of suitable animal runways. The arches were checked and rebaited each week for three weeks, then collected and taken to the laboratory for analysis. Hundreds of hair arches were set and collected, then painstakingly inspected for hairs.

Although Jennifer found potoroo hairs only within Two Peoples Bay Nature Reserve, she showed that quokkas were widespread through the Mount Manypeaks/Waychinicup area, from Cheyne Beach to Two Peoples Bay.

While the lack of new potoroo colonies was disappointing, the presence of quokkas was still good news. The discoverer of Gilbert's potoroo, John Gilbert, called it 'the constant companion' of the quokka, and, indeed, the two species coexist on Mount Gardner. It is likely that many of the runways used by Gilbert's potoroo there are 'dual-use pathways', maintained by the larger quokka. If quokkas are common on Mount Manypeaks, this area may be suitable for the reintroduction of Gilbert's potoroo. Further evaluation of the habitat near Mount Manypeaks and in other areas, particularly regarding the supply of truffles, is required before any sites can be selected. Surveys are continuing in other areas, thanks to a grant from the Threatened Species Network to the Denmark Environment Centre, which is undertaking hair-arch surveys for Gilbert's potoroo, between Albany and Augusta, with the Albany-based Gilbert's Potoroo Action Group.

OTHER RESEARCH

At Two Peoples Bay, research to learn more about potoroos, so that we can assist their survival, has continued. Most importantly, how many potoroos are there? It was clear from the beginning that such a small area could not support large numbers, but the dense bush and rugged terrain have made the discovery of the different colonies on Mount Gardner a drawn-out process. Although Two Peoples Bay Nature Reserve encompasses more than 4000 hectares, potoroos only occur on the Mount Gardner headland, in less than a quarter of the reserve. Furthermore, potoroos are only found in areas with a particular kind of tall kwongan (heathland) dominated by *Melaleuca striata*. Regular trapping in all of the places where potoroos are known to occur results in the capture of only 15 to 20 different individuals. Given that we are trapping in well over half of the known suitable habitat, an upper estimate of 40 animals seems somewhat optimistic.

The tiny size of the only known population of Gilbert's potoroo makes it the rarest mammal in Australia. The only other species that comes close is the northern hairy-nosed wombat, which is found only at one site, but has more than 80 individuals. Both species are clearly very close to extinction, and extremely vulnerable to localised catastrophes. In the case of Gilbert's potoroo, the most threatening event would be an extensive wildfire. While Two Peoples Bay Nature Reserve is carefully managed to exclude fire, the establishment of another population of Gilbert's potoroo is urgently needed.

Young Gilbert's potoroos remain in the same area as their mother until they are about three-quarters grown, when they leave to establish their own home range.
Photo – Jiri Lochman

Regular trapping provides important information on the breeding success of the Gilbert's potoroo population. Females can have a joey in the pouch at any time of the year, but most new animals are caught in winter. These young ones are born in late summer and early autumn and are being weaned just as the serious rains start and truffle numbers increase. It is likely that many of the young born at other times of year don't survive. This may be because they are lost from the pouch or as young-at-heel (young that have left the pouch, but are still suckling or in the early stages of independence). It is unlikely that there is enough room for all of the young that are produced (most young-at-heel are not captured later as young adults). Radio-tracking studies are now under way to see whether they are leaving the mountain in search of new habitat, or starving to death from lack of unoccupied truffling grounds in which to settle down.

Either way, it is clear that more young are produced than can survive on Mount Gardner. Most animal populations produce excess young, as an insurance policy for the individuals trying to pass on their particular genes. It allows natural selection to occur: the fitter survive and the species becomes better

Although it is superficially similar to the long-nosed potoroo from eastern Australia, DNA studies have shown that Gilbert's potoroo is a distinct species.
Photo – Jiri Lochman

adapted to its environment. However, for a species as close to extinction as Gilbert's potoroo, it is something of a luxury!

CROSS-FOSTERING

Although a captive colony was established soon after the rediscovery of Gilbert's potoroo, breeding has become infrequent. Most of the original six animals and three pouch young have died of old age or various ailments. If the colony is to continue, it needs to be rejuvenated. Rather than taking more adults from the wild—where they have an important place in the small population—the excess pouch young may be able to be saved and added to the global total of Gilbert's potoroos.

Since the 1960s, researchers have known that macropod pouch young over a certain age can be taken off the teat and replaced, or swapped from one female to another, if the two young are of similar size. David Taggart of the University of Adelaide has been using this technique—called cross-fostering—in a desperate bid to save the Victorian brush-tailed rock-wallaby from extinction. In a program run by the Victorian Rock-wallaby Recovery Team, tammar wallabies act as surrogate mothers. Pouch young of the endangered rock-wallabies are taken from their wild mothers and placed in the pouches of tammars. Macropod females can hold an embryo in reserve at a very early stage of development, in case their pouch young is lost. During cross-fostering, this young begins to develop as soon as the pouch young is removed. Theoretically, a female of an endangered species could have several young being raised by different surrogate mothers, hence considerably increasing her rate of reproduction. Happily, no species recognition problems have arisen and cross-fostered brush-tailed rock-wallabies have subsequently mated and produced young with their own kind!

In collaboration with the Western Australian Department of Conservation and Land Management and Cleland Wildlife Park in South Australia, David has studied woylies, boodies and long-nosed potoroos to determine which would be the most suitable surrogate species for cross-fostering Gilbert's potoroo. The long-nosed potoroos came out in front, as they were more docile than the others and, of course, very good mothers! Approval has now been given to undertake a limited trial, transferring a few Gilbert's potoroo pouch young from the wild into long-nosed potoroo pouches. If the trial is successful, cross-fostering may have a place in the toolbox of techniques available for saving the species. This is a very exciting prospect.

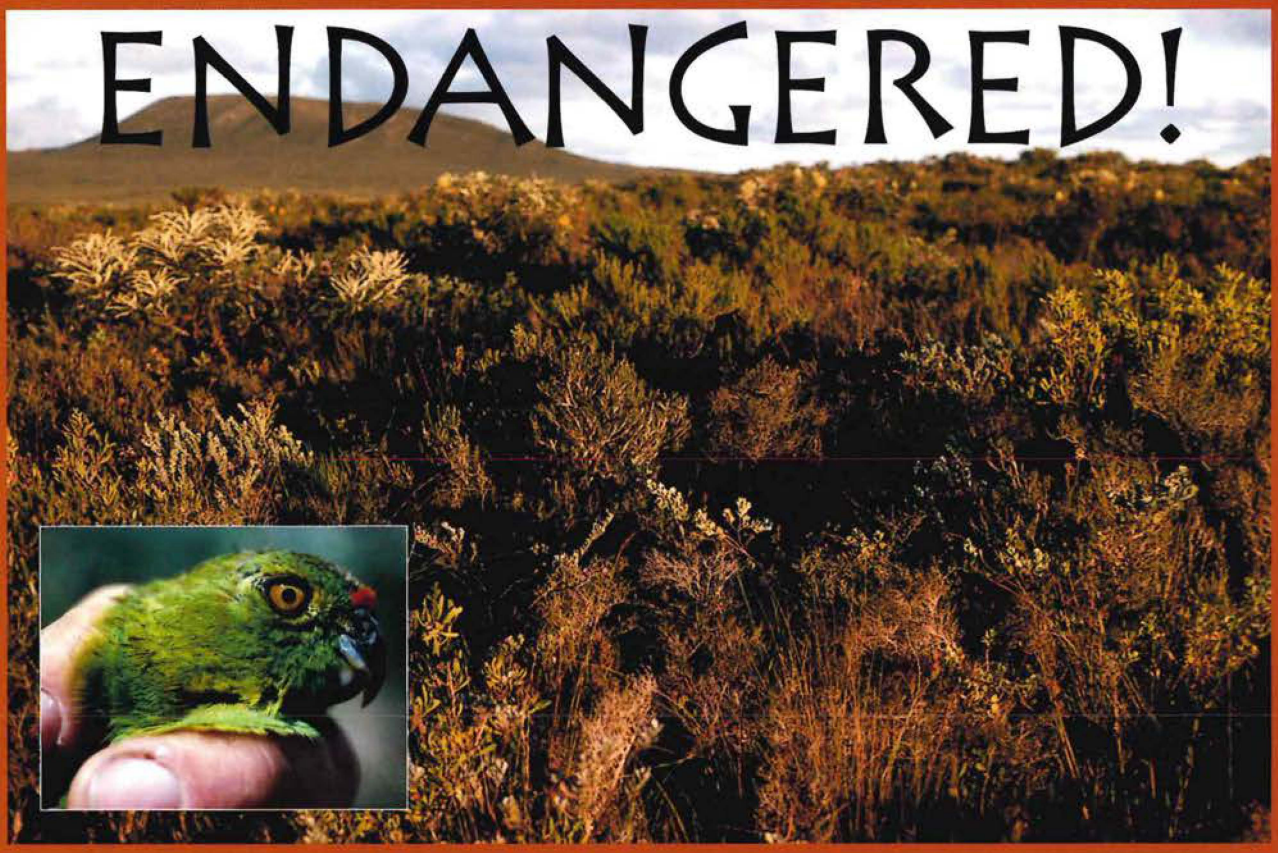
At the same time, a team led by Terry Fletcher in the research section at Perth Zoo will be developing techniques to artificially inseminate long-nosed potoroos. Artificial insemination in marsupials is only in its infancy, because, for many marsupials, semen cannot be stored or transported easily. These techniques will be working well in long-nosed potoroos before they are applied to Gilbert's potoroos. Artificial insemination is a valuable technique, because it can overcome behavioural compatibility, as the animals have no choice about their breeding partner. This is particularly important in captive breeding colonies, where compatible pairs of animals can quickly become over-represented by continually producing young.

FUTURE PROSPECTS

Gilbert's potoroo has survived at Two Peoples Bay for many years without anyone knowing about them. Is the level of intervention being proposed really necessary? It is likely that without the policy of fire exclusion that has been in place over the last 40 years, Mount Gardner would have burnt. Even with current management, a small source of ignition in the wrong place, under the wrong conditions, could easily cause a fire that would kill a large proportion, if not all, of the potoroos on Mount Gardner. A lightning strike in December 2000 started a fire that burnt within two kilometres of the potoroo population. Without at least one more population, the prospect of Gilbert's potoroo lasting another 50 years doesn't look very rosy. But it is encouraging that the support of the community for the recovery program is growing. Let's hope we're not too late.

Tony Friend is a principal research scientist with the Department of Conservation and Land Management's Science Division, based at Albany. He can be contacted on (08) 9842 4500 or by email (tonyf@calm.wa.gov.au).

ENDANGERED!



WESTERN GROUND PARROT

There are probably only about 250 western ground parrots in existence—and the number is most likely decreasing.

The western ground parrot is an unusual parrot, a very secretive bird that spends most of its life on the ground, where it feeds, rests and nests in near-coastal heathlands. It spends most of the day walking through heathland up to about half-a-metre tall, feeding on seeds or, in the hotter part of the day, resting on or near the ground. It is not often seen—you have to walk a long way through heathland before you are likely to flush one.

Ground parrots very rarely call during the day—if you want to hear one, you have to be out on the heath an hour before dawn, or half-an-hour after sunset. They don't finish calling until after the stars are out. Listening for calls is the best way to detect the presence of ground parrots, hence it is the basis for census and survey methods.

In the past, destruction of habitat was a major threat and the species became confined to Cape Arid National Park, Fitzgerald River National Park and the Waychinicup-Manypeaks area. Clearing for agriculture and other purposes no longer threatens known populations—extensive wildfire is now the greatest threat to ground parrot habitat. In dry parts of its range, such as in the northern part of Fitzgerald River National Park, the species can recolonise a burnt area within about six years of a fire, and this time is likely to be less in wetter areas. However, the 90,000-hectare fire in Fitzgerald River National Park in 1999 burnt about half of the ground parrot habitat in the park. As a result, up to a quarter of the total population may have been lost in this one fire. The good news is that one of the remaining populations has been showing strong growth.

On the other hand, recent fires in Cape Arid National Park burnt almost all the available habitat in the park. And at Manypeaks, recent survey work, carried out by volunteers and coordinated by Birds Australia, suggests that the population there is very small and decreasing. Any further extensive wildfires in Fitzgerald River National Park could, therefore, be catastrophic for the ground parrot.

The western ground parrot is currently classified as Endangered, but the results of these recent surveys suggest that it is Critically Endangered.

Because the ground parrot is so difficult to detect, it is possible that hitherto unknown populations still exist on the south coast. However, the methods of survey (we've mentioned before dawn and after dusk!) restrict the area that can be covered with a small number of people. We are, therefore, appealing to anyone with either knowledge of any records of these birds or an interest in participating in volunteer surveys on the south coast to contact us.

by Allan Burbidge & Sarah Comer

Photos by Allan Burbidge

Botanic guardian

A recent exhibition at the New Norcia Museum and Art Gallery showcased the botanic works of Charles Gardner, one of the State's most influential and enigmatic botanic figures and Western Australia's Government Botanist between 1929 and 1960.

Neville Marchant describes Gardner's lasting legacy to science and conservation in Western Australia.

by Neville Marchant

Charles Austin Gardner was just 33 when he was appointed Western Australia's Government Botanist in 1929. Like the Government Geologist, Government Entomologist and others with similar titles, he was expected to provide a service to the Government in his expert field. He was to serve for the next 30 years, providing expert advice on botanically related economic issues confronting a developing State.

He described important timber trees, identified the range of native poison plants and provided a book on native and alien grasses important in the grazing industry. He was to dominate WA's botanical scene until his 'retirement' in 1960 and his untimely death from Parkinson's Disease in 1970. An enigmatic and forceful figure, Gardner accomplished much, although he died regretting that he had never completed his prime aim—to publish a Flora of Western Australia.

Charles Gardner grew up in a farming family of several children at Yorkrakine, near Tammin in the Wheatbelt. Despite having no formal scientific training, Gardner became an all-round expert on many subjects: he was also a competent climatologist, surveyor, plant geographer, soil scientist, botanical historian, scientific and popular writer and illustrator with a vast knowledge of the flora of WA.

Previous page
Main: The shrublands around Middle Mount Barren, now in Fitzgerald River National Park, were recognised by Charles Gardner as a valuable conservation area.
Photo – Jiri Lochman
Insets from top: Charles Gardner photographing a prostrate banksia.
Photo – Loaned by Walter Gardner
Four-winged mallee (*Eucalyptus tetraptera*).
Photo – Bill Bachman

Above: The Gardner exhibition was opened by Lt General John Sanderson (centre right), Governor of WA. The display featured herbarium sheets of the original specimens of material and notebooks used by Gardner in his artwork.
Photo – Michael James

Below: Kalbarri National Park, viewed from Hawks Head lookout.
Photo – Jiri Lochman

Gardner had a photographic memory for plants, and was even able to picture a plant in his mind after he had read a botanical description of it. His knowledge of soils and flowering times was staggering. One of his favourite pastimes was to guess where new WA Herbarium specimens came from—and he was usually right!

A UNIQUE FLORA

South-western Australia is internationally recognised for its rich flora, especially of shrubby plants and their strange flower shapes. Charles Gardner recognised that "...it is only in South-Western Australia...that the true Australian flora is today most richly developed". He estimated that 80 per cent

Top left: Hutt River poison (*Gastrolobium propinquum*) was discovered and described by Gardner. It is now uncommon.
Illustration – Charles Gardner

Above: The WA Christmas tree (*Nuytsia floribunda*), the world's biggest mistletoe, is widespread in coastal south-western Australia, extending inland to near Yorkrakine.
Photo – Jiri Lochman

Top: At the exhibition of Charles Gardner's artworks were (from left to right): nephews Tony and Richard Gardner, art patron Ann Cullity (who studied under Gardner), nephew Walter Gardner, botanist Neville Marchant, botanical author Rica Ericsson, Dom Chris Power from the Benedictine community and exhibition curator Joy Legge.
Photo – Michael James

of south-western species were found nowhere else; an approximation that was amazingly accurate given that the currently accepted figure is 79 per cent.

A characteristic of WA wildflowers noted by Gardner was that flowers were generally small, but aggregated together in heads, such as those of the southern cross (*Xanthosia rotundifolia*)—which are surrounded by large petal-like modified leaves arranged in a cross—and those of the banksias and bottlebrushes.

Charles Gardner was fascinated by the strange Christmas tree (*Nuytsia floribunda*), which grew near his boyhood home, and by sandalwood, the once-widespread shrub closely related to the Indian species of the same genus. Many of the eucalypts he studied and illustrated were rare. He also had a special interest in insectivorous plants—such as the rainbow plant (*Byblis gigantea*), the Albany pitcher plant (*Cephalotus follicularis*) and *Utricularia* species—which were uncommon and bizarre. He was fascinated by the wildflowers that had heads of flowers, such as the mountain bells (*Darwinia*), the rare Mogumber bell (*Darwinia carnea*) and the Qualup bell (*Pimelea physodes*), one of the banjines.

FOREST TREES

Gardner was appointed to the WA Forests Department in 1920, where he developed an intense interest in eucalypts. This group of plants is now placed in two genera, *Eucalyptus* and *Corymbia*, and range from small shrubs to tall trees, such as jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*). They produce many useful products, such as timber, tannin bark, essential oils and nectar, which in turn supports a lucrative honey industry.

Unlike their eastern Australian relatives, many of the WA eucalypts have a shrubby or mallee form. A number of them have enormous sculptured fruits, with the largest being that of the mottlecah (*Eucalyptus macrocarpa*), which may be up to 15 centimetres across.

Beginning in 1923, Gardner published a series of articles on the forest trees of WA that featured his detailed illustrations. A key to eucalypts, enabling identification, was published in 1924, the year that he transferred to the Department of Agriculture. A series of more than 100 eucalypts was described and illustrated in the *Journal of Agriculture* between 1952 and 1966, under the title 'Trees of Western Australia'. They were later reprinted as departmental bulletins, and, after Gardner's death in 1970, a new edition was compiled and published by T E H Aplin.

During his lifetime, Gardner described 15 new species of *Eucalyptus*, including *Eucalyptus megacornuta* and *Eucalyptus coronata*.

POISON PEAS

The first settlers of the Swan River Colony were confronted by an array of

native plants that were highly toxic to their valuable, imported sheep, horses and cattle. After many stock losses, botanists such as James Drummond (the first Government Botanist) found that the major culprits were a number of shrubby species in the legume family. European farmers were used to legumes being nutritious and suitable for grazing; yet in the new colony they caused severe economic losses, which continued well into the 1900s.

As Government Botanist, Gardner was charged with confirming which of the species were toxic, and with making his findings known to the agricultural community. In 1929, the year of his appointment, he joined forces with Dr H W Bennetts, a scientist at the Department of Agriculture. In 1934, a large-scale trial of suspected poisonous plants confirmed the toxicity of a number of members of the genus *Gastrolobium* and all of the *Oxylobium* species (all of which are now recognised as belonging to the genus *Gastrolobium*). A number of poison plant leaflets, covering legumes and other native and introduced poison plants, were published to assist in identification. In 1937, Gardner joined with brilliant botanical artist Edgar Dell to publish an illustrated guide, *The Poison Plants of Western Australia*.

In 1956, Gardner and Bennetts published a definitive account of WA's poison plants—*The Toxic Plants of Western Australia*—with many excellent colour plates by Dell and some by Gardner himself. Gardner also prepared detailed botanical drawings in black and white, to illustrate the distinguishing characters needed for positive identification of poison plants.

Top left: Like many WA blooms, the individual flowers of the southern cross (*Xanthosia rotundifolia*) are small and surrounded by white modified leaves. The inflorescence is arranged in the shape of a cross.
Photo – Marie Lochman

Centre left: Gardner named the rare Mogumber bell (*Darwinia carnea*). This is the very rare Narrogin variant.

Left: The fruits of mottlecah (*Eucalyptus macrocarpa*) are the largest in the eucalypt family and can be up to 15 centimetres across.
Photos – Bert & Babs Wells

GRASSES

A major task of the Government Botanist was to study economically important plants. The huge pastoral industry depended on native and introduced grasses and other fodder plants, so Gardner selected the grass family for treatment as the first part of a massive undertaking—a published book on the flora of WA with descriptions of all known plants, keys to identify them and many illustrations to assist.

In 1952, Gardner published the *Flora of Western Australia, Volume 1, Part 1, Gramineae*. Unfortunately, this was the only part of a statewide flora he published. Nevertheless, it gave detailed descriptions of more than 120 native and alien grass genera, and keys to enable their identification. The book was accompanied by many of Gardner's detailed drawings. Even though grasses are difficult to draw, because of their intricate, small flower parts and complex structures surrounding the individual grass flowers, the drawings were excellent and greatly assisted in the identification of grasses.

Although the grass book was primarily concerned with identification of economically important species, Gardner stressed his underlying concern for their conservation. He pointed out in the introduction to his grass book that uncontrolled exploitation of native grasses might lead to desertification. He wrote:

> It is thus of the utmost importance, in our pastoral areas, to maintain, by careful stocking, that delicate balance between the plant and its environment which, once lost may lead to the irreparable loss of a valued natural asset.

SCIENTIFIC ACHIEVEMENTS

During his lifetime, Gardner collected more than 20,000 pressed and dried plant specimens from all over the State. He described eight new plant genera and 286 species. Gardner was not originally a Latin scholar so he traded his botanical knowledge for Latin tutoring with Father William Gimenez, from the Benedictine community at New Norcia. An early scientific landmark in his career was the publication, in 1930 and 1931, of a checklist of the Latin names of the plant families, genera and species of WA. The *Enumeratio Plantarum Australie Occidentalis* was the only authoritative WA plant list available for 50 years.

Above: Gardner stressed the importance of fire in the development of the WA flora. This Stirling Range silvery-leaved variant of drumsticks (*Kingia australis*) flowers profusely soon after a fire.
Photo – Bill Bachman

Charles Gardner's next landmark scientific achievement was in 1942, when he delivered the Presidential Address to the Royal Society of WA, on The Vegetation of Western Australia with Special Reference to the Climate and Soils. Because of World War II, it was not published until 1944, but was a major compilation and analysis of the origin, evolution and diversity of the WA flora.

Many awards recognised Gardner's scientific contribution. In 1949, he was awarded the Gold Medal of the Royal Society of Western Australia. During the 1950s, probably his most productive decade, Gardner published his definitive study of the grasses of WA, as well as the book about the poison plants of the State.

Apart from other major scientific contributions on the ecology and taxonomy of flora, he presented ideas on the importance of fire in *The fire factor in relation to the vegetation of Western Australia*. This was published in 1957, three years before he retired, and his conclusions on the role of fire became his most controversial publication. He provided evidence that bushfires were an important factor in the evolution of

CHARLES AUSTIN GARDNER

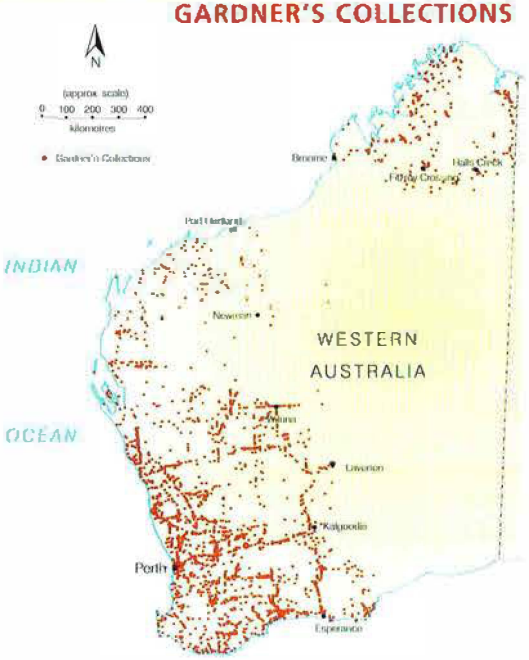
During his lifetime Gardner:

- collected 19,151 specimens of WA flora;
- described eight new genera;
- described 286 species new to science;
- studied and published on the botany of poisonous species of *Gastrolobium*;
- elucidated Kimberley Walkabout Disease after a study trip in 1951;
- published illustrations and details of toxic plants with Dr H W Bennetts;
- published a book on grasses of the State in 1952;
- collected 1454 specimens of *Eucalyptus*;
- described 15 species of *Eucalyptus* new to science; and
- published numerous leaflets describing the eucalypts of WA.

Gardner was also a friend to the Benedictine community at New Norcia. He left his collection of botanical specimens, gathered over 50 years, to the community, which then placed them on permanent loan to the WA Herbarium. He also bequeathed 77 unique botanical pen and ink drawings and delicate watercolours to the community, which were restored and put on public exhibition at New Norcia in winter 2002.

Left: A Gardner watercolour of strychnine bush (*Strychnos lucida*), a toxic shrub or small tree common in the Kimberley.

GARDNER'S COLLECTIONS



Above: Gardner collected widely in WA from the 1920s until his death in 1970. All of his collections, now at the Department of Conservation and Land Management, are databased. Each dot on the map shows an individual collection attributable to Gardner.

WA species and that certain plants were even dependent on fire for survival.

In recognition of his scientific endeavour, the Royal Society of New South Wales awarded Gardner the W B Clarke Medal. In 1965, he gained a well-earned MBE and, shortly before his death in 1970, he received the 1969 Australian Natural History Medallion.

Today, Gardner's extensive specimen collections form part of the holdings of the Department of Conservation and Land Management's Western Australian Herbarium. His specimens have now been databased and his label information on where and when he collected them are available to any researcher.

CONSERVATION LEGACY

As a knowledgeable and colourful lecturer, Charles Gardner eagerly displayed his incredible knowledge of WA flora. His many public lectures, as well as his close involvement with scientific and naturalist study groups, gave him an opportunity to emphasise the need for more effective conservation of the State's flora.

From 1921, when he joined an expedition to the Kimberley district, he travelled widely in WA. Before conservation was fashionable, he argued the need for sound conservation measures. An advocate for large reserves, especially in the most biologically diverse habitats of the State, Gardner predicted that small reserves and road verges were not viable. He believed that to concentrate effort on these detracted from recognition of the importance of large reserves. Largely through his influence, and through the presentation of his own undisputed observations on plant geography, his persistence on large reserves was successful.

During the 1950s, Gardner made a series of landmark recommendations for protecting species-rich botanical areas. These resulted in the reservation of several of WA's most valuable national parks and nature reserves, including Kalbarri National Park, Fitzgerald River National Park, Cape Arid National Park, and the Lake Cronin area east of Hyden.

These are now among the State's most important biological conservation areas. One of them, the Fitzgerald River National Park, has become a World Biosphere Reserve. Gardner also recommended that the incredibly botanically diverse Mount Lesueur area should be reserved, but this did not occur for some time.

It is a fitting tribute to Gardner that a diverse sample of the Wheatbelt flora, close to Yorkrakine where he developed his initial interest and expertise in the WA flora, was set aside and named the Charles Gardner Reserve. This is an excellent sample of remnant Wheatbelt sandplain vegetation and the home of the rare woolly sheoak (*Allocasuarina fibrosa*), a species described as new to science by Gardner himself.

Below: An acacia and the trunked zamia (*Macrozamia fraseri*) are common inhabitants of areas north of Perth, such as Mt Lesueur and Badgingarra, recommended by Gardner as large reserves. Photo – David Bettini

Neville Marchant is a Senior Principal Research Scientist with the Department of Conservation and Land Management, and the Director of the Western Australian Herbarium. As a new recruit in the 1960s, he worked with Charles Gardner, finding him enigmatic, energetic and eclectic.

Neville can be contacted on (08) 9334 0500 or by email (nevillem@calm.wa.gov.au).

Lichens

the poor little peasants of Lake Muir Nature Reserve

Rustici pauperrimi (The poor little peasants of nature) C Linnaeus (1707–1778).

An attractive feature of Lake Muir, which lies east of Manjimup, is the presence of a large display of odd shaped and colourful lichens.

by Ray Cranfield and Richard Robinson

Mist layers dissipate, presenting a scenic vista across Lake Muir, and opening a unique window into the lake's natural diversity. A myriad life forms make up the ecology of its rocky eastern shoreline.

The diversity in any landscape consists of many recognisable layers, some of which are readily observed. One group of organisms that is often overlooked belongs to a section of a larger flora known collectively as cryptogams. Cryptogams are plants that produce spores instead of seeds and include the ferns, lichens, mosses and liverworts. Lichens, referred to by Linnaeus as 'The poor little peasants of nature', can be found in large numbers around Lake Muir. Careful searching will be rewarded by a range of unusual structures and forms that can be either microscopic, with a hidden beauty, or large enough to be observed unaided.

Previous page
Main: Xanthoria ligulata.
Insets from top: Fairy castles (*Cladonia cervicornis*), *Heterodermia dendritica*, *Pseudocyphellaria neglecta* and reindeer moss (*Cladia aggregata*).

Left: A lichen-covered tree on the shoreline of Lake Muir.

Below left: The whimsically-named fairy castles.

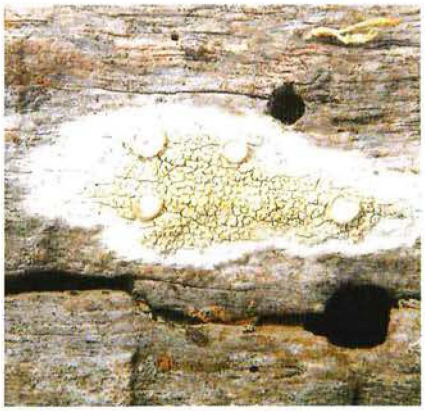
Below: Neofuscelia glabrans has greyish-green lobes.

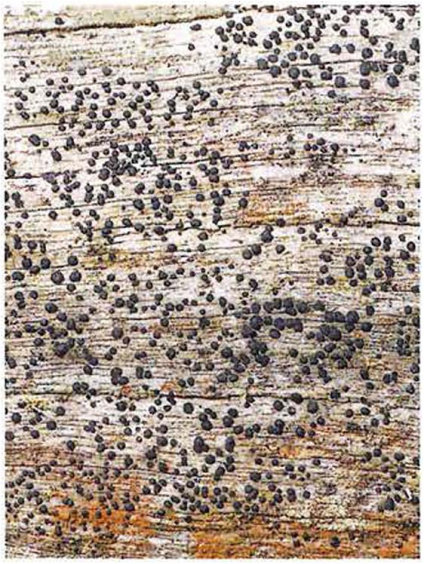
Bottom: The crusty white lichen *Ochrolechia* sp.

LICHENS

Lichens can be classified into simple, non-taxonomic groups based on their structure or growth form. The simplest growth form is a flat crust that adheres to the surface of bare rock or wood, often resembling a splash of paint or a bird dropping. Leafy forms are anchored to their favoured surface by a mass of short hair-like roots called rhizines, and coral-like species can often be seen growing among moss on old logs or on the ground. Beard-like species hang from the branches of living and dead trees and shrubs. In long dry periods, lichens will dehydrate and go into a resting phase. On rewetting, they will resurrect and hydrate back to their former 'living' state.

Lichens are a symbiotic partnership between algae and fungi, sometimes existing apart, but preferring to co-exist. The mechanism of how these two partners find each other is virtually unknown and is one of the mysteries of nature. In the autumn-winter period, the fungal partner forms fruit bodies that arise from the surface of the plant. At Lake Muir, many of the lichens form small disc-shaped fruits either directly on the surface of the plant or on the ends of tall trumpet-like stalks or hanging branches. Lichens were first noted in the third century BC. Further studies occurred during the fifteenth and sixteenth centuries, where records show that they were described in herbals (the earliest medical texts, which published cures based on extracts prepared from natural resources). The development of the compound microscope, during the nineteenth century, encouraged early





botanists to study and advance the understanding of the lichen floras. Today, lichenologists have an impressive array of tools available, which include chromatography methods and chemical spot tests, to assist in the determination of genus and species.

Only a small number of lichen species are known by common names. Many species found in Australia have worldwide distributions and single species have become known by a variety of common names. This has resulted in a high degree of confusion that often leads to mistaken identifications. In many instances, although interesting to lichenologists, lichens may appear insignificant and do not stimulate the development of common names. This has not deterred serious naturalists from having fun by coining a few interesting common names. Examples of fairy castles (*Cladonia cervicornis* subsp. *verticillata*), old man's beard (*Usnea* species), cow's udders (*Ramalina inflata* subsp. *australis*) and reindeer moss (*Cladia aggregata*) can all be seen at Lake Muir.

DISPLAY AT THE LAKE

Lichens can be spectacular when seen massed. They can produce outstanding displays of bright colours, intricate patterns or a combination of both. Many of the smaller lichen species require a lens or microscope to study their structures, but examining them is well worth the effort. Lichens can be found on most stable surfaces and, while some can tolerate conditions that are extremely harsh and exposed to the elements, others prefer secluded protected niches. Lichens have been recorded growing upon some unusual objects, such as old car bodies, broken glass, china and the roof tiles of older houses. Although most stable surfaces provide a place to develop, not all contribute or provide food requirements for lichen growth. The algal partner converts energy from the

Top: The lichen *Ramboldia stuartii* resembles fly spots.

Top right: Pyrrhospora laeta forms a reddish-orange crust on branches.

Above: Old man's beard (*Usnea scabrida*).

Right: The lichen *Hypogymnia subphysodes* has a greyish-green 'leafy' growth form.

LAKE MUIR

Lake Muir was named in honour of farming pioneers of the south-west of Western Australia. The Muir family still farm in the area. The lake was located by Thomas Muir after local Aboriginal people told the family (then based near Mount Barker) that a large body of water could be found further west towards what is now known as Manjimup. The lake was found to be extensive and covered in large flocks of ducks and other waterbirds on what appeared to be a reasonable source of permanent water. In 1856, Thomas's brother Andrew built a two-roomed paperbark hut on the lake's eastern shore at Nabagup where he embarked upon various agricultural pursuits, including wheat and livestock farming.

The Muirs forged botanical links with Baron Ferdinand von Mueller, an eminent botanist based in Melbourne during the early colonial years of Australia. They collected local plant specimens and sent them to Melbourne, assisting in the discovery and understanding of Western Australian flora. In 1873, the rope sedge *Lepyrodia muirii* was named by von Mueller in recognition of the Muir's contribution to the botany of the area. In 1877, Thomas and Andrew Muir hosted a visit by von Mueller to the Lake Muir and Nornalup areas.

Wheat farming at Nabagup lasted only a few years, but stock has been run on this property since, and today wild horses can still be seen in the area. Tree farming (pines) has replaced much of the older agricultural practices on the eastern shores of the lake, adjacent to what now forms the Lake Muir Nature Reserve.

sun, in a similar manner to that of plants, and the fungal partner gains nutrients from the surface on which the lichen grows and from atmospheric particles through breakdown and absorption.

The most commonly colonised natural surfaces found around the shoreline of Lake Muir are granite and quartz rocks, old fence posts, and the branches and stems of dead and living shrubs and trees.

The lichen flora at Lake Muir is quite diverse. The reason for this diversity is not fully understood, but it is likely to be the result of a mosaic of suitable niches, surfaces and hosts in a small area. This includes an abundance of suitable plant species, rocks with variable aspects and a contrasting but cyclic annual climate regime, which allows species suited to both wet and dry environments to co-exist. During a brief visit to the eastern shoreline of Lake Muir, the authors collected 60 specimens, which represented 18 families and 26 lichen genera. It is expected that any further collecting opportunities around the lake's perimeter will find previously unrecorded species or subspecies, some of which may represent new records for Western Australia.

Above left: Shoreline rocks at Lake Muir covered by *Xanthoparmelia* sp. and *Xanthoria ligulata*.

Left: Teloschistes chrysophthalmus (left) and *Menegazzia* sp. (right) grow together on trees and shrubs.

Above: Xanthoparmelia sp. has greyish-green lobes.

A quick glance around the lake's eastern edge will present a riotous splash of colour and form. On the rocky granite outcrops, leafy or lobed species may be either quite large-lobed and loosely attached or small-lobed, flat and firmly attached. Leafy or lobed species range in colour from yellowish-orange (*Xanthoria ligulata*) and reddish-brown (*Pseudocyphellaria neglecta*) to greyish-green (*Xanthoparmelia* sp.) and olive (*Neofuscelia glabrans*). Other species form flat crusts that grow in circular or irregular patterns (*Rhizocarpon* sp.).

Trees and shrubs host a wide range of species that may be yellowish-green and beard-like (*Usnea scabrida*), bright yellowish-orange tufts (*Teloschistes chrysophthalmus*), greyish-green forms resembling cow's udders (*Ramalina inflata* subsp. *australis*), or flat and scaly (*Menegazzia* sp.). There are also crusty reddish-orange (*Pyrrhospora laeta*) or white (*Ochrolechia* sp.) forms. On moss-covered, decaying logs, tiered forms that resemble tiny grey castle towers (*Cladonia cervicornis* subsp. *verticillata*) and coral-like species (*Cladia aggregata*) can be found. Greyish-green leafy or lobed species (*Heterodermia dendritica* and *Hypogymnia subphysodes* var. *austerodoides*) and a black species that resembles fly spots (*Ramboldia stuartii*) like the bare wood surfaces, including old fence posts. On the more sheltered trunks, one may find a strange olive green jelly mass (*Collema* sp.) that dries to a brittle black film adhering to the bark surface. Using a lens, and closely examining the decaying wood, can reward lichen hunters with sightings of the tiny stubble lichen (*Calicium glaucellum*), which appears as a mass of individual black structures 0.25 millimetres tall.

The more you look for lichens at Lake Muir the greater the experience, as an expanding diversity of forms quickly becomes apparent.

Above left: Lichen on fence posts at Lake Muir Nature Reserve.

Above: Cow's udders (*Ramalina inflata* subsp. *australis*).

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The authors would particularly like to acknowledge and thank Alison Muir of Manjimup for sharing the family history of those early pioneers at Lake Muir.

All photos by Richard Robinson.

In search of the elusive western flat

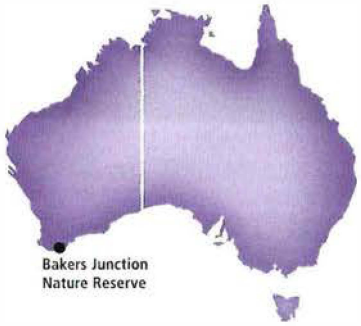
Originally described in 1888, the western flat butterfly is found only in Western Australia. For more than 100 years, the life history of this rare butterfly remained unknown. Andrew Williams and Matthew Williams describe how the door to this mystery was finally unlocked.

by Andrew A. E. Williams
and Matthew R. Williams

Illustrations by Andrew Atkins

When European settlers first arrived in Australia, they found a continent very different from their previous homeland. The vastness of the land and its flora and fauna were unlike anything they'd seen before. No doubt, they would have been intrigued by the array of new mammals, birds and plants. Not only were the animals and plants new and varied, so too were the butterflies they encountered.

Butterflies have always attracted attention. Many of the species found in Australia were spectacular, and it wasn't long before naturalists had named a host of different kinds. As time went by, life cycle details, such as what plants the caterpillars fed upon, were progressively documented. However, for more than 100 years, the life history of the rare western flat butterfly remained unknown.



The western flat (*Exometoeca nycteris*) is a small skipper butterfly known only from a few localities in the south-western corner of Western Australia. It usually occurs in or immediately adjacent to forest habitats from as far north as the Chittering Valley to Albany in the south. It belongs to the subfamily Pyrginae, a group of butterflies collectively known as 'flats' because of their moth-like habit of resting with wings spread out flat rather than closed.

FLAT OUT SEARCHING

More than 1000 species in the Pyrginae subfamily occur throughout the world, but only eight species are known from the Australian region. The western flat is the only species to occur in the temperate south-west. Most butterflies have extremely restricted diets in their caterpillar stage, and will only feed on particular plant species. The food plant of the western flat was previously unknown, and discovering its identity was the key to finding the early stages.

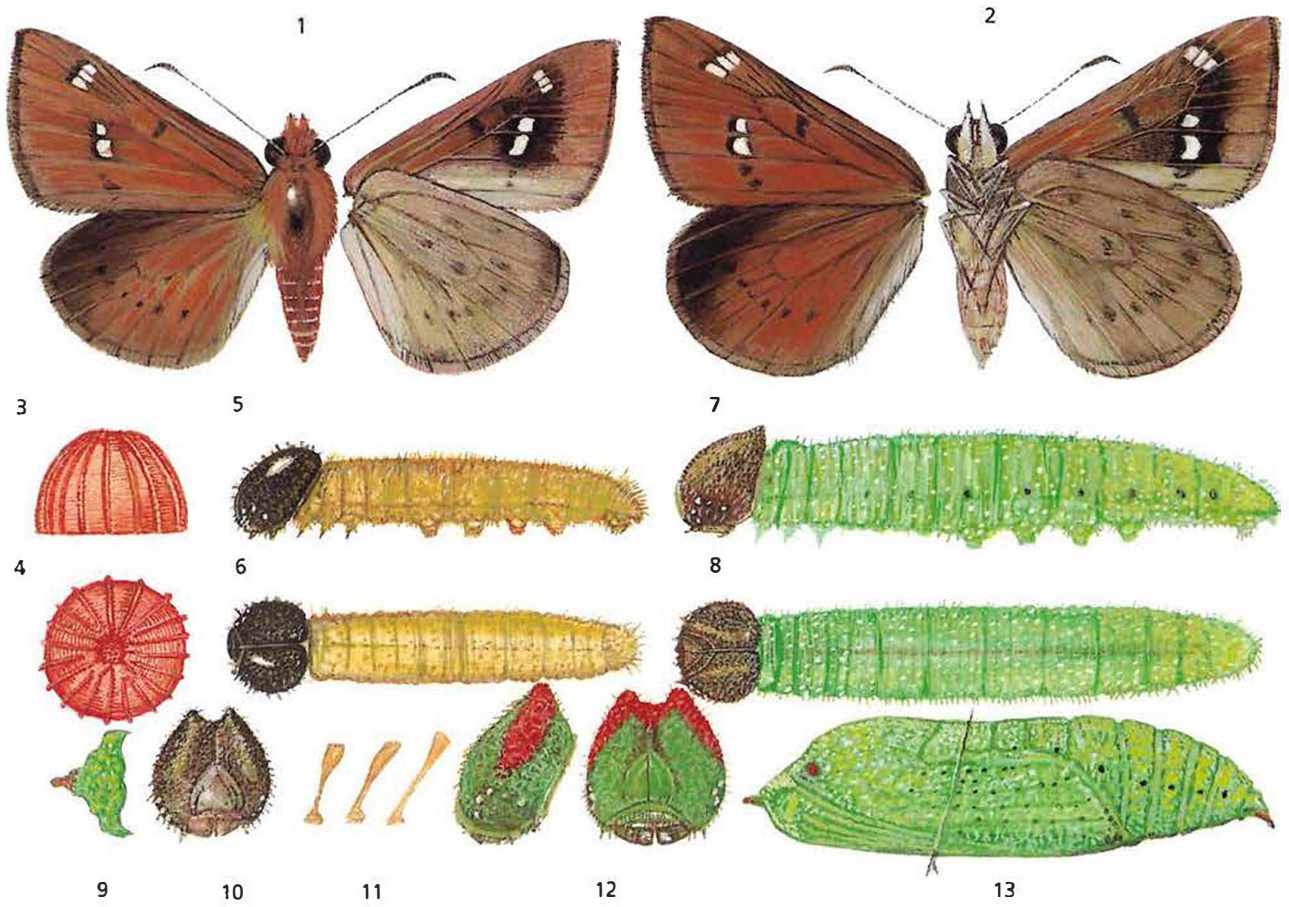
The butterflies are on the wing only between October and December. Like many butterflies, they have a one-year life cycle, with the egg, caterpillar and pupal stages taking around 11 months to complete; only the one remaining month of their life is spent as a butterfly. Butterflies spend most of their time seeking out mates and feeding at nectar-producing flowers; females have the additional task of finding suitable plants on which to lay their eggs. Like most butterflies, the eggs, caterpillars and pupae are well camouflaged and trying to find them, without knowing which species of plant to look on, is a near-impossible task.

Many people had previously speculated on the likely food plant of the western flat. Because some related African and Indian species of flats, and the Australian pied flat, fed on species of yams (*Dioscorea* spp.), the native yam was thought to be a probable candidate—especially as it occurred in the same habitats as the flat. Many years ago, the native *Hibbertia* had also been suggested, although no-one seemed to know why!

In early December 1999, we began searching areas around Albany where the butterfly was known to occur in reasonable numbers. A large population at Bakers Junction Nature Reserve gave us a wonderful opportunity to closely study their ecology and behaviour.

Above left: A perched western flat butterfly, showing the underside pattern of the wings.
Photo – Andrew Atkins

Left: Department of Conservation and Land Management researcher Andrew Williams searching for the elusive western flat butterfly.
Photo – Eleanor Williams

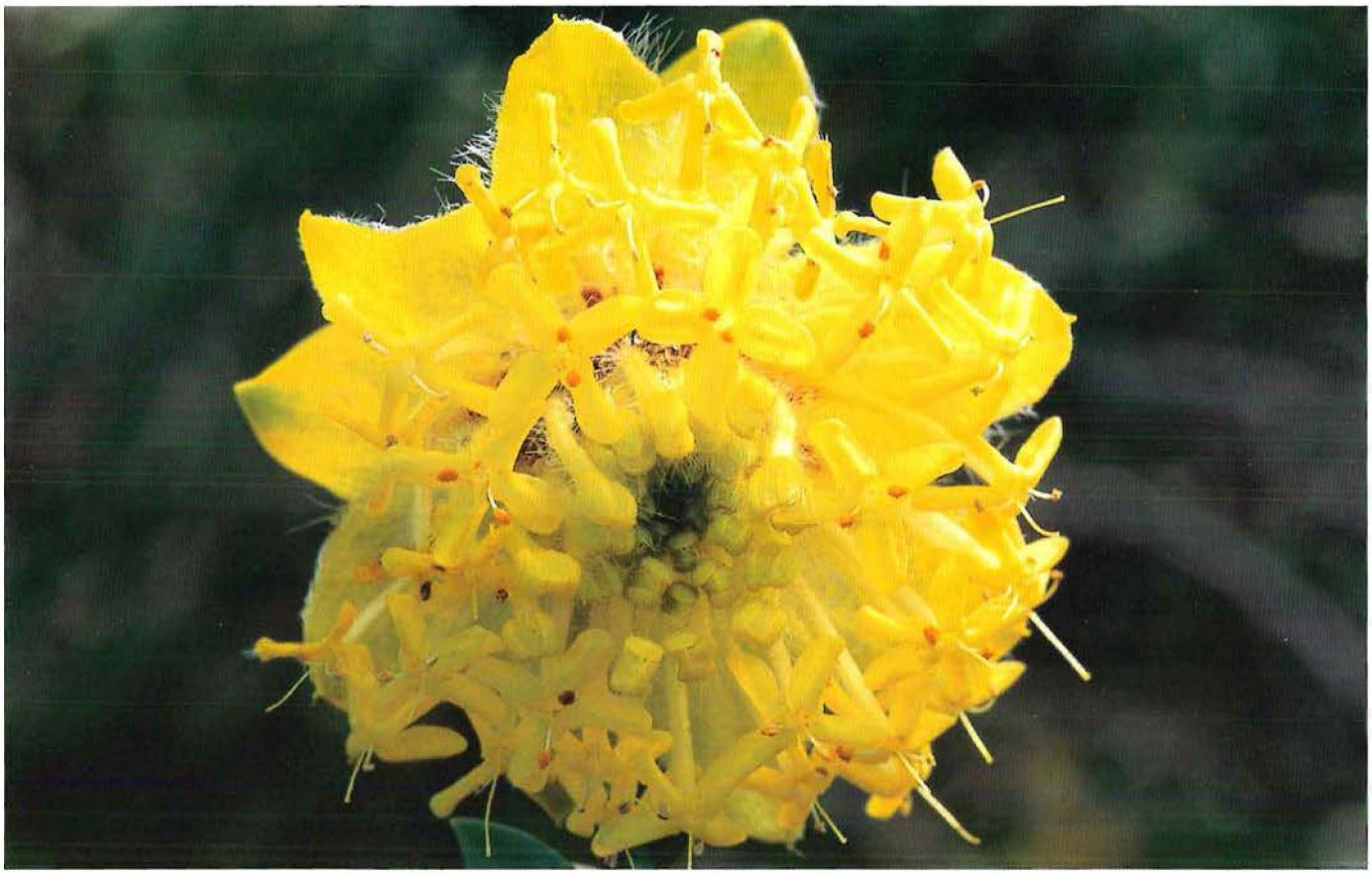


Western flats were active during sunny spells between nine in the morning and three in the afternoon. Both males and females congregated in small open areas of winter-wet heathland, surrounded by jarrah and sheoak woodland. Males established territories in these open areas, often perching on prominent dead sticks or taller sedges. At other times, they were seen spiralling together high above the ground. Both sexes were seen visiting the flowers of small herbs and shrubs, particularly *Pimelea* sp. and pineapple bush (*Dasypogon bromeliifolius).*

We then saw a western flat fly directly and swiftly from a flower, across an open area of heathland, to a shaded damp area of the surrounding woodland. Here, it laid a single tiny pale yellow egg on the extreme tip of a small purple-flowered shrub. Close inspection (and subsequent identification by botanists) revealed that the plant in question was *Tetratheca hispidissima.*

ILLUSTRATIONS
Figure 1. Western flat–Male upper and underside.
Figure 2. Western flat–Female upper and underside.
Figure 3. Lateral view of egg.
Figure 4. Dorsal view of egg.
Figure 5. Lateral view of 1st stage larva.
Figure 6. Dorsal view of 1st stage larva.
Figure 7. Lateral view of 3rd stage larva.
Figure 8. Dorsal view of 3rd stage larva.
Figure 9. Pupal cap.
Figure 10. Frons of 4th instar larva.
Figure 11. Larval setae.
Figure 12. Lateral view and frons of final instar larva.
Figure 13. Lateral view of pupa.

Right: A large population of western flat butterflies was found at Bakers Junction Nature Reserve, giving researchers the chance to discover their larval food plant.
Photo – Andy Williams



The mystery surrounding the butterfly's larval food plant had at last been solved—and this unlocked the door to discovering the details of its life history.

Tetratheca is a genus of plants in the family Tremandraceae, which is restricted to temperate southern Australia. Previously, no species from the family had been recorded as a food plant for an Australian butterfly.

Following the food plant's discovery, further eggs were located, and these were transferred to potted *Tetratheca* plants, located at Wanneroo, for observation.

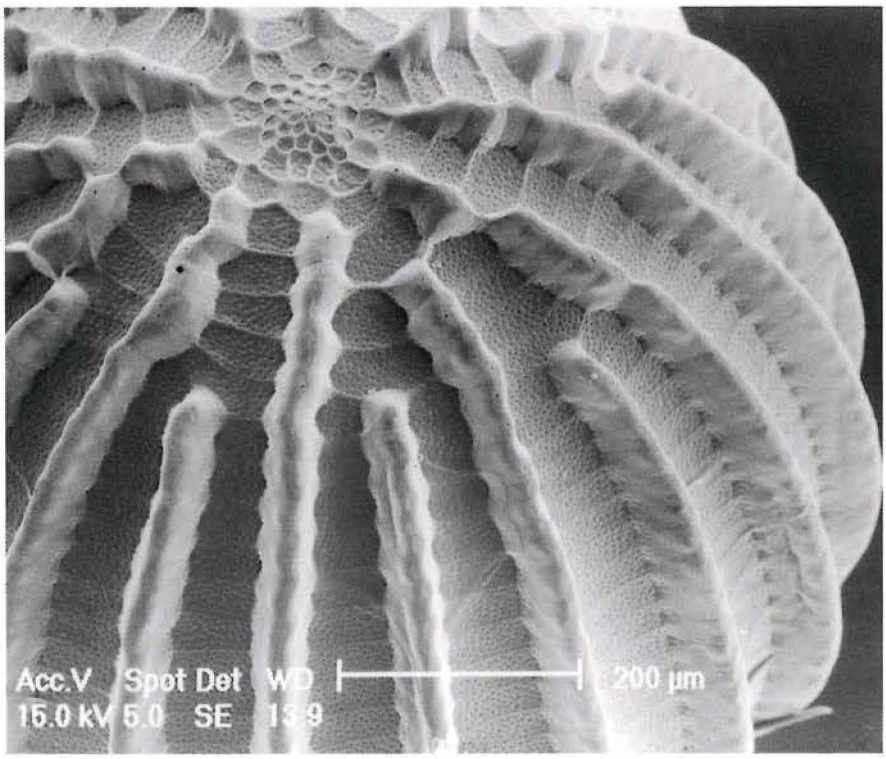
INSTARS

All butterflies start life as eggs, which hatch into tiny caterpillars. Most caterpillars feed on leaves or flowers. As

Top: The western flat has been seen visiting the flowers of *Pimelea*.
Photo – Marie Lochman

Centre left: A pupa removed from its shelter.
Photo – Matt Williams

Left: Western flats were recently found breeding on the black-eyed susan (*Tetratheca hirsuta*) at Lesmurdie.
Photo – Jiri Lochman



Above: Scanning Electron Micrograph (SEM) of an egg of the western flat butterfly.
Photo – Gary Weber

they increase in size, they go through a series of moults, shedding their old skins for new larger ones. The intervals between moults are called instars. When fully grown, the caterpillars stop feeding, shed their final skins and become pupae. In this immobile pupal state, the internal organs of the chrysalis break down and the adult butterfly's structures begin to form.

Our eggs from Bakers Junction Nature Reserve hatched into tiny caterpillars after 12 days. They immediately fed on the young shoots of the potted *Tetratheca* food plant, where they were difficult to see. Before long, they constructed dome-shaped shelters on the underside of leaves, pulling the edges of the leaf closer together with strands of silk. The caterpillars habitually lived within these shelters, only venturing out for short periods to feed. They grew slowly over summer and autumn, periodically moulting their skins before reaching mature size in late October. They then pupated inside their shelters—the pupa (or chrysalis) supported by a strong silken girdle around its mid-section. The adult butterflies emerged three weeks later.

Under the microscope, the eggs of the western flat proved to be dome-shaped, with exquisitely sculptured vertical ribs (their sculptured surface can be clearly seen in the micrograph). The newly hatched caterpillars were two millimetres long, with greenish-yellow bodies and shiny black heads. After the first moult, the body became green with an indistinct mid-dorsal line. Mid-stage (third instar) larvae were six to eight millimetres long, with green bodies and a darker mid-dorsal line. By this time the dark head capsule had developed two pronounced dorsal horns. Mature (fifth instar) caterpillars were similar but larger (17–19 millimetres), though the head capsule was now green with variable reddish-brown markings. The pupa was bright green in colour and had an unusual projection on its head.

Soft-bodied caterpillars are generally vulnerable to predators such as spiders, wasps and birds, and different species use different techniques to avoid being eaten. Western flat caterpillars use two strategies to avoid detection; they build shelters and rely on camouflage for protection. Their shelters give them a place to hide, and offer protection from sun and rain. Their green body colour perfectly matches the foliage on which they feed, while the dark markings on their head capsules match discoloured patches on the leaves.

NEW LEADS

The western flat has an interesting life cycle. The adult butterfly may be visible for only two or three weeks, but in its juvenile state it actually lives for a year. The discovery of the *Tetratheca hispidissima* food plant at Bakers Junction has given researchers the opportunity to search for butterflies in other places where this plant occurs. Recently, butterflies were found breeding on a similar species, black-eyed susan (*Tetratheca hirsuta*), which grows near Lesmurdie east of Perth.

Dried *Tetratheca* material held in the Western Australian Herbarium collections has also been examined for signs of eggs and shelters. One hatched eggshell was found on a plant specimen collected near Beraking, south-east of Sawyers Valley, indicating the presence of western flats at this locality.

As more information on the western flat's distribution and habitat requirements becomes available, the Department of Conservation and Land Management will be better able to adequately manage this rare endemic Western Australian skipper.

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Matthew Williams is a Senior Research Scientist in the Department of Conservation and Land Management's Science Division. He is based at Kensington and can be contacted on (08) 9334 0399 or by email (mattw@calm.wa.gov.au).

Andrew Atkins is an authority on Australian skipper butterflies and has been involved in collaborative research with the Department of Conservation and Land Management's Science Division.

Over the past few years both Andrew and Matthew have been documenting the distributions, life histories and conservation status of Western Australian butterflies.

URBAN ANTICS

A SAUCERFUL OF SECRETS

Mushrooms... not places where you train Siberian huskies, but rather, little, flat or round-capped beings that are neither plants nor animals, where gnomes and fairies might dwell.

A mushroom is any of a variety of fleshy, umbrella-shaped fruiting bodies of fungi that spring up from the ground after a night of heavy rain. They occur in either wooded or grassed areas, usually in late autumn and onwards. They are regarded as the fifth kingdom (fungi) of living things and differ from the green plant kingdom (plantae) in that they lack chlorophyll, the green substance that is used to make food. Instead, mushrooms survive mainly by absorbing food material from surrounding living and decaying plants or animals.

Although there are hundreds of species of fungi throughout the south-west of the State, many have not yet been named or described, They vary in shape, size, colour and texture. Mushrooms and toadstools are the best known fungi, but the brackets and jellies on wood, puffballs in the back lawn, stinkhorns, yeast and common moulds on bread are also fungi (see *LANDSCOPE*, Vol. 18, Spring 2002).

While some species of mushrooms are tasty and safe to eat, others have a bad taste and some are poisonous. A few of the poisonous types, such as species of *Amanita*, can be fatal if eaten. In legend and fairytales, mushrooms that are poisonous or have a bad taste are often referred to as toadstools.

Since the emergence of humans, it was very likely that mushrooms were part of our diet, as they were very easy to gather and, as we know today, a source of phyto-nutrients—rich in Vitamin B and containing minerals such as potassium, phosphorus and iron.

And so it was, when this little 'Neanderthal' was taken on picnics, a long time ago, to the mushroom Mecca of WA; my auntie Poll's poopy little cow paddock right in the town of Gingin. Following the first decent rains of every autumn, my dad would think nothing of dragging us kids through a minefield of fresh pats to gather our delicious, delectable, saucer-sized 'mushies'. Fried in butter with salt and pepper, then served on toast they were, and still are, absolutely to die for... well, not quite.

Most mycologists (scientists who study fungi) list mushrooms as either agarics or boletes. Agaric mushrooms have gills under their caps, and boletes have tubes. When the mushroom is ripe, the gills or tubes release millions of minute spores that scatter with the wind. After reaching a place with ideal food and moisture, a spore sends out a microscopic, thread-like filament called a hypha. The hypha lengthens from its tip and branches out into a root-like system called a mycelium. On various parts of the mycelium, pinhead-size buttons appear and, as they mature, tiny caps and stalks become recognisable. With the onset of enough moisture, such as a rainstorm, the cells of the underground fruit wildly expand, shooting the stalk upwards, the cap unfolding like an umbrella. Within two days, a field mushroom matures, as the gills go from pink to brown and the spores begin to shed. The fruit withers and dies, but the mycelium in the soil continues its spread, along with the new spore germination, to produce for many years to come.

The local common whitish-coloured field mushroom, with its chocolate brown gills, and the smaller table mushroom, found in most supermarkets, are close relatives. However, the cultivated, and usually undeveloped and insipid, imposter is not a patch on its cousin for flavour.

A word of warning: all mushrooms absorb heavy and toxic chemicals. Even edible field mushrooms found in cities and near drains can be toxic! You would be better to stick to a healthy little sheep paddock somewhere. Now, that's even better habitat than cow pasture.

BY JOHN HUNTER

DID YOU KNOW?

- *Mushrooms are an important food source for insects and many small animals. They also cause decay of the materials on which they live, in turn releasing important minerals back into the soil.*
- *The 2000-year-old book, Shen Nong's* Herbal Classic, *describes some species of mushrooms as having strong medicinal value. Today's scientists have discovered compounds in mushrooms that stimulate human immune systems, combat tumours and prevent blood platelet adhesion that is responsible for coronary artery disease and strokes.*
- *The word mushroom is from the French* mousseron, *a derivative of the word 'moss' on which some species grow.*

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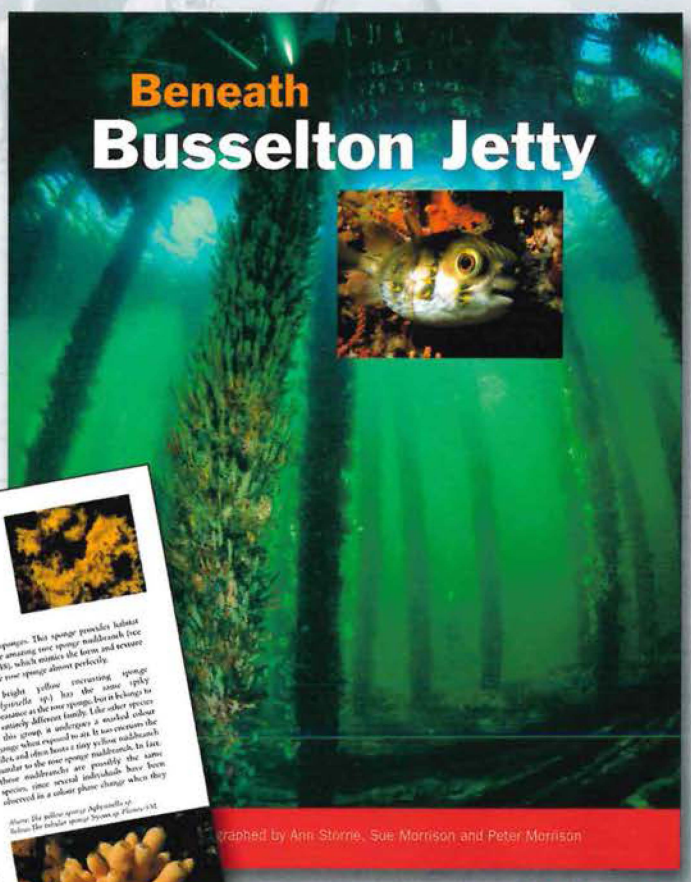

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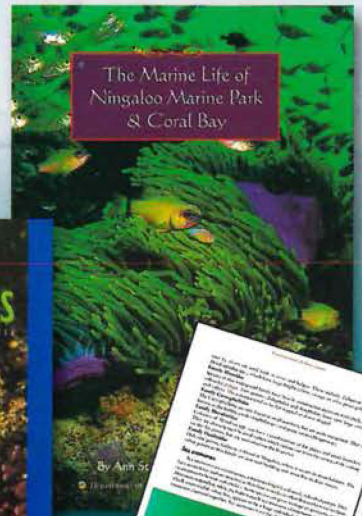

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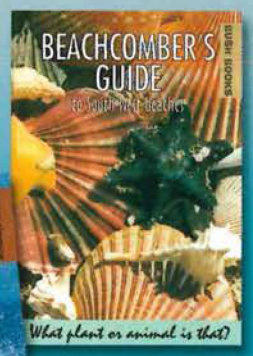

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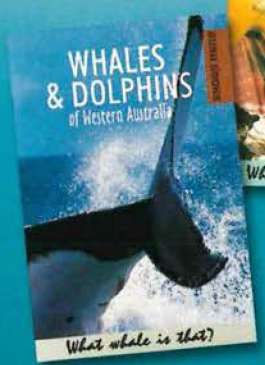

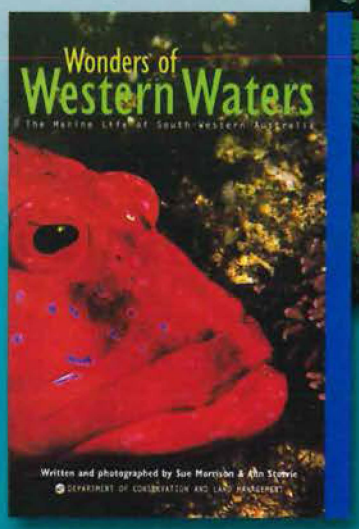

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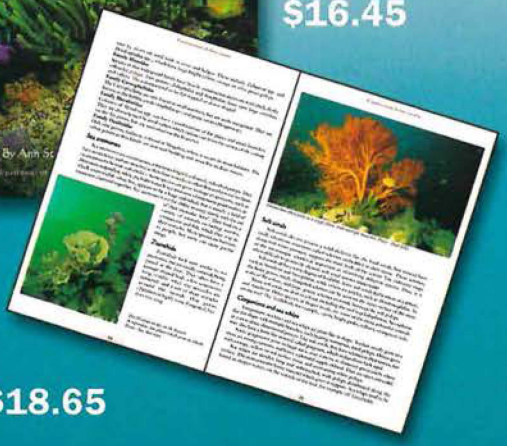

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