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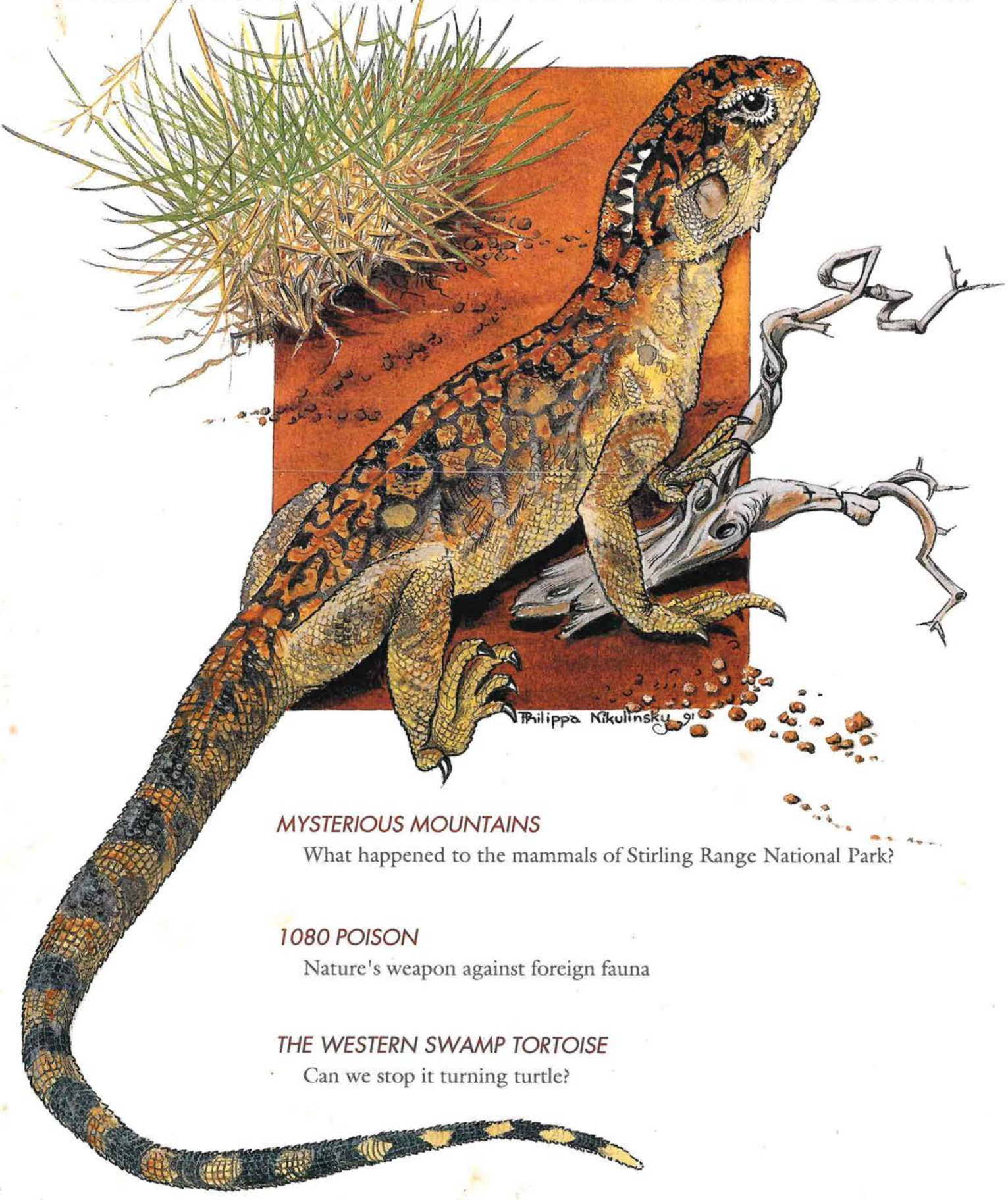
WINTER 1991

LANDSCOPE

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



MYSTERIOUS MOUNTAINS

What happened to the mammals of Stirling Range National Park?

1080 POISON

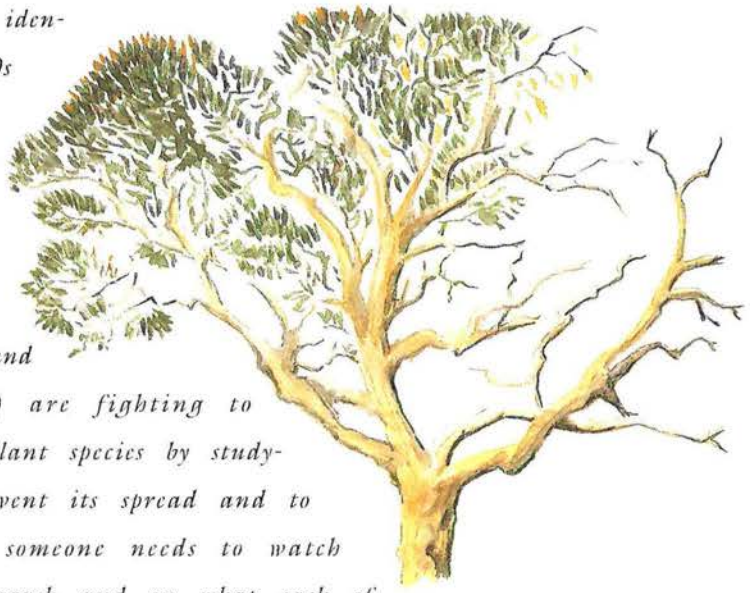
Nature's weapon against foreign fauna

THE WESTERN SWAMP TORTOISE

Can we stop it turning turtle?

PLANT KILLER

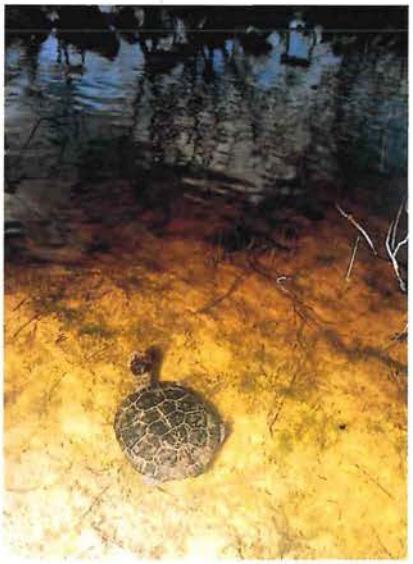
A tropical fungus that was brought to our shores over a century ago has been slowly killing many of Western Australia's plants. The microscopic fungus **Phytophthora**, *which lurks in the soil, was identified in the mid-1960s by CSIRO scientist Frank Podger as the killer plant disease 'dieback'. Scientists from the Department of Conservation and Land Management (CALM) are fighting to save our endangered plant species by studying the disease to prevent its spread and to develop a cure. But someone needs to watch and report on the research and on what each of us can do to stop the spread of this plant killer. That's where* **LANDSCOPE** *magazine comes in.* **LANDSCOPE** *is WA's premier conservation quarterly. Our stories on wildlife, forests, reserves, and national and marine parks are well informed and scientifically researched. We pack each issue with facts, problems, solutions and achievements, and we care about the future of our planet. We think you do, too. That's why we want your continued support. If you'd like to subscribe to* **LANDSCOPE**, *for yourself or a friend, please write or telephone.*



LANDSCOPE
window on the west

Department of Conservation and Land Management
50 Hayman Road COMO Western Australia 6152
Tel: (09) 389 8644 Fax: (09) 389 8296

Cloud-capped Bluff Knoll, majestically brooding sentinel of the Stirling Range. Does it hold a secret in its stony heart - perhaps the answer to the missing mammal mystery? See story on page 9.



A western swamp tortoise (Pseudemydura umbrina). *Could this be one of the last to be photographed? Not if CALM's ten-year recovery plan succeeds. See page 28 for details.*

LANDSCOPE

VOLUME SIX NO. 4 - WINTER EDITION 1991

Mulga and fire - at best an uneasy relationship - sometimes symbiotic, sometimes disastrous. Find out when and where on page 20.

The Kimberley's rugged grandeur is deceptively fragile. Additional reserves managed by CALM help protect the region's delicate, complex and diverse ecosystems. See page 35.

An uncommon dragon, Caimaniops amphiboluriodes *inhabits mulga shrubs. Many other dragon lizards prefer harsher habitats such as rock-piles and salt lake beds. See page 51.*

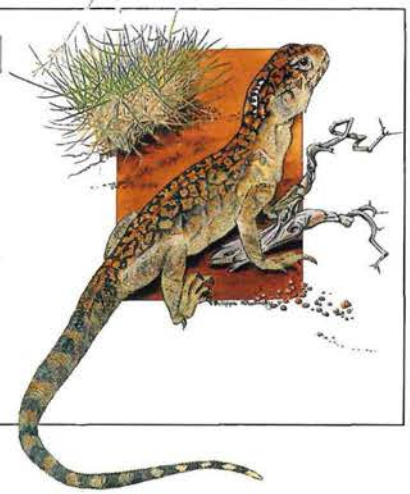
F E A T U R E S

R E G U L A R S

C O V E R

Central netted dragon (Ctenophorus inermis), *one of the more than 60 species of dragon lizard that inhabit the arid and semi-arid parts of Australia. The acute eyesight and swiftness of dragon lizards are essential in order to avoid predators and to capture food. See page 51.*

Illustrated by Philippa Nikulinsky



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A LAST FRONTIER

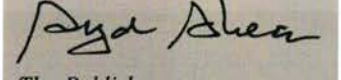
The Kimberley combines stark beauty, bizarre ecosystems, and ancient culture with a "last frontier" atmosphere which makes it unique. While European settlement of the Kimberley goes back many decades, the region contains some of the world's least disturbed ecosystems.

Too often our concern for the environment has come long after ecosystems have been severely disturbed. In many areas of the State we have shown it is possible to restore ecosystems, but only at extraordinary expense. We have the opportunity in the Kimberley to get ahead of the oncoming disturbances and plan to manage them.

Some people would argue that there should be some embargo on people's access to this unique region. But that would have the same success as King Canute's attempt to stop the rising tide, as more and more people will want to visit and experience the atmosphere of the Kimberley.

The Kimberley region can sustain without damage the increasing number of people who want to visit it, if there is proper planning and management. In this issue, two CALM experts on the Kimberley, Kevin Kenneally and Norm Mackenzie, discuss the report produced by CALM on the need for nature conservation reserves in the Kimberley. This is one of the most important first steps in planning for the maintenance of the Kimberley's wonders: the setting aside of the jewels of the region in a reserve system.

CALM looks forward to working with the Kimberley's residents and visitors in developing a total plan of action - one to ensure that people can enjoy the region and live off its land, while preserving it for the future.



The Publisher

STOP WATER LITTER

I am a resident of Wanneroo City and have become concerned at recent reports of the amount of rubbish collected from our ocean.

Local fishermen leave behind their bait packaging, causing a deadly trap for marine life. Many boat owners, while enjoying the outdoors, forget how to care for it and throw beer or soft-drink cans and plastic wrapping overboard, creating a threat to the fish and other ocean life. I feel that boat owners should use special rubbish bags attached to parts of their boats, and store the rubbish until they reach land. But I have seen only one example of this being done.

The people who pollute our oceans are very careless. They obviously don't realise how precious our waters are and how much it would take to totally flush them of litter. It is fortunate that there are people who care. I hope something can be done so that our beaches stay as clean as possible for future generations.

JEMMA MITCHELL
HILLARYS

SELL IT, SHARE IT, OR GIVE IT AWAY?

The story 'Eucalypt Emigrants' by Ian Kealley in the Summer 90-91 *LANDSCOPE* highlights with pride the fact that over the years Western Australia has provided seed to a wide range of overseas customers. Although this might appear commendable, what it really means is that Western Australia has given away for 'a song' the chance to be a world leader in providing plantation trees for the reafforestation of drought-affected and damaged lands around the world.

By selling our genetic resource in the period between WWII and the 70s, we lost the opportunity to develop an export industry which could have rivalled wheat or sheep in export earnings if it had been carefully nurtured and developed. What would the wool industry be today if Marino ewes had been exported widely? The world's largest plantations of Tasmanian blue gums for high-quality paper pulp are not in Tasmania but in Brazil and Portugal. The world's leader in the sales of macadamia nuts is not Queensland but Hawaii. The floricultural rights to the production of waratah are held by New Zealand and the world knows this flower as the New Zealand rose.

Techniques now exist to produce tissue-culture sterile genotypes which can hold Plant Varietal Rights. These Rights provide protection from exploitation by overseas industries as patents do for inventions. Providing foreign buyers with clonal plantlets would be a value-added industry which would continually require resales with each timber cutting rotation. Now that these trees are overseas we have possibly lost forever that potential economic benefit. Would it not be better to ban the export of seed of such a valuable genetic resource and develop this industry for the future benefit of Australians? I appeal to CALM to consider carefully future sales of seed to overseas buyers.

DR DAVID T. BELL
UNIVERSITY OF WA

ENGLISH SPRING ARRIVES - AUTUMN *LANDSCOPE* DOESN'T

Many thanks for the copy of *LANDSCOPE* that has just been delivered. However, it is the summer edition. Should I not have received the one for autumn?

I enjoy reading your publication very much and have been careful to maintain the back numbers; *LANDSCOPE* is an impressive magazine and it covers a fascinating range of topics while also keeping its readers abreast with conservation and land management issues in Western Australia. The botanical articles are particularly interesting, the more so given the acute contrast between the Australian flora and that which exists here in England. I recall seeing quite a few English 'alien' species in WA; over here we see very little that is of Australian origin, apart from *Eucalyptus gunnii* in suburban gardens and *Crassula helmsii* currently running riot around many an English pond, smothering the indigenous flora in places.

You can imagine my disappointment at finding I had the wrong edition of *LANDSCOPE*. I drove off to work feeling quite glum - although the riotous onset of an English spring does a lot to ameliorate such depression!

RODNEY COLE
ESSEX, U.K.

Thank you for a charming scold, Mr Cole. Our autumn issue should be with you now - we hope it enhances the euphoria brought on by the English spring! - Ed.

Your letters are welcome. Please address any correspondence to *LANDSCOPE* Editor, CALM, 50 Hayman Road, Como WA 6152

OUR KIMBERLEY CARNIVORES

Crocodiles are best admired from a safe distance.
Photo - Jiri Lochman

Crocodiles might not have the same cuteness appeal as a lot of WA's wildlife, but they are still in need of protection and the task of protecting them is just as demanding.

Department of Conservation and Land Management (CALM) officers in the Kimberley monitor the wild populations of freshwater and saltwater crocodiles and are involved in regulating the commercial farming industry. If population numbers drop, a percentage of one-metre-long crocodiles from breeding farms in Wyndham, Broome or Fremantle will be returned to the wild.

In 1986, a survey by researchers Andrew Burbidge and Harry Messell produced an estimate of 2 500 wild saltwater crocodiles in the Kimberley. This compares with 50 000 to 60 000 in the Northern Territory. While saltwater numbers are low, there are high populations of freshwater crocodiles - numbers at Fitzroy River are estimated to be 13 500, Lake Argyle 25 000 and Lake Kununurra 10 000. Both species are on CALM's specially protected wildlife list. Of the two, only the saltwater crocodile poses a threat to human life.

CALM Kimberley regional manager Chris Done said work associated with crocodiles is a major part of the region's role. This role includes capturing and relocating freshwater crocodiles from Lake Argyle spillway, where they become trapped and could slowly starve to death.

CALM officers also monitor the collection of eggs and hatchlings for the State's three crocodile farms. No wildlife is removed from protected areas (nature reserves and national parks), but is instead taken from crocodile management areas. (There are three "crocodile" zones - one in which CALM attempts to remove the reptile as it poses a threat to human life, one in which crocodiles can be taken for breeding farms, and crocodile protection areas where they remain undisturbed.)

Eggs and hatchlings may only be removed by crocodile farmers from half of the active nests found in an area.

Chris Done said that hatchlings had a better chance of survival in a breeding farm - 80 to 90 per cent, compared with only about 1-2 per cent in the wild.

Earlier this year CALM took over supervision of the care of animals at the Wyndham Crocodile Farm after a report of high mortality rates among crocodile hatchlings there.

BEYOND OUR BACKYARDS

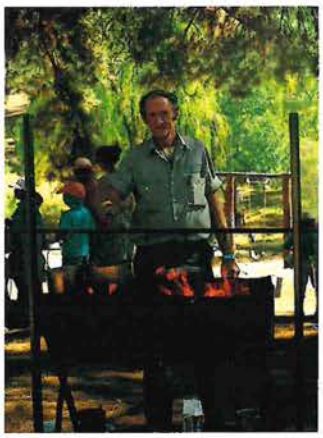
City dwellers are being enticed away from their TV sets and cluttered suburbs to explore the forests on the city's edges as part of the Department of Conservation and Land Management's (CALM) *Let's Go Bush* environmental education program.

The explore-the-outdoors program is one of many school holiday activities organised by CALM throughout Western Australia. Activities range from a night-time spotlighting tour of Kalamunda National Park to breakfast with the birds, and provide families with a fun way of learning about their natural environment rather than sitting at home reading books or watching TV documentaries.

During autumn, about 750 adults and children converged on Fred Jacoby Park near Mundaring to experience one of the program's 16 activities: "A Forest Affair". Visitors watched timber sawing, log-hauling and fire-suppression demonstrations, and were able to look at several craft and educational displays. Some took advantage of the free barbecue facilities in the park, while others availed themselves of the free bushman's tucker on offer - johnny cakes and billy tea.

The first *Let's Go Bush* program was held in the forests bordering the Perth metropolitan area in October 1990 and almost all of the 10 activities trialled sold out.

Feedback from participants in this year's program was enthusiastic: most participants wanted more activities more often.



Barry Rhodes, storeman at CALM's Mundaring office, demonstrates the art of making authentic billy tea.
Photo - David Gough

Other holiday programs are run by CALM at Yanchep National Park, Mundaring, Walpole-Nornalup National Park and Serpentine National Park, with additional programs in the South West aimed at school children and holidaying visitors.

KINGS PARK RECOVERING

Despite the combination of a dry winter and this year's long hot summer there has been a steady recovery for the native flora of Kings Park following the devastating fire in 1989 (see *LANDSCOPE*, Autumn 1989).

Permanent quadrats (areas marked for comparison) placed after the fire by Kings Park and Botanic Garden staff and researchers from the University of WA have shown tree death rates to be high. However, most of those that have not died are resprouting from their bases. It is likely to be many years before the tree canopy is re-established.

One concern is *Banksia ilicifolia*, normally found in much wetter areas or on sandy soils with a higher water table. This species is under severe threat as most of the parent plants in the park were killed by the high-intensity fire and there has been no seedling growth since.

However, the understorey shrubs, bulbous, tuberous, and other small plants are growing exceptionally well - particularly the kangaroo paws, of which there was a stunning display last spring.

The Ground Fauna Project, in collaboration with the Perth Wildlife Watch, WA Museum staff and many willing volunteers, is monitoring the movement of animals from unburnt areas in the park into the burnt areas. But because of a lack of funds this project is winding down, so the long-term effects of the fire on King Park's fauna will not be recorded.

Kings Park horticultural advisory officer Bob Dixon said that veldt grass control was in hand after large-scale spraying with Fusillade, a selective herbicide for the control of certain grasses, and the testing of a new, similar herbicide, Assure. The enormous weed invasion after the fire, especially in highly disturbed areas (e.g., at the sides of tracks) is moderating as perennial native plants, especially shrubs and groundcovers, filled in the bare areas.

Tree death rates have been high in the burnt areas of Kings Park. Photo - Bob Dixon

Despite the high fire risk, the 1990-91 summer was kind to Kings Park. There were no wildfires, accidental or deliberate. Mr Dixon said it was hoped this situation would continue for several years so that the bush could naturally repair previous wildfire damage.

DIEBACK THREAT TO FAUNA

Wildlife that depends on flowering plants for its food source may become the second line of victims of the killer plant disease *Phytophthora*, commonly known as dieback disease.

Dieback disease is probably the greatest crisis facing Western Australian natural ecosystems, and the need to stop the disease's spread is the reason for a public awareness campaign by the Department of Conservation and Land Management (CALM).

The disease is now known to be widespread in tropical and subtropical regions throughout the world. As well as in Western Australia, it is common in NSW, Victoria and Tasmania. In the South West it occurs in many natural areas once considered dieback-free, including several national parks. The known number of dieback sites in the northern sandplains area has increased in recent years - spelling trouble for the insects, birds and mammals that thrive on wildflowers.

The honey possum is one mammal that relies on a cycle of flowers of different native species throughout the year. This animal depends entirely on a diet of nectar and pollen, and banksias are one of the main groups it frequents.

The Proteaceae family, which includes the *Banksia* genus, has been badly affected by dieback (*Banksia grandis*, *Banksia brownii*, *Banksia littoralis* and *Banksia coccinea* are a few examples). If an area has had these species wiped out by the disease, local extinctions of dependent wildlife, such as the honey possum, can occur.

Other animals that could lose their food source include nectar-feeding birds such as the red wattle bird, new holland honeyeater and the western spinebill. Birds that feed on insects may also suffer, as may the boobook owl and bats that feed on moths attracted to wildflower nectar.

Another example of wildflower-fauna dependencies is found in the northern sandplains. Carnaby's black cockatoo feeds on moth larvae that live on *Banksia tricuspis*. If dieback kills these banksias, the black cockatoo could be lost from this area.

CALM's dieback public awareness campaign, *Fight Dieback - Give Our Plants A Chance*, is designed to educate people how they can avoid spreading the disease.

FUR SEALS' ORDEAL

Just how do you catch and clean wild, wriggling, snarling, snapping, oil-coated seal pups on a slippery granite rock island in the middle of nowhere?

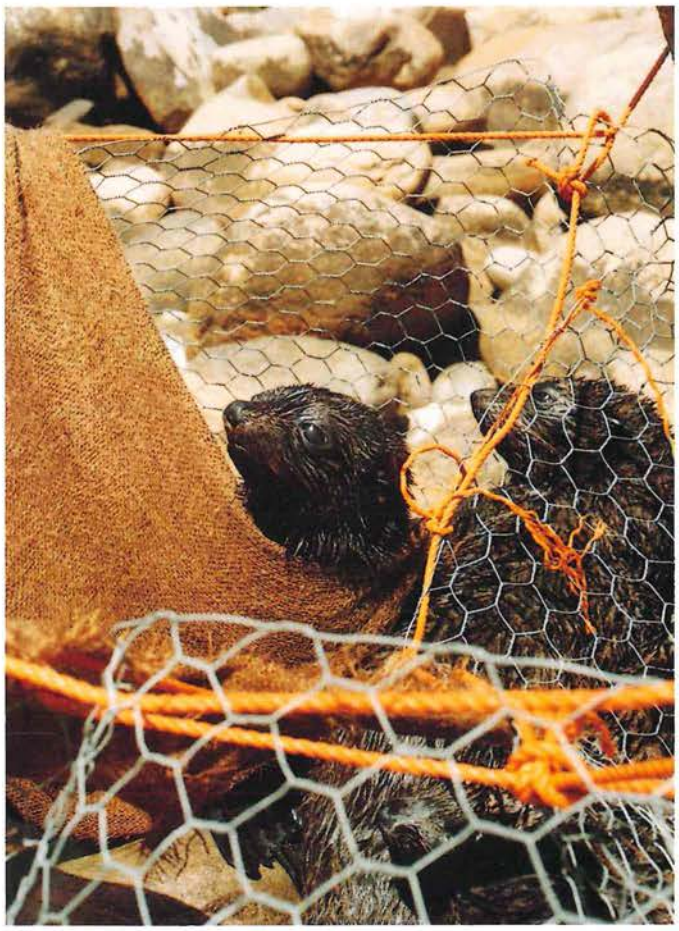
That was the dilemma facing Department of Conservation and Land Management (CALM) rescuers on two remote island nature reserves off Esperance earlier this year when a bulk carrier ran aground spilling tonnes of bunker oil into the ocean.

The New Zealand fur seal pups had been playing in tidal pools away from their mothers, who were in nearby waters fishing. The oil surged in, leaving them black and tarred.

CALM officers and volunteers had to crawl into tight rock crevices and be lowered into tidal pools upside-down (being wary to avoid incoming waves!) to catch the pups by the tail and behind the head (to avoid those teeth!) and to pen them before the clean-up.

Before their release, cleaned seal pups were treated and their eyes coated with protective ointment. Photo - Brenton Siggs

Tarred babies: pens were set up on both affected islands to contain the pups before they could be cleaned. Photo - Brenton Siggs



Teams of cleaners washed the seals, using brushes and biodegradable detergents (two washes), followed by a spray with Preen - a stain remover for clothes. The pups were rinsed and put back in the pen for treatment by a veterinarian before being released.

At the same time, their habitat had to be cleaned. Rescuers used high pressure hoses to wash the oil off the rocks and into the surging waves where it was naturally dispersed.

It took eight days from the time the oiled seal colonies were found to when the last equipment and people were airlifted off the islands by helicopter, leaving the seals undisturbed (for a week).

Most of those who had worked on the islands to clean seals received bites and had to make a trip to the local doctor for an anti-tetanus shot.

Research data collected from the two NZ fur seal pup colonies affected by the oil spill will contribute to a benchmark study and add to information previously collected on the species.

Several visits have been made to the two islands since the pups were released, although researchers have been careful not to disrupt the bonding process between mother and pup.

CALM's consultant veterinarian Nick Gales believes the subsequent documented growth rate and health of the surviving pups is an encouraging sign.

Of the 38 seal pups affected on Hood Island, Dr Gales has put mortality of the two-week to two-month-old pups at between four animals (10.5 per cent of initial pup population) and 12 animals (31 per cent of initial pup population).

Blood samples taken from the animals during the monitoring visits have been sent to scientists who worked on the Exxon Valdez oil spill in Alaska for special analysis on hydrocarbon levels.

Dr Gales is now preparing a detailed report and a scientific publication on the fur seals' ordeal.

WOOD FESTIVAL AT CURTIN

A festival to promote scientific and artistic dialogue on the subject of wood will be staged at Curtin University of Technology in Perth from September 20-28, 1991.

Organised by Curtin and CALM, the festival, to be called *Woodworks*, will include scientific and technical exhibitions and workshops plus a series of arts-related competitions, exhibitions and other events.

A major event during *Woodworks* will be a CALM-organised symposium, "Trees and Timber - Technologies for the 21st Century".

The purpose of the festival is to demonstrate that wood and trees play an important role in both the technical and artistic aspects of our lives.

The eminent Australian furniture designer Helmut Leuchkenhausen, playwright Tony Nichols and poet/novelist Thomas Shapcott are three of the major figures in the arts who will be participating in the festival.

A WILDFLOWER WEEKEND

Flora buffs will get a chance to discover the wealth of wildflowers at Manjimup's Perup forest, on a course offered by the University of Western Australia extension program.

Like the Wild Weekend at Perup, which focuses on the area's unique and endangered mammals (see *LANDSCOPE*, Summer 1990-91), people who do the course get the opportunity to participate in practical conservation.

Last year they went in search of a species of *Andersonia*, a type of heath, that had not been seen since 1966. The *Andersonia* was discovered by Tony Annels, who runs CALM's herbarium at Manjimup, on a quartzite ridge that supports many Wheatbelt species.

Course members relocated and photographed it - an opportunity that thrilled the wildflower enthusiasts.

"The place where the plant had been found had been quarantined because of dieback and we had to get special permission to enter it," said Greg Keighery, who took the course last year. "No-one had been on the tracks since the area was quarantined and there were large trees growing in the middle of the road."

Last year course partipants also removed five rubbish bags of fresias from the nature reserve. Fresias were introduced to the area when it was a farm and they choke out the native plants, especially the orchids.

"The course gives people an idea of the number of different plant communities in the forest and of how complex the forest is to manage," said Greg.

Perup forest is a particularly rich area for orchids, as it supports both wet country orchids and dry country orchids. Some areas have been recently burnt, which stimulates orchid flowering.

Participants are also taken spotlighting for the possums, woylies, chuditch and other nocturnal animals - many of them rare - which live in the forest.

Botanist Bronwyn Keighery will take this year's course. People who would like to attend the Wildflower Weekend (1-3 November) should telephone Jean Collins at the University of WA on 380 2433.

A rare Andersonia species, lost since the 1960s, was found during a wildflower weekend at Perup. Photo - Greg Keighery

OF PIXIE MOPS AND BEARDED HEATHS

Botanists have completed a detailed vegetation map and complete flora list for Scott National Park and discovered new populations of poorly known and presumed-rare plants on the Scott Plain with the help of a Federal endangered species program grant.

The Scott Plain is a complex of low-lying wetlands and ridges between Black Point and Augusta - an area increasingly pressured from tourism, new town developments, mining and farm clearing.

Botanists Chris Robinson and Greg Keighery were able to map and list more than 500 species for Scott National Park. Many new populations of poorly known or presumed-rare plants were located, including the Scott Plain myrtle, beard heath, wiry sedge, melaleuca and silvery pea. The Scott Plain twining wild violet, previously known only from one stand at Margaret River, now has four recorded populations in the park.

Numerous range extensions of locally endemic species were found. Some of the more spectacular of these were an undescribed species of trigger plant from near Busselton, and the twining *Ampera* from Black Point, their ranges both extending to Scott National Park.

Surveys were also undertaken and flora lists compiled for Chester, Moonah and Forest Grove forests. Accurate maps for the ranges of the Boranup wattle and Boranup *Bossiaea* have also been made.

Surveys of the ironstone heaths on the lower Swan and Scott Plains revealed a previously unknown species of ironstone pixie mop on the Swan Plain.

To their disappointment, Robinson and Keighery did not locate any substantial populations of the declared plants ironstone darwinia and round-leaved lambertia. Fortunately, consultant botanists have found stands on land owned by BHP. The company has agreed to protect these areas to preserve the endangered flora.

MOUNTAINS *of* MYSTERY

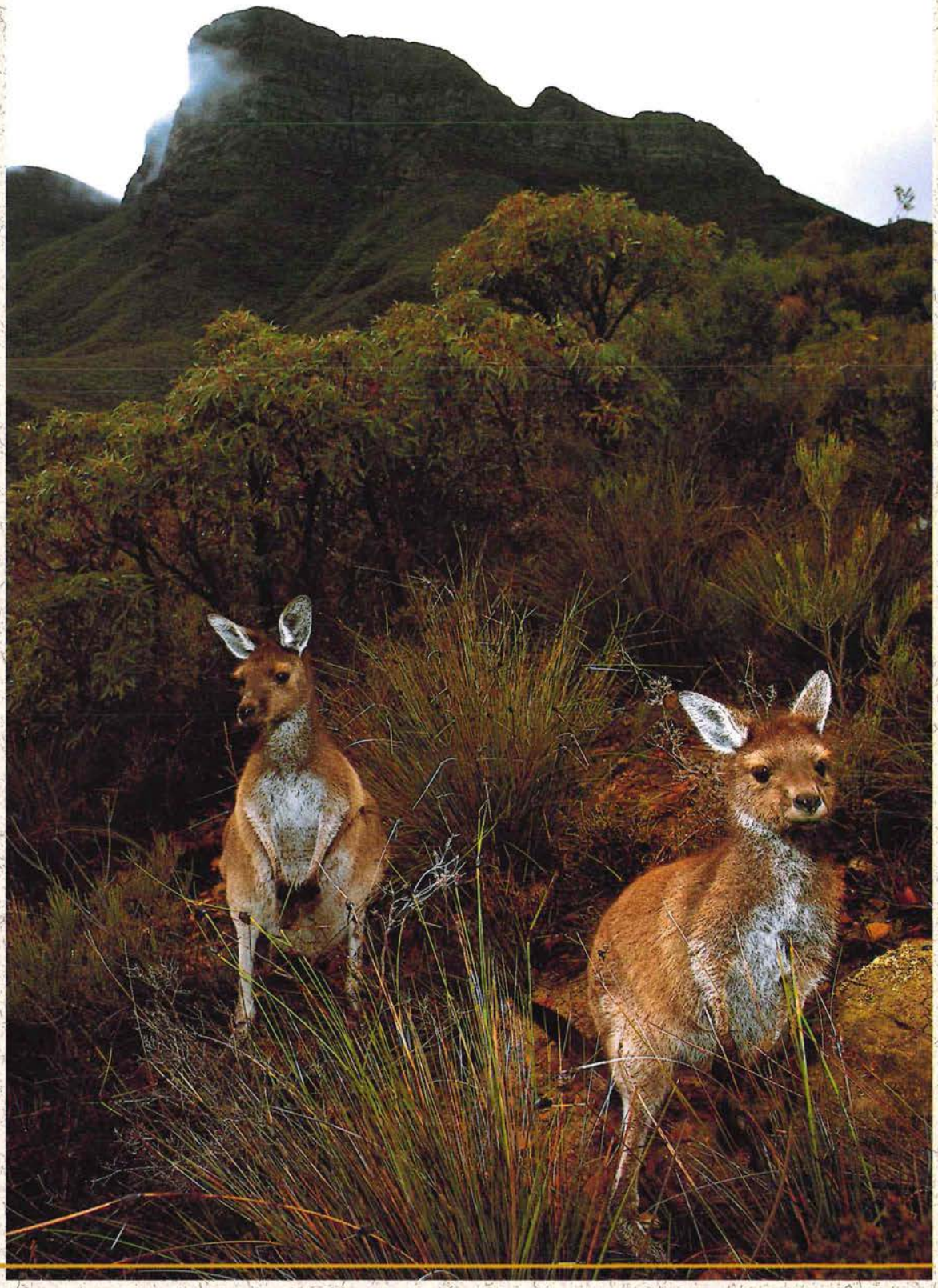
by

GORDON FRIEND

and

GRAHAM HALL

The unique flora of the Stirling Range has inspired botanists throughout the world, but what about the Range's mammals? Why have so many relatively common mammals disappeared from such a large and well-preserved reserve? Gordon Friend and Graham Hall shed some light on this enigma.



The rugged peaks, surrounding plains and brooding beauty of the Stirling Range has long captured people's imagination. The range was known as *Koi Kyeneuruff* by the Bibbulmun Aborigines who lived around King George Sound, and the various peaks like *Toodyeverrup* (Mt Toolbrunup) were significant landmarks in the otherwise subdued terrain and were the source of many Dreamtime legends.

The first known ship to visit the area of King George Sound was the Dutch *Guilden Seepaart* in 1627. In 1792 the French ships *Recherche* and *Espérance* visited the southern coastline, but the first recorded sighting of the Stirling Range was by English explorer Matthew Flinders, on 5 January 1802. Dr Alexander Collie, who explored the Woogenillup district in May 1831, was the first person to describe the Range. In January the following year Ensign Robert Dale led an expedition to the Range and was probably one of the first Europeans to set foot there.

PEAKS IN THE WILDERNESS

It was not until late 1835, however, that the range was named by Surveyor-General John Septimus Roe and the Governor of the Swan River Colony, Sir James Stirling, as they travelled from Perth to Albany. On 3 November, Roe glimpsed 'some remarkable and elevated peaks'. The following day they travelled closer to the Range and 'these remarkable and picturesque mountains being as yet unknown, and His Excellency having

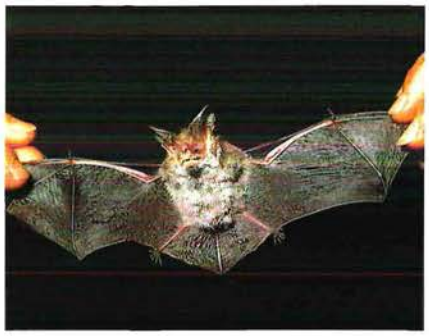
kindly consented to my conferring on them a name, I called them the Stirling Range'.

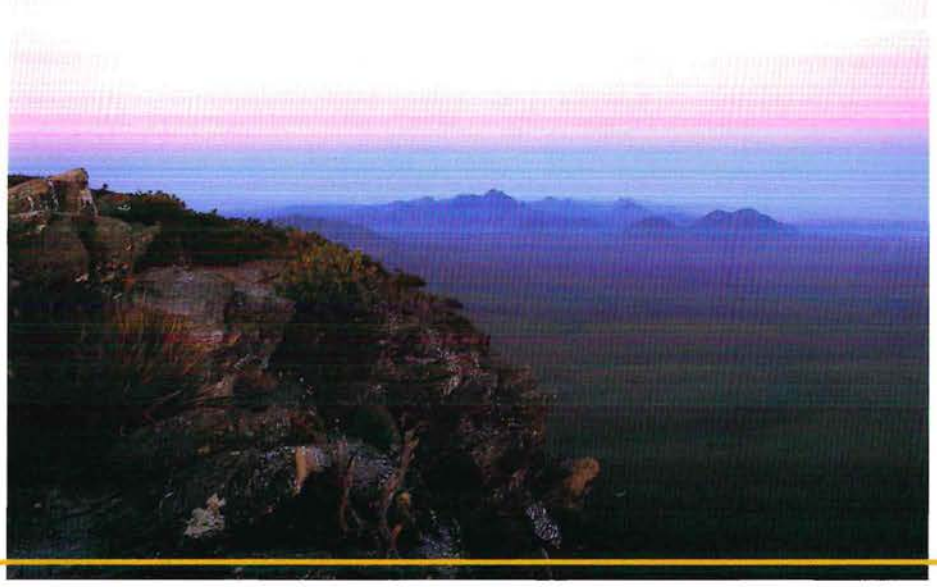
Roe was impressed with the area's wildlife and made numerous notes on the kangaroos, bandicoots, brush wallabies and birds that his horses and dogs flushed from the undergrowth.

A series of explorations followed Roe's trip. In 1839 the Government offered land grants to anyone who could discover coal in the vicinity of the south coast, and there were a number of hopeful claims. Any profitable venture in a colony so short of ready cash was enthusiastically received, and the Government in 1848 promoted the export of sandalwood from Fremantle and the tiny south coast port of Cape Riche. Soon cutters were hacking paths through rugged country to the east and north of the Stirling Range in search of the aromatic wood. With bulky loaded wagons making lengthy treks back to the coast the tracks soon became permanent arteries, along which the sheep and wheat farmers eagerly came to carve out their own fortunes. One of these early tracks has become the main road through the Ranges. The Chester Pass Road, named after the policeman and early settler George Chester, connects Albany with the agricultural country to the north.

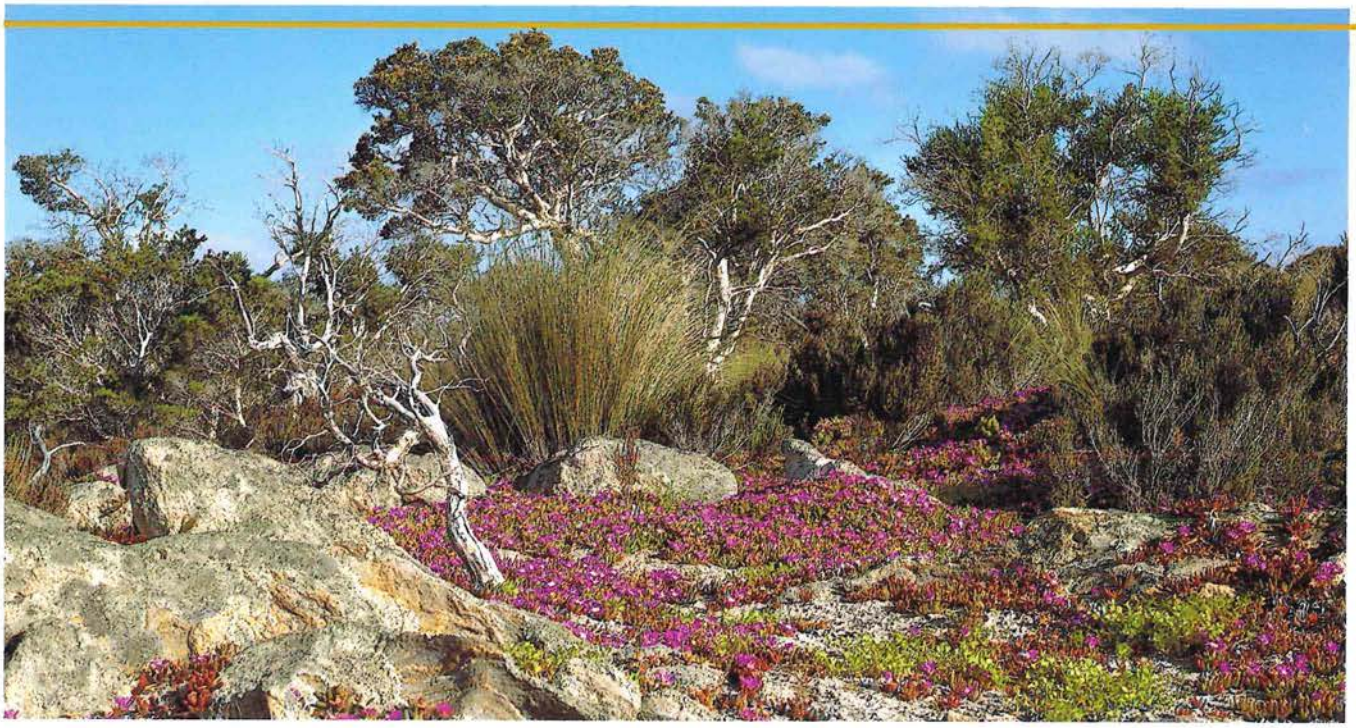
These early developments in the region were relatively small-scale and probably did not impinge greatly on the native plants and animals. It was 116 years after Dale's exploration that the major agricultural clearing began near the Range. The South Stirling Land Settlement Scheme, one of the largest land development programs ever

Previous page:
Western grey kangaroos below Bluff Knoll.
Photo - Robert Garvey





Stirling Range from Bluff Knoll; lesser long-eared bat; willy wagtail; honey possum.
Photos - Allan Rose



undertaken in Western Australia, commenced in 1948. In the next 10 years many thousands of hectares of the 'almost endless plain' described by the early explorers was cleared and developed for pasture by post-war soldier settlers. This was made possible by the introduction of essential trace element fertilisers which corrected deficiencies in the sandy soils.

Such widespread impact on the region's plants and animals did not directly affect the Range, because it was dedicated as a national park in June 1913. It was Western Australia's third national park. The 115 000-hectare park was declared because of its outstanding wildflowers, spectacular scenery and unique geology. The strange aura of the mountains, contrasting with the flat, rather monotonous surrounding plains, had long attracted bushwalkers and naturalists and led to their being described as 'mountains of mystery' in an article in the *Albany Despatch* in 1927.

Long before this, some of the botanical mysteries of the Range had been revealed. Botanist James Drummond visited the area in 1843, 1846 and again in 1848 and was amazed at the richness and unique character of the flora. He collected many species which proved to be endemic to the Stirling Range, and fired the enthusiasm of botanists throughout the world. This interest persists to this day, and the park is understandably best known for its remarkable plant diversity, displayed at full bloom in spring, when visitors flock to the area.

Granite outcrop with flowering pigface and saltwater paperbark.
Photo - Jiri Lochman ▲▲

Brushtail possums are restricted to small pockets of taller forest along watercourses.
Photo - Jiri Lochman ◄

The spotted-thighed frog has well-developed webbing for climbing trees.
Photo - Allan Rose ▲

An echidna - one of the few ever seen in the park - photographed on the Red Gum Pass Road in 1979.
Photo - Babs & Bert Wells ►

NO MORE MAMMALS

By comparison, the fauna of the Range has received scant attention in recent times, perhaps because of the massive decline of the mammals since the turn of the century. Well-known zoologist John Tunney lived on his property, Gracefield, near Cranbrook in the early 1900s and made extensive collections of mammals and birds in the area. He led a scientific expedition through the Stirling Range in May 1900, but unfortunately most of his mammal specimens are simply labelled as from 'near Cranbrook' and provide no precise data on the composition of the mammal fauna of the park. Prior to Tunney's work, George Masters had collected animals in the south coast region in the late 1860s and recorded an impressive array of species, but, again, specific information for the Stirling Range was not available. Later visits to the actual Range by A W Milligan in 1902 and F L Whitlock in 1911 mainly dealt with the birds, and only general notes were made of the mammals.

The mammal fauna of the Range at

the time of these early collections probably comprised about 27 species (excluding bats) and included species like the numbat, the western barred bandicoot, the dalgyte (or bilby), the boodie (also known as the burrowing bettong) and the crescent nailtail wallaby, which have all long since disappeared from the region.

The boodie is a good example of a once-common mammal that has disappeared from the Stirling Range. Before European settlement, the boodie was one of the most widespread animals in Australia. These gregarious creatures were so common that early explorers and surveyors had to shoo them away from their tents. However, the boodie has now completely disappeared from the Australian mainland and is found on only four islands off the WA coast: Bernier and Dorre Islands in Shark Bay and Barrow and Boodie Islands near Dampier.

More puzzling than the disappearance of these mammals is the apparent rarity throughout the Stirling Range of species which are ubiquitous throughout much of the South West of Western Australia. The only systematic mammal survey of the park since Tunney's day was carried out by the former National Parks Authority in 1984 and recorded only 10 of the 27 species of mammals known from the region in 1900. The survey failed to record relatively common species such as echidna, yellow-footed antechinus (mardo), southern brown bandicoot (quenda) and brushtail possum.

The Stirling wilderness rises abruptly from the surrounding farmland.
Photo - Allan Rose ▼

The tawny frogmouth - one of the common nightbirds of the Stirling Range.
Photo - Allan Rose ▼▼

The echidna does not appear in the WA Museum listing for the park, and has thus never been officially recorded in the area. The 1984 survey report, however, refers to a record from 1905, and also mentions that an individual was captured and photographed by wildlife photographer Bert Wells on the Red Gum Pass Road in 1979. The rarity of the echidna in the Stirling Range is an enigma since the animal is readily observed, or detected by its characteristic droppings, and is quite abundant throughout the agricultural country to the north, though less common in the wetter forested areas of the South West.

The brushtail possum, by contrast, 'could be found anywhere in the white-gum belt' according to Milligan in 1902, and Tunney collected many around the Cranbrook area during the early 1900s. Although the species may have declined significantly during the intervening period, recent observations by the authors and by zoologist Barbara Jones suggest that moderate numbers still exist in the taller woodland areas in the damper valleys throughout the park (e.g. Kojoneerup Springs). Again, however, it is strange that such a common and widespread species as the brushtail possum seems to be relatively rare in the Stirling Range. Perhaps this reflects both a lack of survey work and the remote and inaccessible nature of much of the park. Likewise, the mardo and quenda appear to be restricted to the wetter habitats in the gullies and on the peaks, and their detection requires much effort and some degree of luck according to Allan Rose, the Assistant National Park Ranger for the Stirling Range.

Even these 'common' species are no longer common in the park. The exceptions are the western grey kangaroo, the western brush wallaby and the honey possum.

SEARCHING FOR REASONS

So why have these animals declined in such a large wilderness, which has been subjected to less disturbance than smaller areas where the same animals still exist? Tutanning Nature Reserve, for example, which is 200 kilometres north of the Stirling Range and only

2 000 hectares in size, still supports good populations of woylies, tammars and red-tailed phascogales. All of these species were known from around the Stirling Range in the early 1900s.

A number of theories have been put forward to explain the disappearance of most medium-sized mammal species from various habitats in Western Australia. These include competition with introduced herbivores, habitat clearing, changed fire regimes and the effects of exotic predators like the fox and cat (see *LANDSCOPE*, Spring 1990). In the Stirling Range the last two factors help explain the demise of these mammals. Before European settlement, fire was probably quite frequent in the Range, particularly in the drier summer and autumn months, but since this time there has been a marked change in the frequency and intensity of fire and the seasons in which they have occurred. At the same time foxes and cats have become more common in the Range.

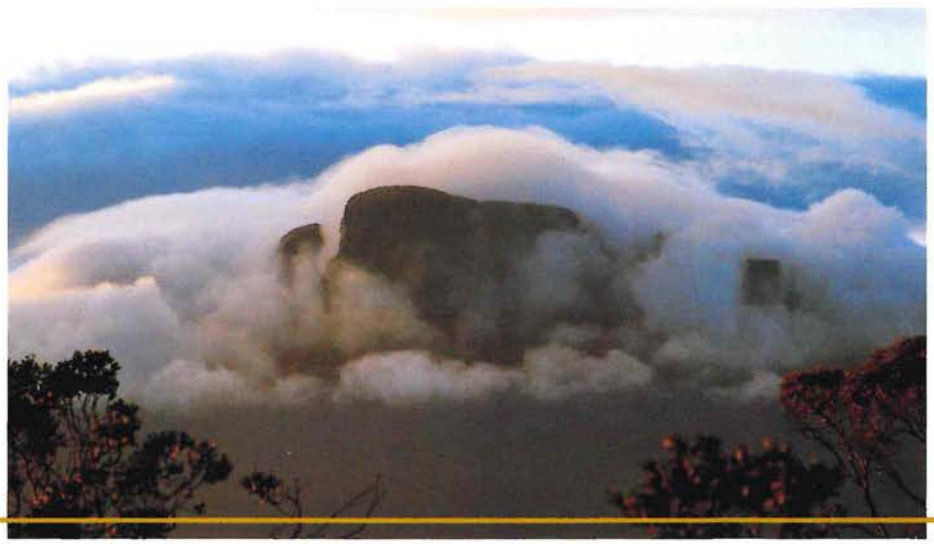
Another important factor, however, is that this region represented the southern limit of the distribution of many of the arid-adapted mammals that have now declined, and is near the northern and eastern boundaries of distribution for species adapted to wetter conditions, such as the mardo. Factors like exotic predators and altered fire regimes have compounded on this marginal habitat in the Range, and led to the disappearance of the species whose optimal habitats were the drier areas like Tutanning Nature Reserve. Species preferring wetter habitats with tall forest also declined in the drier mallee-heath vegetation types of the Range. The size of the respective reserves and the extent of habitat alteration around them have probably contributed less to mammal extinctions than has their geographic position in relation to the former distributions of these species.

However, another factor with increasing impact is dieback disease, which, by affecting plant composition and food resources (such as nectar for honey possums), has the potential to further reduce mammal populations and species-richness in the park.

It is certainly not too late to remedy the lack of attention the Stirling Range National Park mammals and other fauna have received to date, and delve into this puzzle with some systematic and detailed surveys. The impact of fire on the small vertebrate fauna is currently being studied by the authors and other CALM scientists. However, this work is being conducted in a small area on the southern plains of the park, and with pit traps that only attract small mammals. So far, the dunnart, the ash-grey mouse, and the pigmy and honey possums are the only mammals to be collected. The medium-sized mammals such as bandicoots, bettongs and brushtail possums are not being trapped in the fire ecology study, yet these are the species that have declined. Despite its limited nature, this project is the first systematic, long-term scientific research on fauna that has ever been done in the park.

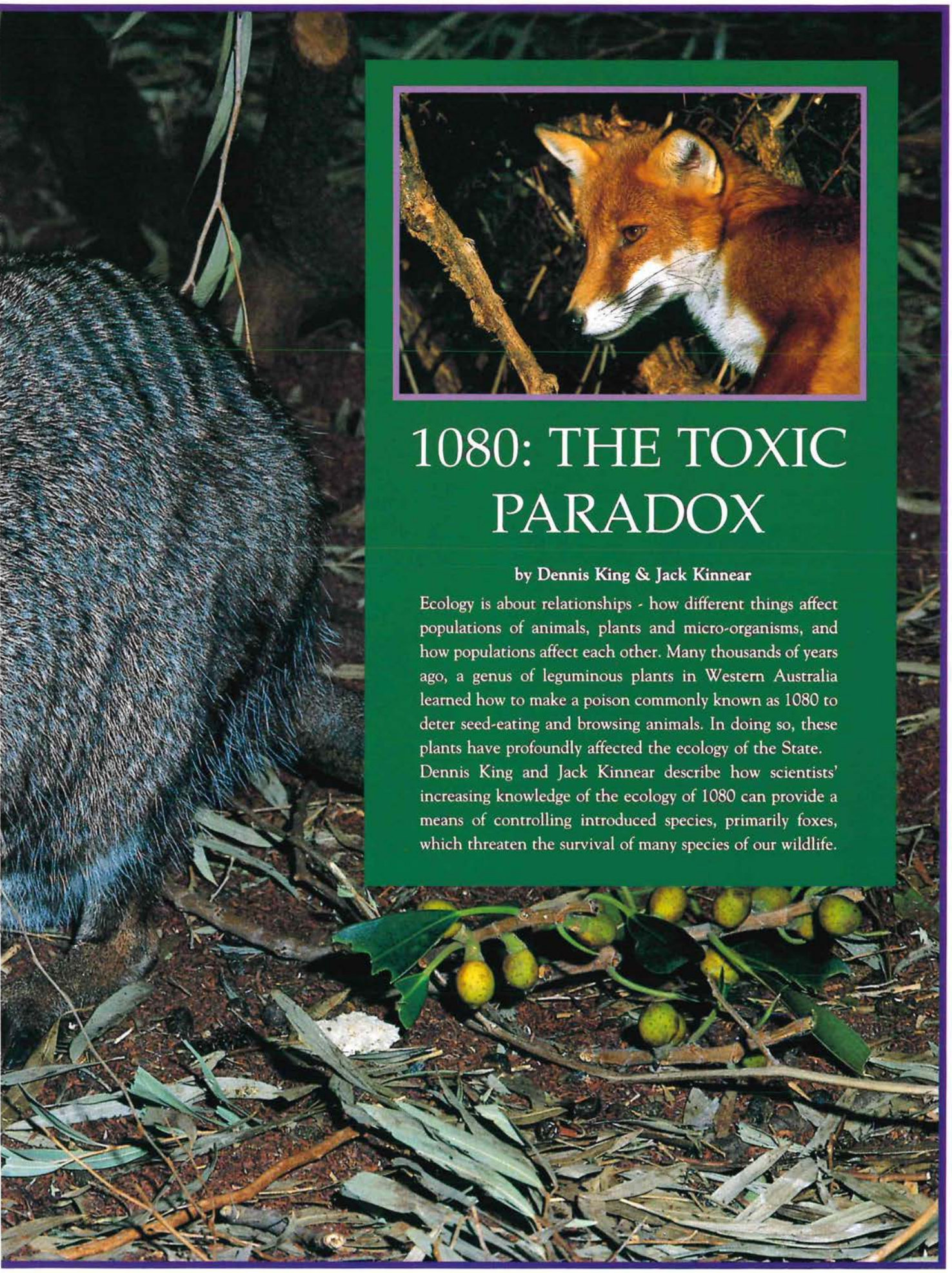
Who knows what animals the damp, cloudy gullies of Bluff Knoll or the lofty summit of Toolbrunup might harbour? We may yet discover whether or not the Stirlings are truly 'mountains of mystery'.

The mardo is a relatively common species that is restricted to wet areas in the Stirling Range.
Photo - Michael Morcombe ▶



The range's abrupt rise and closeness to the Southern Ocean can cause some unusual cloud phenomena.
Photo - Allan Rose ▶

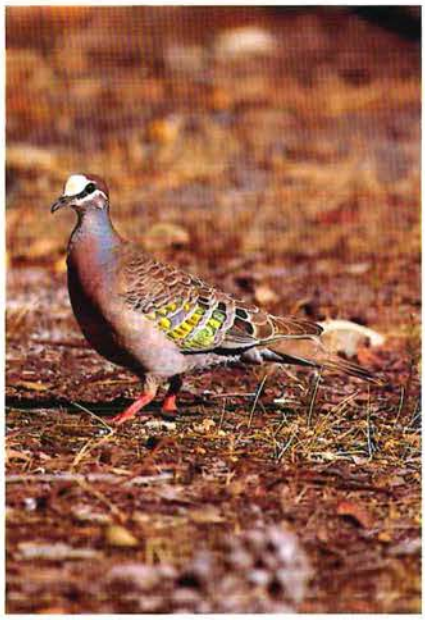
CALM Senior Research Scientist Gordon Friend and consultant ecologist Graham Hall are studying the effects of fires on small animals in the Stirling Range. Both are based at CALM's Wildlife Research Centre on (09) 405 5100.



1080: THE TOXIC PARADOX

by Dennis King & Jack Kinnear

Ecology is about relationships - how different things affect populations of animals, plants and micro-organisms, and how populations affect each other. Many thousands of years ago, a genus of leguminous plants in Western Australia learned how to make a poison commonly known as 1080 to deter seed-eating and browsing animals. In doing so, these plants have profoundly affected the ecology of the State. Dennis King and Jack Kinnear describe how scientists' increasing knowledge of the ecology of 1080 can provide a means of controlling introduced species, primarily foxes, which threaten the survival of many species of our wildlife.



Kite-leaf poison *(Gastrolobium laytonii)*, one of the 40 species of south-west Australian peas known to be toxic.
Photo - S.D. Hopper ▲

The common bronzewing *(Phaps chalcoptera)* safely eats the seeds of 1080-producing plants. This misled the early colonists.
Photo - Babs & Bert Wells ▲◀

Previous page: The banded hare-wallaby *(Lagostrophus fasciatus)* is now found only on islands with no 1080-producing plants, but still has exceptional 1080-tolerance.
Photo - Jiri Lochman

The introduced fox *(Vulpes vulpes)* is extraordinarily susceptible to 1080.
Photo - R. Knox

Early descriptions of life in the Swan River Colony invariably convey the feeling that life was definitely not meant to be easy. The environment was harsh, the soil infertile, and the plants and animals strange and alien. To make matters worse, the bush was hostile and life-threatening; when the settlers moved their flocks and herds inland from the coastal plain, many of their precious animals sickened and died.

Nobody knew why. Disease was first suspected, but after 10 years of sometimes acrimonious dispute, it was finally realized that the stock were dying as a result of eating poisonous pea-flowered legumes, now known to belong to the genus *Gastrolobium*.

To some extent recognition of the cause was delayed because the colonists' view of nature was coloured by their European origins. In their minds it was inconceivable that a legume could be poisonous. Their European experience also taught them that poisonous plants tasted bad; these plants did not. Moreover, they knew that legumes are particularly nutritious, which is why the shepherds actively sought them out. They had even observed that some native animals, such as bronze-winged pigeons, could eat the seeds with impunity - although it was noted (without arousing suspicions) that dogs which ate the pigeons died.

Nobody could explain why native pigeons could eat the seeds of poison plants and survive. Indeed, it is only because of recent research carried out by scientists at the Agriculture Protection Board and Murdoch University that we understand the reasons, though not everything is yet fully understood. One aspect is clear, nonetheless: when the *Gastrolobium* genus evolved the ability to make the poison we call 1080, it made the southern part of WA a very poisonous place in which to live.

In effect, these species declared war on animals that sought to eat their leaves and seeds. As part of their defensive armoury they made a toxic chemical which must at first have killed native animals just as it did the colonists' livestock. Gradually, though, the fauna fought back and learned to live with this deadly toxin by evolving tolerance to the poison. By the time the Europeans arrived, this chemical warfare had reached a stalemate, with the fauna widely resistant to the toxin. For the colonists and their menagerie, however, it was back to square one. Their animals lacked any previous exposure to 1080 and were utterly defenceless against it.

It took the settlers some time to identify the source of the poison (see Steve Hopper's 'Poison Plants: Deadly Protectors' in this issue of *LANDSCOPE*). Once they had done so, they found ways to minimise stock losses. However, the actual poison itself remained unknown until 1964, when it was found to be a deceptively simple substance known as monofluoroacetate. Chemically it is very similar to vinegar; indeed, a clever chemist could probably make it from fluoride toothpaste and vinegar. It is toxic because the body is fooled into acting as if it were vinegar (acetate), which is burned for energy by all animals. However, the cells in an animal's body cannot use 1080 at all, and 1080 in very small amounts prevents the cells from burning ordinary foodstuffs for energy, with fatal consequences.

PEST CONTROL

In Australia, a commercially available but identical form of sodium monofluoroacetate, commonly known as 1080™, is used for the control of rabbits, dingoes, foxes and some other pest species. In WA, the Department of Conservation and Land Management (CALM) uses 1080 to control foxes, and for good reason. If we do not control the fox, much of the surviving mammal fauna on the mainland simply does not have a future.

It is readily apparent from monitoring wildlife populations that rare and endangered fauna become more abundant as a result. Most people readily appreciate this point, but frequently express concern

about the threat baiting poses to native animals in general. After all, goes their reasoning, how is it possible to use 1080 baits for fox control without poisoning everything in sight?

One answer lies in the different levels of poison in the 40 or more species of *Gastrolobium* in WA which contain fluoroacetate. The poison levels vary from very high to relatively low, and are highest when plants are most nutritious; that is, when they are actively growing and flowering. They are found on loamy, alluvial, granitic or lateritic soils, but not on deep sandy or limestone soils such as are commonly found on the coastal plain. They are very abundant in the jarrah and wandoo forest watersheds which supply Perth. One species also occurs in the Northern Territory and Queensland, but no poisonous species occur in south-eastern Australia.

While most of the 1080-producing plants are located in the South West, we still find that many animal species living elsewhere are tolerant of 1080. This may be because these plants had a much wider distribution in the past, or because of gene flow due to migration of animals. Whatever the reason, the point is that some of the fauna still retains a 1080 tolerance in its genes even though it no longer needs it. Thus, 1080 tolerance is not restricted to animals living in the South West.

TOLERANCE IS THE KEY

During the past 15 years, research on the tolerance of native fauna in WA has been conducted by the Agriculture Protection Board (APB) in collaboration with Dr Bob Mead, Dr Laurie Twigg (now with the APB) and Dr Mike Calver at Murdoch University. These studies, which have resulted in the production of more than 40 scientific papers, have provided the information necessary for CALM and the APB to control predators of wildlife and domestic stock without risk to the native fauna.

A great deal of research has been directed towards measuring the 1080 tolerance of native and pest species. The APB has perfected methods for testing species that do not harm the test animals. Using small blood samples it is now possible to determine a species' tolerance by measuring citrate, a natural substance in the blood which increases after 1080 is eaten. The greater the citrate content, the lesser the animal's tolerance of 1080.

These studies have found that some of our species are remarkably tolerant. Brush-tailed possums, the woylie and the banded hare-wallaby (the latter from islands in Shark Bay where there are no 1080 plants) are exceptionally so. Woylies presumably eat seeds containing 1080; because, like squirrels, they bury the seeds of 1080 plant species. Birds are generally more tolerant than mammals; the emu's tolerance is outstanding. The common bronzewing (which misled the early colonists) is highly tolerant. Many parrots are quite resistant to 1080 and, rather surprisingly, so are the common black duck and the wood duck.

Tolerance to 1080 is highest in animals that eat 1080 plants and their seeds. But even the carnivorous species at the top of the food chain have acquired resistance. The wedge-tailed eagle is quite tolerant, as is the little crow. Any animal that preys or scavenges on a herbivorous species that eats 1080 plants cannot afford to be susceptible to 1080; otherwise, it may be poisoned by 1080 residues in the bodies of its victims. This is an example of what is known as secondary poisoning, an ecological demonstration of how 1080 affects the higher levels of the food chain.

Reptiles are naturally resistant to

The emu *(Dromaius novaehollandiae)* eats seeds and fruits; it is exceptionally tolerant of 1080.
Photo - Babs & Bert Wells ▲▶

The northern quoll *(Dasyurus hallucatus)* - once thought to have been at risk from dingo baiting.
Photo - Jiri Lochman ▶

1080 because they expend relatively little energy. The most tolerant species known is the common bobtail lizard from the South West; these lizards are virtually 1080-proof.

Imported species are generally very susceptible to 1080, members of the dog family especially so. Nobody understands why dogs and foxes are so susceptible, but it makes the task of designing baits for foxes a lot easier.

SELECTIVE BAITING

Apart from determining tolerance to 1080, the APB has carried out many trials with native species to test the palatability and attractiveness of different bait materials. Captive animals are offered non-toxic bait materials, and the amounts eaten (if any) are carefully recorded. To be doubly certain, test animals are deprived of food for a period of time to simulate natural food shortages, and then the tests are repeated on hungry animals.

Armed with this knowledge and the tolerance of a particular species, it becomes possible to assess the risk of baiting to wildlife and to design baits accordingly. If there is any doubt about the safety of baiting, field trials are carried out.

Such a trial - involving the northern quoll, which was thought to be at risk - was carried out by the APB. The trial to determine their actual risk was conducted on the Fortescue River. Radio transmitters were attached to 10 quolls and their movements were followed for two weeks. A normal aerial baiting for dingoes was then done over the area they occupied. The movements of the quolls were tracked for a further two weeks. All quolls survived, a clear indication that they are not at risk from these baiting programs.

Selecting a material for use as a bait has been extensively researched. The first requirement is that foxes are attracted to the bait and that they readily eat it. The next is that the bait is safe for wildlife. These studies have revealed that meat baits meet these requirements.

Dried meat baits are very safe for wildlife. After drying, the meat becomes tough and stringy - too tough for the smaller native carnivores to chew. Also, the baits can be made fairly large. Thus, even if a small carnivorous animal were capable of eating a large meat bait, to be at risk it would have to eat more than its own body weight at one sitting.

Finally, meat is safe because many of our rare and endangered mammals eat only plants or insects.

TESTING THE BAITS

Actual field trials have proven that meat baits are very effective. A study carried out by CALM scientist Dr David Algar revealed that six meat baits per square kilometre reduced the fox population by 90 per cent. Within six standard baits, the total amount of 1080 is infinitesimal. When a large nature reserve or national park is aerially baited for foxes, CALM will be distributing an amount of 1080 weighing less than one tenth of an aspirin tablet per square kilometre.

During this study Dr Algar, with the help of the APB, unintentionally produced some convincing ecological evidence about the potency and mobility of 1080 in the food chain. He had radio-collared foxes living on Watheroo National Park and was engaged in tracking them. Then things started to go wrong; the activity of some foxes ceased and some signals went off air. An investigation revealed that many foxes had died, and the causes were traced to the activities of an APB officer carrying out his duties on an adjoining farming property.

What had happened was this: the owner had requested the APB to poison rabbits, and this was done using 1080-treated oats. The rabbits ate the oats and

The brushtail possum *(Trichosurus vulpecula)*. This leaf-eater is exceptionally tolerant of 1080.
Photo - Jiri Lochman ◄

The habitat of the western brush wallaby *(Macropus irma)* is home to many 1080-producing plants.
Photo - Babs & Bert Wells ▲►

1080 warning sign - a more common sight as CALM works to conserve endangered wildlife by selective baiting.
Photo - Stephen Kelly ▲►►

died: the foxes ate the poisoned rabbits and they died too - much to the chagrin of the fox researchers.

Despite this outcome, some valuable knowledge was gained. This unplanned experiment provided the first real evidence of secondary poisoning, a process which had been the subject of much speculation. During the 1950s and 1960s, some nature reserves supported thriving populations of native marsupials, but they crashed when the 1080 rabbit-poisoning programs were curtailed. Dr Per Christensen was the first to note this association by showing that there was a link between the amount of 1080 used by the APB and the abundance of native mammals - in other words, the more 1080 is used over a wide enough area, the better for fauna conservation.

All this confirms that very little 1080 is required to kill foxes and, futhermore, there is absolutely no danger that 1080 will accumulate in the environment. Research done for CALM by Dr Dee Wong at Curtin University has shown that 1080 is rapidly degraded by soil bacteria and fungi. These microbes are widespread, and there is thus no possibility that 1080 will persist where CALM needs to bait. Indeed, if 1080 were not degraded in soil and water, Perth's water supply could well be poisonous because of the large amounts of 1080 naturally made by the vegetation in the catchment areas.

Laboratory studies suggest that under some conditions doses of 1080 which do not kill animals may have a temporary effect on their reproductive performance. Scientific opinion is that this is most unlikely. There is no indication that it happens under natural conditions, but further studies are about to be done in response to concerns.

TOWARD A GREATER UNDERSTANDING

A little-perceived benefit of fox-control with 1080 relates to wildlife research. In order to understand the factors which affect our threatened fauna, we must first control the fox; otherwise we learn very little. For example, we need to understand how bush fires affect our fauna; we need to understand what their habitat needs are, and so on. This cannot be done while the fox continues to have an impact. In other words, the activities of the fox distort and confound our understanding of the ecological requirements of our fauna.

Armed with a natural remedy for predator control, CALM has been able to re-introduce endangered species to areas where they formerly existed. This counters the trend caused in part by foxes. It is good conservation, for spreading the species spreads the risks. The more populations of threatened species we can maintain, the less threatened they should become; it is a form of anti-extinction insurance.

But how long must we bait with 1080? CALM views fox control by baiting as a holding action that is essential for fauna conservation. It is part of a long-term conservation strategy to ensure the survival of many species until a method of biological control is developed. Research on this fascinating subject is under way.

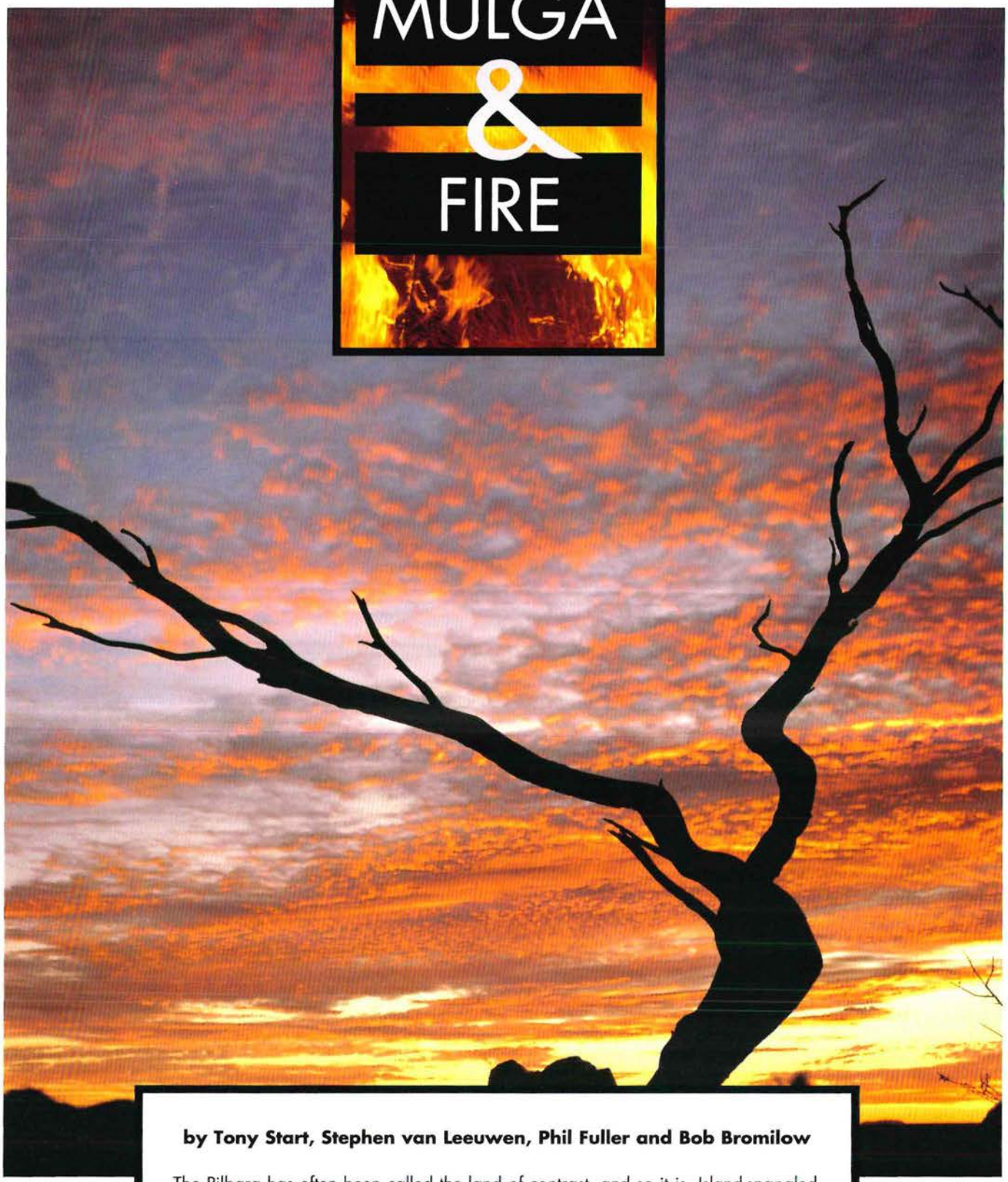
Dennis King is from the Forrestfield Laboratory, Agriculture Protection Board.
Jack Kinnear is from the CALM Wildlife Research Centre, Woodvale.

PREDATORS: NATURE'S REMEDY

Nature devises innumerable ways to combat predators. One of the most common defensive strategies is to make toxic or offensive substances which kill or deter predators. When a WA group of pea-flower plants were heavily depredated by seed-eating and browsing animals, they responded by making a colourless, tasteless (at least to humans) substance known as 1080 which killed their predators or made them sick. The consequences of this particular example were extraordinary and widespread. Food webs were disrupted, links in the chain were severed and old relationships were broken. With time, tolerance evolved in native fauna. Out of this initial chaos, there emerged a 1080-tolerant wildlife community inhabiting much of the western regions of Australia.

This was the situation when the continent was invaded by Europeans and their 1080-intolerant fauna. The balanced ecological structure was upset. When some members of the European fauna, such as rabbits, ran wild, we responded, unknowingly at first, in a similar manner to nature by using a commercially available form of 1080. As research into the use of 1080 evolved, Agriculture Protection Board scientists made the major discovery that our wildlife communities were 1080-tolerant. In a nutshell, this explains why we can use 1080 so effectively, and so selectively, to control introduced species with minimal risk to the species we seek to protect.

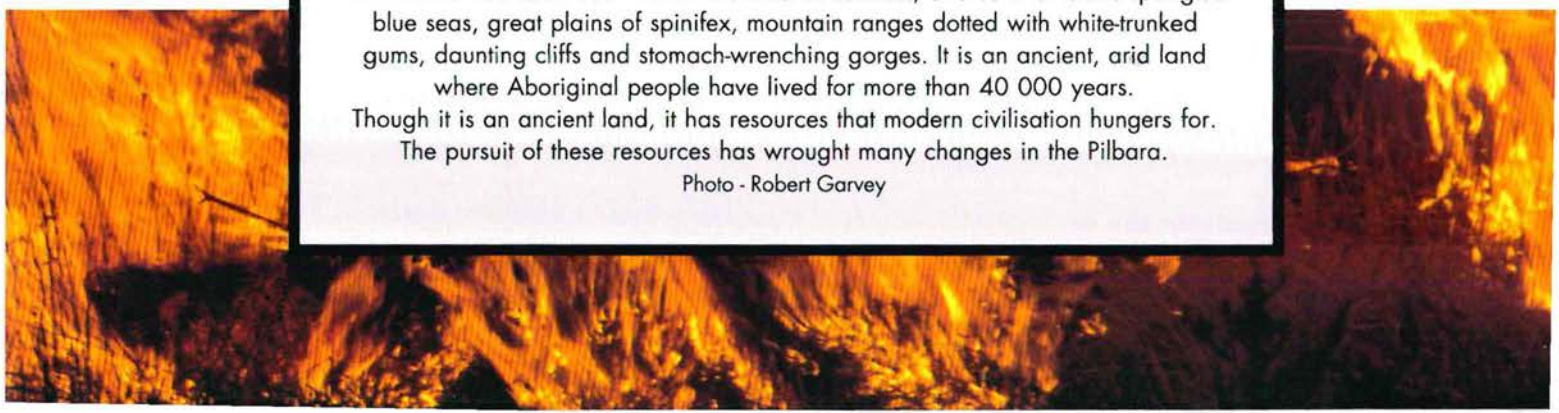
MULGA & FIRE



by Tony Start, Stephen van Leeuwen, Phil Fuller and Bob Bromilow

The Pilbara has often been called the land of contrast, and so it is. Island-spangled blue seas, great plains of spinifex, mountain ranges dotted with white-trunked gums, daunting cliffs and stomach-wrenching gorges. It is an ancient, arid land where Aboriginal people have lived for more than 40 000 years.
Though it is an ancient land, it has resources that modern civilisation hungers for. The pursuit of these resources has wrought many changes in the Pilbara.

Photo - Robert Garvey



We extract salt from the sea and exploit deposits of gas, iron and other minerals. We create air-conditioned towns with green lawns, and plant trees where none grew before. For a hundred years or more, pioneering pastoralists have grazed sheep and then cattle on the once seemingly endless pastures.

But to those who look past the transient monuments of modern humans, and see through the mask of an apparently immutable landscape moulded by nature over countless ages, there are other contrasts and other changes. Woodlands of mulga trees live juxtaposed with grasslands dominated by spinifex, that hummock-shaped perennial grass renowned for being so prickly.

The woodlands are shady, often with an understorey of shrubs that vary with the site on which they grow. There are blue- or red-flowered eremophilas, yellow-flowered cassias and, after rain, a bewildering array of brightly coloured annuals. Where cyclonic storms inundate low-lying flats the understorey changes to metre-deep swards of kangaroo grass. After rain the kangaroo grass sends up tufts of green leaves and copper-coloured flowering spikes. Later it produces seeds with silky barbs that work their way through the best of socks to torment tender ankles.

There are, of course, many animals that relish these woodlands. They include arboreal geckos that emerge at night to prey on unwary insects, and dragon lizards that wait at the entrances of mulga ants' nests, gobbling up the artisans as they emerge, then retreating to the safety of the mulga tree's lower branches to sleep off full stomachs.

Mulga ants and specialised lizards are not the only animals that depend on mulga woodlands. There are many others such as thornbills, warblers, and those gems, the unobtrusive, pastel-coloured Bourke's parrots that feed on the seeds they find on the ground under mulga trees. Mulga trees provide safety for the parrots when they are threatened and nesting holes when the breeding urge takes hold.

Metres away from a clump of mulga the ground is hot and stony. Spinifex strives to cover it but seldom manages to occupy more than half of the space available. Despite this it provides for the needs of an impressive assortment of animals that have adapted to this seemingly inhospitable habitat. Amongst their specialisations is the ability to recover from frequent fires, for spinifex is a fire-friendly fuel. It is well aerated and rich in flammable oils.

Lightning, carelessly thrown matches, or, before the advent of European man, Aborigines' fire sticks, frequently set the spinifex alight. A breeze is all that is needed to spread the fire from hummock to hummock. Fanned by a good wind the fires can cover many square kilometres and burn for weeks. Spinifex grasslands have evolved with fire. All the animals and plants that inhabit them have mechanisms that ensure survival or the capacity to recolonise the burnt areas, provided, of course, the fires are not too frequent and extensive.

In contrast, fire often kills mulga trees, letting the sun's heat onto the ground. Animals and plants dependent on the shade and protection of the trees perish. A few that can tolerate the harsher conditions persist, and some, including the fire-prone spinifex, flourish. With time, the woodland should regenerate and be recolonised.

In the Pilbara, Aborigines probably secured the mulga woodlands, making firebreaks around them by cleverly patch-burning in the grasslands. But Aboriginal people have migrated to townships, abandoning thousands of years of traditional practice.

The result is change. Fires now burn into the mulga from the spinifex. Some of the once-safe woodlands are retreating, their place apparently being taken by spinifex grasslands.

Many geckos live in mulga trees, emerging at night to hunt insects. This one is *Diptodactylus strophorus*.
Photo - Jiri Lochman ▼

White cassia. Cassias are common elements of mulga woodlands and spinifex grasslands.
Photo - Jiri Lochman ▼▼

SOME MORE FLAMMABLE THAN OTHERS

However, the picture is not that simple. The understorey in a mulga woodland varies with the site on which it grows. For example, in some parts of Hamersley Range National Park there are well-watered creek banks and flats that are liable to flooding after heavy rains; such places often have deep, fine-textured soils with a high clay content and carry a dense, waist-high sward of kangaroo grass. At the other end of the catchments, high on rocky ridges where soil is confined to crevices in the cracked and crumpled ironstone, the understorey is mostly limited to a sparse and select suite of hardy, woody shrubs.

Where creeks draining the high country spill out onto the flats, and sometimes in the broad valleys of the larger rivers like the Fortescue, mulga grows in bands stretched across the barely perceptible flow line. Each band or 'grove' acts as a contour bank trapping moisture and nutrients and supporting a diverse understorey of shrubs, herbs, grasses and ferns. In stark contrast, the 'intergroves' are devoid of vegetation except when carpets of tiny ephemerals flourish briefly after heavy rains.

Gentle slopes above the flats are made up of materials eroded from the ridges. Their freely draining soils are often characterised by the presence of many stones, especially on the surface. They seem to have supported the most diverse understorey of shrubs and grasses including, significantly, some spinifex. Variation in the flora on these slopes reflects subtle variations in their topography.

Apart from arboreal species such as birds and some reptiles, most species of plants and animals found in the mulga woodlands live in the understoreys. Here, as we have seen, there is great variety in structure and composition; indeed many of the communities that have been lumped together as 'mulga woodlands' have little in common besides mulga trees and some animals that live in those trees. However, we still know very little about the characteristics of the different communities and we don't know to which communities many of the species belong that 'live in mulga'.

As one might expect with such variation in the understorey, the capacity for different communities to carry fire is also variable. This is reflected in the differing degrees of vulnerability amongst the woodland communities to long-term damage or even elimination by fire. The most vulnerable communities are those with an understorey that readily carries fire and regenerates fast enough to burn again before the woodland structure redevelops. If the interval between successive fires is too short for mulga seedlings to mature and produce their own crop of seed, then the mulga itself can be wiped out.

Where the mulga grows in groves, there is often evidence of occasional fires: fire scars, charred stumps and, very occasionally, even-aged groves of regenerating trees. However, the bare intergroves seem to confine most fires to one or two groves and the frequency is so low that the burnt groves regenerate. This community seems to be fire-safe, although it is vulnerable to other

Grey honeyeaters, unobtrusive birds of mulga woodland.
Photo - Babs & Bert Wells ▸

Ptilotus rotundifolius - mulla mulla that thrives in spinifex country.
Photo - Jiri Lochman ▾

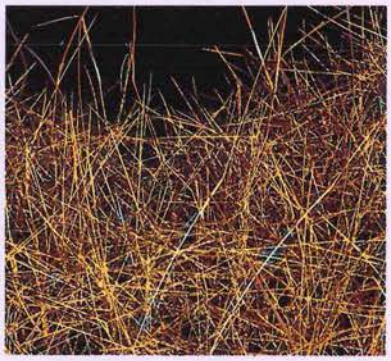
MULGA

Mulga, *Acacia aneura*, grows in a broad belt across the arid mid-latitudes of Australia from the southern Pilbara in Western Australia to western Queensland, western New South Wales and northern South Australia. It usually grows into a small tree with a semi-rounded canopy and commonly forms extensive woodlands.

However, it is remarkable for the diversity of life forms and phyllode ('leaf') shapes it exhibits as well as the variety of habitats in which it grows. There are weeping forms, forms that look like Christmas trees, shrubby forms and many others. Some have short broad phyllodes, others have long needle-like phyllodes and there are many in-between shapes and sizes. This variation poses one of the major unresolved problems to Australian arid-zone botanists interested in the classification of plants. Is mulga one species, as current wisdom has it, or in fact a complex of species? It is hoped that future research will address this issue. Photo - Tony Start

SPINIFEX

Spinifex is the common name given to several species of grass that belong to the genera *Triodia* and *Plectrachne*. Botanists often refer to these grasses as hummock grasses or, occasionally, porcupine grass to distinguish them from quite different grasses belonging to the genus *Spinifex*. The latter grow on coastal dunes. Photo - Tony Start



disturbances. These include alteration to drainage, and grazing by cattle, donkeys and feral horses.

Similarly, woodlands on the rocky ridges can burn. Here, the sparse, woody shrubs that grow below the mulga canopy produce little fuel. They can burn, but they do so very infrequently.

On the flats, mulga persists, suggesting that this community is fairly resilient; but it is still not completely safe. Indeed, when the kangaroo grass has flourished after good cyclonic rains and then died off, there are times of great danger.

But the relatively gentle slopes where the understorey is diverse are the most vulnerable sites. In fact, in much of the Pilbara, it is now difficult to find intact mulga woodlands on gentle slopes. It seems that the spinifex that was part of the understorey flourishes after fires, creating a highly flammable stage in the regeneration cycle. Today's fire regimes, without the complex pattern of patch burns that Aboriginal people created outside the woodlands, increase the likelihood of repeat fires before the woodland has reformed.

GOING, GOING...?

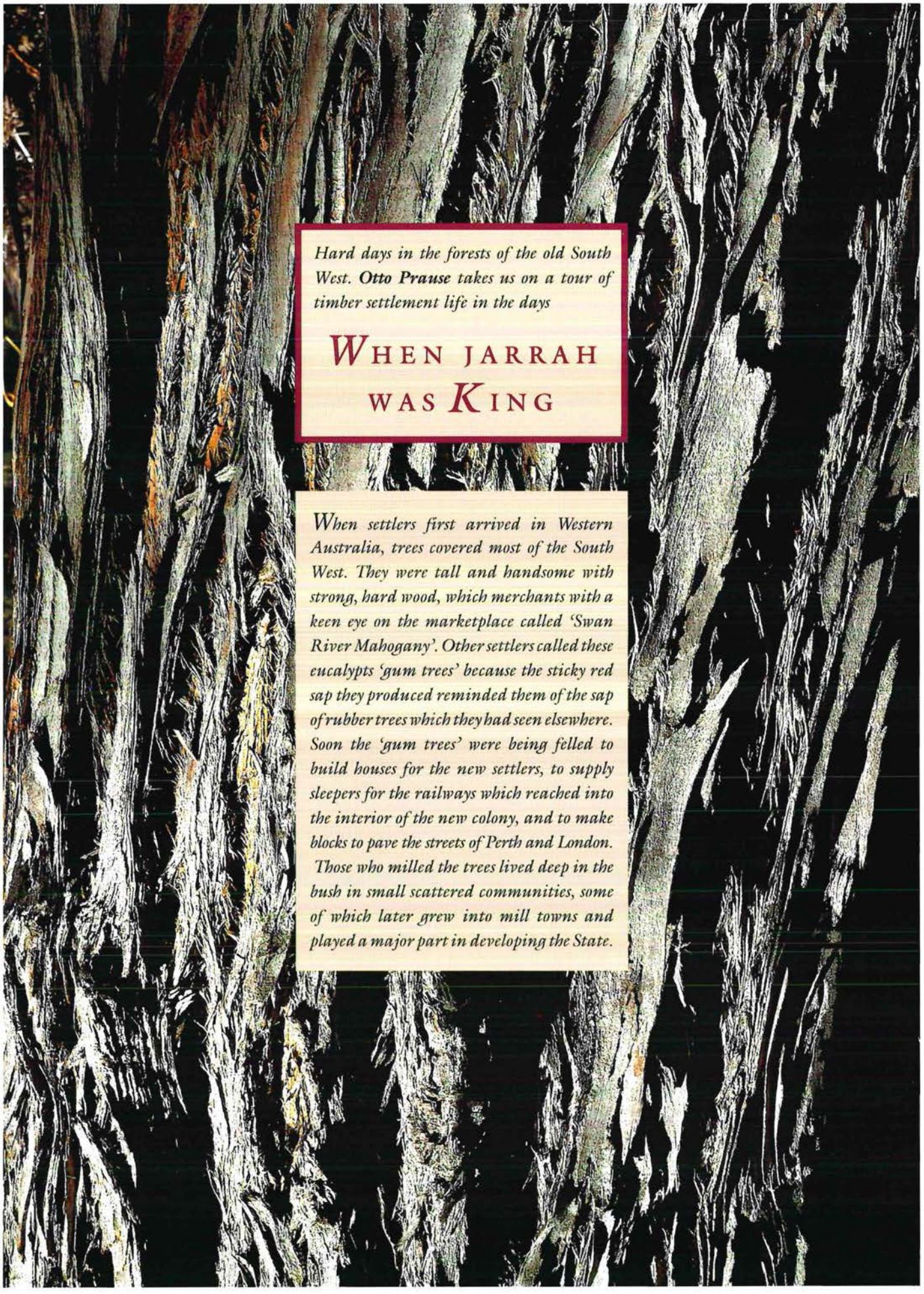
Extensive areas of dead and charred mulga stags standing defiantly over dense spinifex grasslands are mute evidence of the changes occurring on slopes in the Pilbara. A few more years, a few more fires, and even the dead stumps will have gone: people will not know that there was ever a woodland there. Gone too will be the diverse array of animals and plants that depended on the woodland structure - at least they will have gone from those sites, and those confined to that community will be gone from the area.

CALM staff are aware of the dangers. They have started a long-term research project to find out more about the characteristics and the composition of the different communities and to locate the most vulnerable ones in the Hamersley Range National Park, where patch-burning is being reintroduced. The aim of all this work is to make sure that, at least in nature reserves and national parks, good management will ensure that the diversity of the mulga woodlands persists. ▣

There is little chance that regenerating mulga will survive the next fire in this spinifex.
Photo - Tony Start ◄

Mulga woodland on scree slopes has a sparse understorey that seldom carries fire.
Photo - Tony Start ◄

The authors are members of the Research Division of CALM. They have all lived or worked in the Arid Zone for many years. They are researching the problems of fire management in mulga woodlands in the Pilbara Region. Tony Start and Phil Fuller can be contacted at CALM's Wildlife Research Centre on (09) 405 5100. Stephen van Leeuwen and Bob Bromilow are based at CALM's Karratha office and can be contacted on (091) 868 288.



Hard days in the forests of the old South West. ***Otto Prause*** *takes us on a tour of timber settlement life in the days*

When Jarrah was King

When settlers first arrived in Western Australia, trees covered most of the South West. They were tall and handsome with strong, hard wood, which merchants with a keen eye on the marketplace called 'Swan River Mahogany'. Other settlers called these eucalypts 'gum trees' because the sticky red sap they produced reminded them of the sap of rubber trees which they had seen elsewhere. Soon the 'gum trees' were being felled to build houses for the new settlers, to supply sleepers for the railways which reached into the interior of the new colony, and to make blocks to pave the streets of Perth and London. Those who milled the trees lived deep in the bush in small scattered communities, some of which later grew into mill towns and played a major part in developing the State.

During the early days of cutting hardwood, there were many small, makeshift timber operations scattered throughout the South West of Western Australia, producing pit-sawn timber for local consumption. Around them, a collection of cottages grew to house the workers. The cottages were mostly basic, temporary structures built with cast-off timber nailed together, an iron roof, and sometimes only a hessian bag for a window to keep out the winter chills. They were quickly built and just as easily demounted when the sawyers moved to another location.

The pit sawyers were mostly single men. There were no facilities for women and children in the tiny settlements, and to get there you either had to walk or hitch a ride on a 'jinker'. These were big, lumbering log-wagons with huge wheels and were drawn by teams of horses or bullocks. Everything that was needed - tools, food and drink - was brought in on them, and everything the sawyers produced went out the same way.

Soon the saw pits were replaced by steam-driven machines, and railway tracks snaked through the forest. Timber companies, some of which survive to this day, sprang up rapidly. During the early years of this century, when hardwood timber-cutting reached its peak, the mills and their attendant settlements were big and had an air of permanency about them. The houses built for their workers were much more elaborate than the earlier structures. Other services were gradually attracted to the towns: first a trader would come and open shop, then a pub, school and church would follow and establish themselves on the periphery;

This is how it all started. A restored saw pit of the type used by the original timber sawyers.
Photo - Marie Lochman ▲

Jarrah forest in morning mist. An aerial view of part of the Darling Range.
Photo - Marie Lochman ▼

Opposite page:
Photo - Jiri Lochman

and, before long, what started out as a company-owned mill town would become an actual town. From about 1920 onwards foresters and field crews of the Forests Department also became established in the timber towns. Their role was to control tree-cutting, carry out regeneration and fight forest fires. Most of our South West towns developed this way, owing their creation and existence to timber and forestry. In some areas, timber-cutting helped to clear land for farming and produced an income for the struggling new colony. The timber industry also produced wealth for some of the more enterprising pioneers who, around the turn of the century, when the industry was at its peak, built large houses for themselves and lived the life of English country squires.

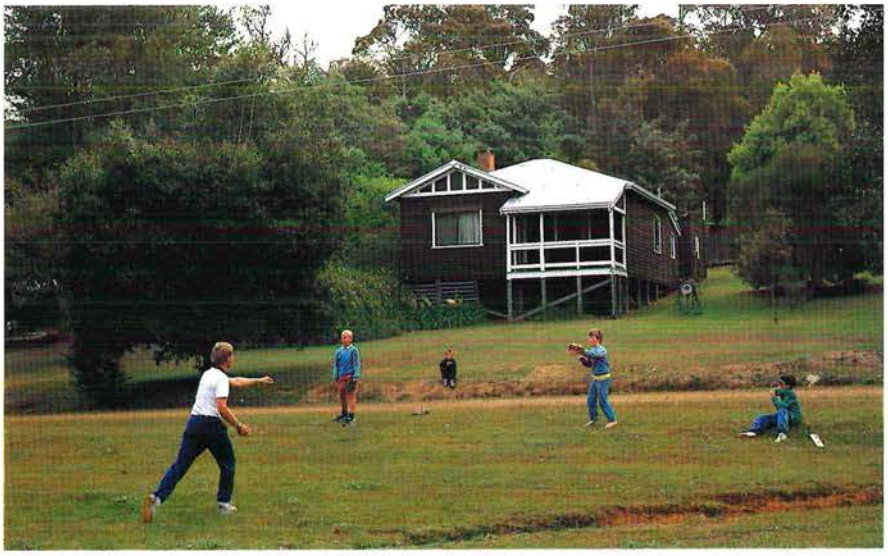
World War I and the Great Depression heralded the beginning of a decline. Many mills closed and disappeared as, gradually, all that was salvageable was taken out and what was left was reclaimed by the forest. The larger mill towns - those that did not rely on timber alone for their livelihood - kept going. Other settlements shrank in size and importance. Workers' cottages stood empty, weeds invaded the flower beds and machinery rusted away. It was a fate that befell many of our once-famous mill settlements and towns: Nanga Brook, Mornington, Hoffmans and Donnelly River. Some, however, were given a new lease of life by being used for other purposes. Four of those that remain today in the jarrah forest, in an area managed by the Department of Conservation and Land Management (CALM), are now run by the Ministry of Sport and Recreation as school camps and holiday cottages. They are Myalup Pines, Wellington Mills and Tone River.

Myalup, located between Harvey and the coast (the closest to Perth), together with Wellington Mills, some 10 km south of Wellington Dam, started out like so many typical timber mills in the Collie-Harvey-Yarloop triangle. They were big operations and the equipment used in both places would have been similar to that now on display at the Yarloop Mill's Workshop Museum. Both mills helped to produce the timber needed by the growing domestic and export market until the late 1920s. They then became bases for the Forests Department's experimental tree planting, as there was a growing realisation that timber harvesting could not go on indefinitely without restocking and putting something back for the generations to come.

After the interruption brought about by World War II, pine planting began on a vast scale in the 1950s. The newly erected cottages, built to a State Housing Commission design, became home to many a post-war migrant family whose breadwinner was employed on the reafforestation project. At this stage the valley settlement of Lewana, on the Blackwood River halfway between Balingup and Nannup, was established on farmland bought from a local grazier.

A typical mill worker's cottage - sole survivor from an era long gone by in a forest clearing near Tone River.
Photo - Otto Prause ▼

Children at play at Wellington Mills.
Photo - Jiri Lochman ▼▼



TRANQUIL TONE

Tone River, by contrast, was a working mill until recent times. Some 40 km east of Manjimup, it was operated by a big private timber company which had obtained a permit from the Forests Department to cut and mill logs from a large tract of land beside the Tone River. The mill operated between 1952 and 1978 and was one of the last real working mill towns, others being Deanmill and Nyamup. Jane McConnell's book, *A Town Like Tone* (written for the Ministry of Sport and Recreation), draws on the experiences of former residents, and what we read about life at Tone probably applies equally well to the other mill towns. According to Ms McConnell, the town was meant to be called Strachan (pronounced 'strawn') after the farmer

The living bushland ... regrowth forest near the Blackwood Valley settlement of Lewana.
Photo - Otto Prause

who pioneered the area; but everybody called it Tone, so the name stuck. There was a sense of tranquillity about the area that persists to this day. The town itself was a pretty place with freshly painted houses, each with a picket fence in the front and fruit trees at the back. The mill was on the other side of the river, separated from the town by a screen of trees.

In the morning, the mill-hands would cross over on the swing bridge and prepare for the day's work. Very soon the air would be filled with the faint hum of the big circular saws and the muffled clatter of machinery, while puffs of steam from the Robey compound steam engine (a museum piece even then) could be seen drifting lazily through the crowns of the trees. Once the children had been sent off to school in the school bus, the women could do their shopping at the general store (which sold everything from baby food to bicycle clips), or they could dress up for a rare outing by bus to Manjimup. Nobody had a car in those days and the 40 km to 'Manji' seemed a long way. The outside world was quite remote for the people in the little bush town which, apart from the company's private line, could boast only one telephone, a public one located outside the general store.

There was an oval just behind the town, and on weekends there would be cricket in summer, football in winter. For the children, nothing could beat the river. A section of it was kept clear of snags and tree trunks to make it suitable for swimming, canoeing and general horseplay. One winter the river flooded and washed away the footbridge which provided access between the town and the mill. For weeks, the men were ferried across the river until one of the mill's leading craftsmen built a new swing bridge.

Films were shown at the community hall, which was also used for church services with clergy visiting about once a month. One day there was a wedding - and what an occasion that was! The whole town was there, including the mill manager (the unofficial mayor), a father-figure who knew all the children by name and was always available to give advice, usually of a civic rather than personal nature. Tone was a place where everybody, including the boss, was your friend.

There was also a forestry depot at Tone, with a forester in charge of operations in the bush; and an overseer and gang of field workers to fight fires, plant trees and maintain roads, bridges and telephone lines.

Eventually, time caught up with the mill on Tone River, as it had done with others. Steel sleepers (which seemingly last forever) and double-brick houses on concrete rafts altered the community's needs for timber. Above all, however, the need for much bigger, more permanent mills in different locations meant that the usefulness of these towns came to a natural end.

But for those who wish to cast themselves adrift on a wave of nostalgia and catch a glimpse of life in a mill town, whilst sitting on a verandah watching smoke curl lazily out of a neighbouring cottage's chimney, then a visit to Myalup Pines, Wellington Mills or the town on the Tone is a must.

Although they no longer echo to the distant buzz of sawing or to the gentle click of leather on willow on a Sunday afternoon, they still retain some of their former charm and are perfect places to shake off the shackles of city life. A few days spent at any of these former mill settlements will give the visitor a fascinating insight into the age when jarrah was king. ▣

Otto Prause is a writer and photographer with an interest in Western Australian history. He can be contacted on (09) 453 6309.

WHAT THE *Tortoise* TAUGHT US

by Andrew Burbidge

"When we were little," The Mock Turtle went on... " we went to school in the sea. The master was an old Turtle - we used to call him Tortoise -"

"Why did you call him Tortoise, if he wasn't one?" Alice asked.

"We called him Tortoise because he taught us," said the Mock Turtle angrily: "really you are very dull!"

(Alice's Adventures in Wonderland *by Lewis Carroll*).

There is no simple method for conserving all endangered species, no strict formula for success. In this article Andrew Burbidge looks at the problems and possible long-term solutions for the successful conservation of the world's rarest tortoise. The lessons learned may help with the conservation of other endangered species.

Of all well-studied vertebrate animals in Australia, the western swamp tortoise is considered the most threatened with extinction. With only about 25 to 30 animals remaining in the wild plus 48 captives, it is the rarest tortoise or turtle on earth. How has this situation come about and what can be done to reverse its trend towards extinction?

In 1901 the western swamp tortoise was named *Pseudemydura umbrina* from a specimen in the Vienna Museum, which had been sent to the Museum in 1839 by the collector J.A. Ludwig Preiss and labelled simply 'New Holland'. No further specimens were collected until 1953, when two were found between Upper Swan and Bullsbrook, only 30 km north-east of the centre of Perth.

Following the interest generated by the rediscovery of a presumed-extinct species so close to Perth, the Government of the day, aided by a public appeal for funds, created two Class A nature reserves that protected much of its remaining habitat. These are Ellen Brook Nature Reserve of 65 ha, situated on the west side of Highway One, two kilometres north of Upper Swan, and Twin Swamps Nature Reserve of 155 ha, located on the south side of Warbrook Road, about 5 km north-west of Ellen Brook Nature Reserve. Research studies commenced shortly after rediscovery, increased in intensity in 1963 and have continued to the present day.

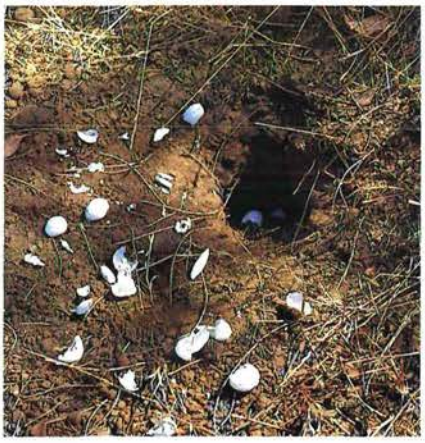
However, despite habitat protection and research the tortoises have become increasingly rare, being reduced in number from about 150 in 1964 to fewer than 50 by 1988. Although some tortoises still remain in their natural habitat at Ellen Brook, the population at Twin Swamps was extinct by 1985. Did something go wrong or was rediscovery too late?

UNUSUAL LIFE STYLE

The western swamp tortoise is the smallest of its family, reaching a maximum of 15.5 cm shell length and 550 g in weight. The tortoises live in and around ephemeral (temporary) swamps with a clay or sand-over-clay soil. They have been recorded only from scattered localities in a narrow 30 km strip of the Swan Coastal Plain, roughly parallel to the Darling Scarp, from near Guildford to near Bullsbrook.

Previous page: A young western swamp tortoise, unaware of its endangered status, searches for food.
Photo - Babs and Bert Wells

Swamps at Twin Swamps Nature Reserve are shallow and contain dark, coffee-coloured water.
Photo - Babs and Bert Wells ▲



Clutch of oblong tortoise eggs dug out and destroyed by a fox.
Photo - Jiri Lochman ▶

Their stronghold was probably the clay soils of the Swan Valley, the first part of Western Australia developed for agriculture following European settlement of Perth in 1829. Almost all this land is now cleared and drained, being urbanised, used for intensive agriculture or the extraction of clay for brick and tile manufacture.

In June or July the swamps fill and the tortoises are found in shallow water, feeding when water temperatures are above 14°C. They are carnivorous, eating only living food such as insect larvae, small crustaceans and young tadpoles. As the swamps warm in spring, the tortoises' food intake increases and fat supplies are laid down for the forthcoming summer. When the swamps are nearly dry and water temperatures rise above 28°C, usually in November, the tortoises leave the water to aestivate until the next winter. Aestivation (dormancy during summer) refuges vary with the soil type: at Ellen Brook Nature Reserve they are naturally occurring holes in the clay, while at Twin Swamps Nature Reserve most tortoises hid under banksia leaf litter or fallen branches.

Females lay three to five hard-shelled eggs of about 35 x 20 mm in an underground nest in November or early December. Only one clutch per year is produced. In most other Australian tortoises multiple clutching is usual and clutches are much larger: the oblong tortoise, for example, lays two or three clutches of eight to eighteen eggs each spring and summer. The hatchlings of the western swamp tortoise emerge the following winter, about 180 days after laying; hatching is triggered by a lowering of incubation temperature, presumably caused by the first winter rains. Hatchlings weigh only about 5 g. Growth in juveniles

is slow and varies considerably from year to year. This depends on seasonal conditions; for example, the lower the winter rainfall the shorter the swamp life and the slower the growth. Consequently, age to sexual maturity varies from six-and-a-half to more than 15 years, with a mean of about 12 years. It is not known how long western swamp tortoises can live, but animals more than 50 years old are still producing eggs.

Hatchling survival rates are low, especially in drought years. Unless hatchlings grow to at least 25 g before the swamps dry, desiccation during the following summer causes death. Growth to a suitable size requires at least five months' standing water. Research suggests that two (or perhaps three) good rainfall years in a row were necessary for young to enter the population at Twin Swamps - one (or two) years for egg production and one year for hatchling survival. Swamp life is more reliable at Ellen Brook and egg laying and hatching seems to happen in most years; nevertheless very few animals survive.

Foxes, which are abundant in both Ellen Brook and Twin Swamps nature reserves, are known to predate western swamp tortoises. Tortoises were more prone to predation at Twin Swamps, where aestivation refuges are mostly on the ground's surface. At Ellen Brook, where aestivation refuges are underground, the species is better protected, but the very small population size means that even occasional predation can have a significant effect.

Since the mid-1960s, Perth has had many years with significantly reduced winter rainfall, resulting in short swamp life at Twin Swamps Nature Reserve. This, combined with high levels of fox predation, is thought to have led to the extinction of the tortoise population at Twin Swamps.

RECOVERY PLAN

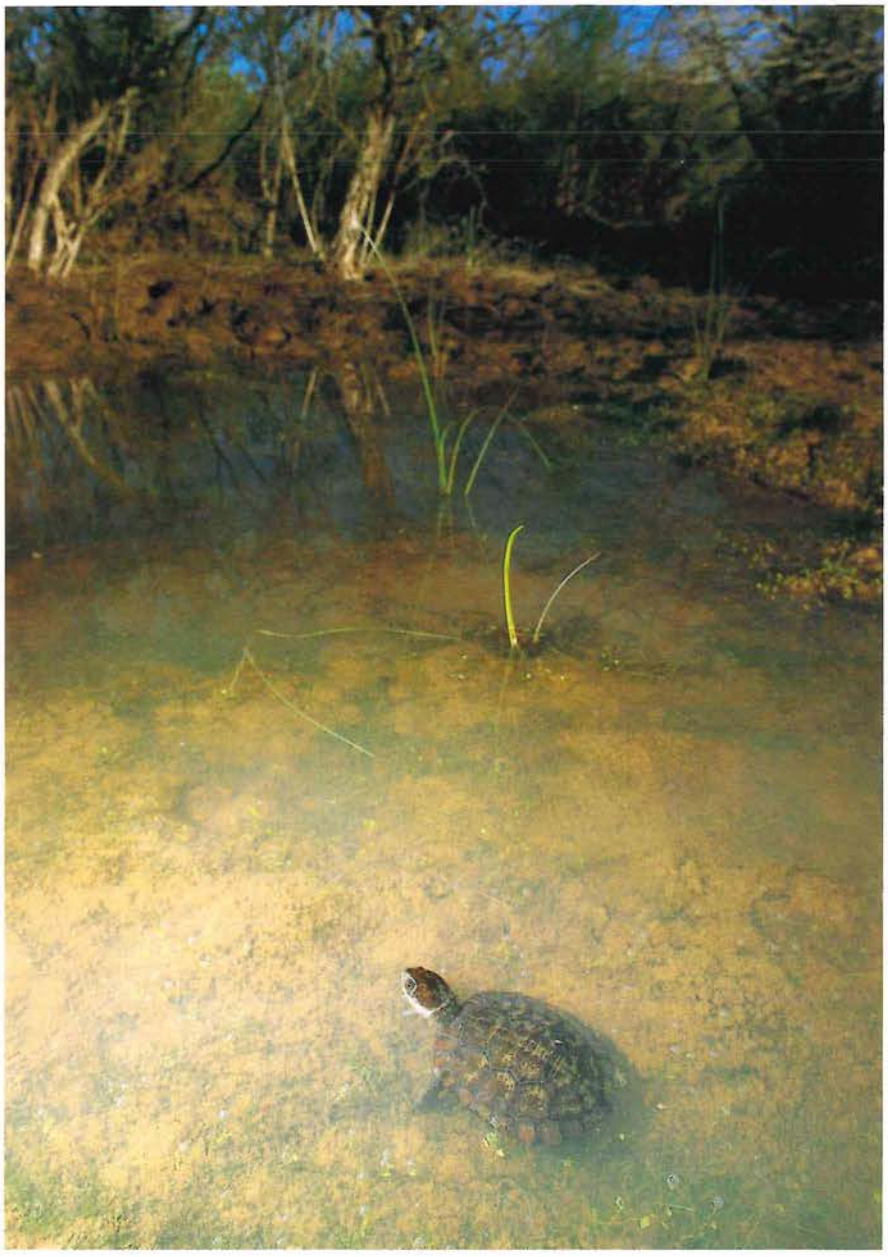
A recovery plan for the next ten years has been developed by the Department of Conservation and Land Management (CALM) and was launched by the President of World Wide Fund for Nature, Prince Philip, in November 1990. Its aim is to ensure that the western swamp tortoise persists by creating at least two viable populations in the wild. A 'recovery team', with members from CALM, Perth Zoo, the University of Western Australia, Curtin University of Technology and the Australian National Parks and Wildlife Service, has been set up to implement the plan.

Available knowledge of the tortoises' biology and ecology suggests that if certain critical factors can be ameliorated or manipulated by wildlife managers, recovery should be enhanced.

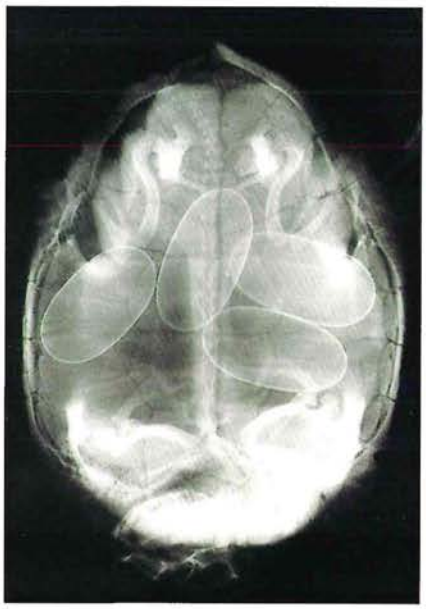
These critical factors are: the inadequate area of habitat in protected areas; the poor quality habitat in existing protected areas, especially relating to a short period of swamp life; predation by the European red fox; low fecundity (the capacity to produce young) and high juvenile mortality, leading to low recruitment; very low total numbers, thus increasing the chance of extinction; and only one wild population.

The following strategies have been developed to deal with these factors.

Additional suitable habitat: Purchase by CALM of suitable land adjacent to Ellen Brook Nature Reserve is under way, and plans are being developed to rehabilitate the areas purchased and deepen some swamps on the existing reserve. Identification of other areas of habitat suitable for purchase will continue.



A young tortoise at Ellen Brook Nature Reserve.
Photo - Gerald Kuchling



Success!
Photo - Gerald Kuchling ▲◄

A radiograph (X-ray image) reveals four eggs. Western swamp tortoises lay only one clutch of up to five eggs each year.
Photo - Andrew Burbidge ▲

Extending swamp life: The swamps on Ellen Brook Nature Reserve contain water for about five months in most years and no action is planned to manipulate existing deeper swamps (those greater than 25 cm) at present. Swamp life at Twin Swamps Nature Reserve is far too short during most years, and extending the life of the swamp by pumping from groundwater is currently being investigated with help from the WA Water Authority.

Controlling exotic predators: Fox control has been carried out on Ellen Brook Nature Reserve since 1979, but the technique available at that time proved to be inadequate. Predator control was stepped up in 1988 by CALM's Metropolitan Region staff using new fox control techniques developed by Dr Jack Kinnear and colleagues (see *LANDSCOPE*, Spring 1990). But much of Ellen Brook Nature Reserve is under water for up to six months of the year and using Compound 1080 under such conditions can be ineffective, because of its high solubility in water (see '1080: The Toxic Paradox' by Dennis King and Jack Kinnear in this issue of *LANDSCOPE*). Furthermore, the tortoises are most likely to be eaten by foxes during the wet months when they are not aestivating.

Another problem is that the reserves are small and re-invasion of them by foxes from surrounding land is rapid.

It was considered that these problems could be largely solved by the construction of a fox-proof fence. In 1989 CALM got a $24 000 grant for this purpose from the Australian National Parks and Wildlife Service under their Endangered Species Program. The remainder of the cost (approximately $45 000) was met by CALM itself. Construction commenced late that year, but was delayed because of unseasonal heavy rains during the summer of 1989-90. The fence was finally completed in December 1990.

Captive Breeding: The extremely small size of the population and its continued decline in the wild means that captive breeding is essential if the species is to recover in numbers and range. Captive breeding was attempted in a low key, non-interventionist way ever since western swamp tortoises were first kept at Perth Zoo in 1964. Success was, however, very low with only four animals still being alive from the 26 that hatched between 1966 and 1977.

In 1979 the three adult females from the Zoo population were transferred to CALM's WA Wildlife Research Centre for more intensive husbandry and the use of artificial techniques for obtaining and incubating eggs. About 20 eggs were obtained and incubated during 1979 and 1980. Some hatched, but all hatchlings died within a few months. No further eggs were produced until 1987.

In 1987 Dr Gerald Kuchling came to WA from Austria to study tortoise reproduction with Professor Don Bradshaw at the University of Western Australia (UWA) and started to assist CALM with captive breeding. The use of ultra-sound scanners for the examination of the female reproductive tract enabled studies to be made of egg development for the first time. Previously it was not known whether eggs were being developed until ovulation had taken place and the shell had been laid down. Husbandry was also changed and improved.

In 1987 seven eggs were obtained from two of the three females then in captivity. All these eggs were incubated artificially, but none hatched, the embryos dying at an early stage of development. The reasons for this are not clear: recent research suggests that the most likely explanation is poor quality eggs due to inadequate nutrition of the females that produced them.

Also in 1987 CALM and UWA's Zoology Department developed a budget for a two-and-a-half year captive breeding project. Funds were sought and obtained from the World Wide Fund for Nature Australia, the Australian National Parks and Wildlife Service, and CALM. The project has been carried out by Dr Kuchling while based at UWA. CALM has supported the project with extra funds and staff time, and UWA has provided facilities and financial administration. Perth Zoo has provided staff support, and obtained sponsorship for the construction of new facilities for the captive tortoises and hatchlings.

The new breeding management is based on an improved and better balanced diet as well as on new enclosure designs, feeding patterns and aestivation management, which reflect more closely the conditions in the wild.

This project has been successful. In 1988, 12 eggs were obtained from three females and 11 of these hatched between February and April 1989. Because of past difficulties in raising hatchlings, husbandry difficulties were expected and did arise; in particular the hatchlings developed an infection of the skin, which extended to the eyes and toes. The infection proved hard to combat. Five of these hatchlings are still alive and now responding well to treatment. Nursery facilities and food have been continually improved and growth rates are now approximating those in the wild.

In 1989, 13 fertile eggs were obtained from five females; two eggs had thin shells and cracked when being laid, the remaining 11 were incubated, and all hatched during April 1990. The health difficulties that arose with the 1989 hatchlings have not recurred. Experiments to determine the most effective method of raising hatchlings will be continued by Perth Zoo and the University of Western Australia.

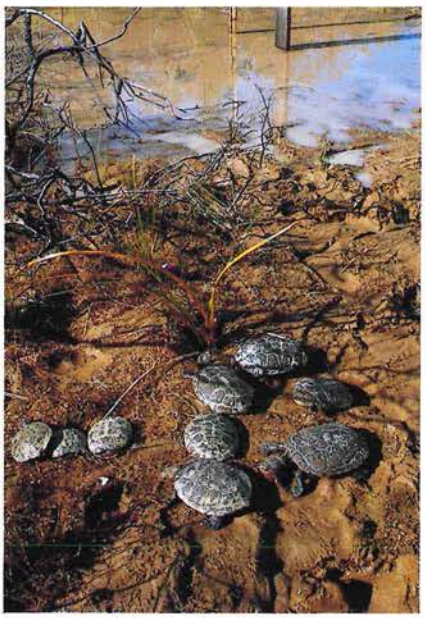
In late 1990, 20 eggs were obtained. Eighteen of these began developing, but two embryos died early in incubation. In April 1991, 16 eggs hatched, including the first two from a tortoise bred in captivity in Perth Zoo in the 1960s. Captive breeding will continue, with Perth Zoo taking full responsibility for the project this year.

Re-introduction to the wild: The Recovery Plan lays down procedures for the re-introduction of western swamp tortoises to Twin Swamps Nature Reserve, thus creating two populations in the wild. The reserve appears to have offered good habitat during periods of average to above average rainfall (e.g., the mid-1960s) when the tortoises reproduced successfully and grew much faster than those at Ellen Brook. However, the population did not fare well during periods of drought; this was possibly due in part to nearby drought refuges outside the nature reserve having been destroyed. Predation by foxes is thought to have been a significant factor in the decline of the Twin Swamps population. Both these factors will need to be addressed, the first by swamp management (probably by pumping groundwater into the swamps), and the second by more effective fox control, possibly including the construction of a fox-proof fence.

The timing of translocations and the number of tortoises released will be dependent on the continued success of captive breeding and on the implementation of remedial measures at the reserve. Dr Kuchling will continue to work part-time with CALM on the re-introduction project and will also be available to help Perth Zoo with captive breeding.

WHAT HAS THE TORTOISE TAUGHT US?

The near-extinction of the western swamp tortoise was due to two depressingly familiar causes: habitat destruction and introduced predators.



Some of the 13 western swamp tortoises captured in one afternoon at Ellen Brook Nature Reserve - the most ever caught there at one time.
Photo - Gerald Kuchling ▲

Western swamp tortoises eat live food such as these small crustaceans.
Photo - Babs & Bert Wells ▼

Perth Zoo has built specially-designed pens to raise tortoises bred in captivity.
Photo - Gerald Kuchling ▼▼

The lessons for the future are that conservation action must not be delayed until species are approaching extinction. The later action is taken, the more difficult and expensive it will be.

As is the case for most critically threatened species, only a concerted and continuing effort can result in the recovery of the western swamp tortoise. Because of its extreme rarity, the slow production of its young and its long generation time, its recovery will be slow. For the project to have any chance of success, a long-term commitment is required by conservation and funding agencies, and careful monitoring of progress will be necessary. ⊡

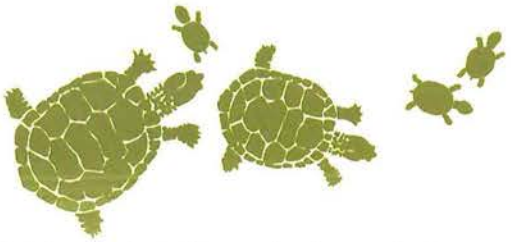
To protect the last wild group of western swamp tortoises CALM has built this fox-proof fence around their habitat.
Photo - Stephen Kelly ▶

The oblong tortoise, known locally as the long-necked tortoise, is common in freshwater wetlands in the south-west of Western Australia.
Photo - Marie Lochman ▼▶

The western swamp tortoise bends its neck sideways to gain some head protection from its shell.
Photo - Gerald Kuchling ▼▼▶

Andrew Burbidge is Director of Research at CALM's Wildlife Research Centre at Woodvale. He can be contacted on (09) 405 5100.

Come crown my brow with leaves of myrtle
I know the tortoise is a turtle
Come carve my name in stone immortal
I know the turtoise is a tortle
("Carnival of the Animals" by Ogden Nash)



The common names of many Australian animals have been derived from similar-looking species from England, even though they may not be closely related to them. Thus Australian magpies and northern hemisphere magpies are unrelated - their black-and-white colouring is all they share. Australian robins are not closely related to English robins; they got their name because some species have red breasts. Even when confronted by animals totally unlike European ones the early settlers still gave them familiar, English-sounding names, such as 'native cat' for the chuditch and 'banded anteater' for the numbat. Similar problems exist with the common names of many other Australian animals and plants.

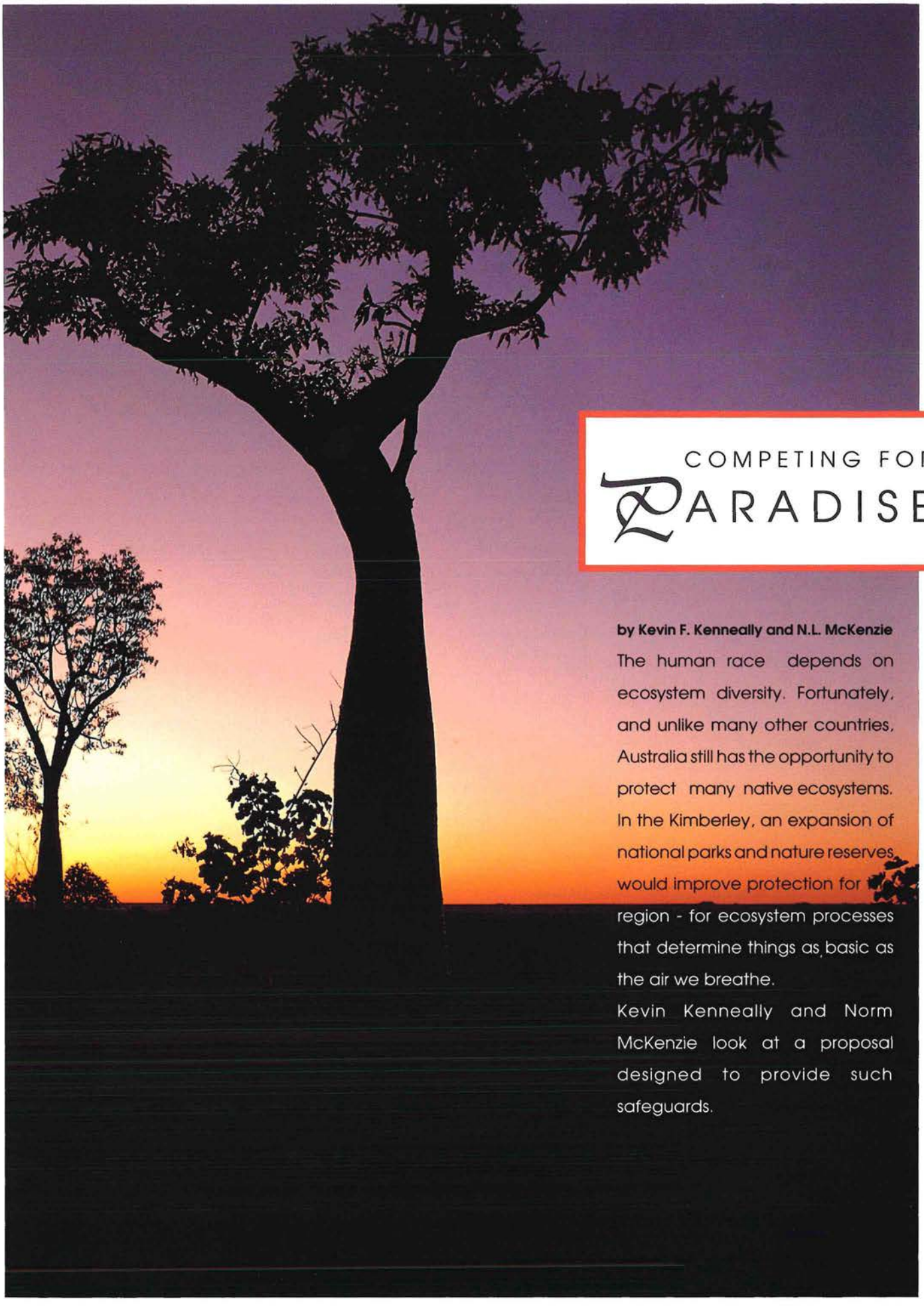
Tortoises and turtles belong to the reptile order Testudines, which has two living sub-orders, the Pleurodira and the Cryptodira. The Pleurodira (side-necked families) are unable to withdraw their necks into the shell but are able to gain some protection for the head by bending the neck side-ways between the upper and lower parts of the shell. There are only two living families within this group. With the exception of marine turtles, the Cryptodira (hidden-necked families) are able to withdraw their heads into the shell by bending the neck in an 'S' bend. But because this bending takes place within the shell it gives the impression that the head is being withdrawn without the neck being bent at all. Most living species belong to this group.

In English-speaking parts of the northern hemisphere the land-dwelling, herbivorous species are usually called 'tortoises'. In England, freshwater-dwelling species also are usually called 'tortoises' (sometimes 'marsh tortoises'), but they are called 'terrapins' or 'turtles' in north America.

In Australia, and elsewhere in the English-speaking world, 'turtle' is always used for marine species, which have flippers rather than toed or clawed feet, while 'tortoise' has usually been used for the freshwater species. All our 'tortoises' belong to the Pleurodiran family Chelidae, which is restricted to Australia, New Guinea and some adjacent islands, and South America. One additional freshwater species, the unusual pig-nosed turtle of Arnhem Land (also New Guinea), belongs to the Cryptodira.

So Australian 'tortoises' are only distantly related to any of the northern hemisphere families. They are as different from northern hemisphere freshwater turtles as marsupials are from eutherian (non-pouched) mammals. Perhaps we should develop our own Australian name for them.

After its rediscovery, the western swamp tortoise was generally known to Western Australians as the short-necked tortoise to distinguish it from the oblong tortoise *Chelodina oblonga*, a long-necked species, which is the only other tortoise in the South West. The name used today was proposed many years ago for Australia-wide usage, since there are many other 'short-necked' tortoises in three other genera that occur in northern and eastern Australia.



COMPETING FOR PARADISE

by Kevin F. Kenneally and N.L. McKenzie

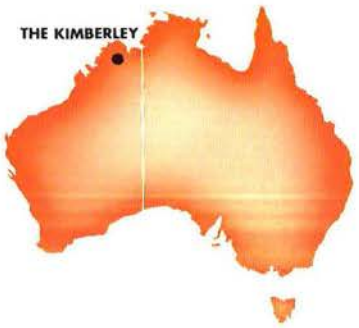
The human race depends on ecosystem diversity. Fortunately, and unlike many other countries, Australia still has the opportunity to protect many native ecosystems. In the Kimberley, an expansion of national parks and nature reserves would improve protection for the region - for ecosystem processes that determine things as basic as the air we breathe.

Kevin Kenneally and Norm McKenzie look at a proposal designed to provide such safeguards.

Previous page: Boabs add a sense of strangeness to the Kimberley landscape.
Photo - Marie Lochman

Sandy embayments, rugged sandstone headlands and mangroves are a feature of the Kimberley coastline.
Photo - Kevin Kenneally ▲

Permanent rivers are fringed by dense and often luxuriant vegetation.
Photo - Jiri Lochman ▲►



The World Conservation Strategy supports the idea of conservation reserves to protect representative areas and indigenous species. Earlier this year the Western Australian Government, which is committed to the Strategy, released the Kimberley Regional Planning Study - a long-term plan for the region that includes proposals by the Department of Conservation and Land Management (CALM) for a number of additional conservation reserves. These have now been published in a comprehensive report (*Nature Conservation Reserves in the Kimberley, Western Australia*).

The proposed reserves were selected to make conservation areas more representative of the region's wildlife and landscapes. They are based on current biological data, taken largely from ecological surveys made since 1970, but should not be considered the final word on reserves in the Kimberley.

The Kimberley is one of the last great wilderness regions of the world. It extends from the red sand dunes of the Great Sandy Desert to the rugged sandstone escarpments and coastal and oceanic islands of the humid north-western Kimberley. It includes savannas, riverine forests, floodplains, pindan, rainforests and mangroves. The last two are so scattered that it is particularly difficult to represent their diversity in reserves. Like Arnhem Land and far north Queensland, the Kimberley presents a rich tapestry of tropical plants and animals. Each year, the great complexity of its landscapes attracts ever-increasing numbers of tourists.

The Kimberley offers a special magic to those modern visitors who fall under its spell. Its apparent splendid isolation, its tropical climate and vegetation, a history linked with exotic industries such as pearling, and its proximity to south-east Asia all tend to give this remote area of the State a romantic and pristine image. But this hasn't always been so - the Kimberley was once regarded as a place to avoid.

HUMAN IMPACT

Aborigines arrived in Australia perhaps 30-50 000 years ago, but the effects of their colonisation on the Kimberley area are shrouded in the Dreamtime, and occurred against the backdrop of climatic fluctuations. Only fragments of their history have been constructed by archaeologists.

The next visitors to the Kimberley were probably Indonesian-Macassan fishermen who spent time ashore seeking water and a place to boil down their catches of bêche-de-mer, also known as trepang or sea cucumber. Contact between the Macassans and the Aborigines resulted in some trade, but the Macassans did not venture inland. Evidence of their visits remains in archaeological pot shards and stone hearths; they also introduced the tamarind trees found growing at abandoned campsites along the Kimberley coast.

At this time the sea gave explorers their only access to this highly dissected coastline fringed by tall cliffs, mangroves and saline flats and inundated by twice-daily tides of up to 11 metres. Many of the early European sailors quickly learned to stay well clear of the Kimberley coastline with its treacherous reefs, racing tides and swirling whirlpools. Other hazards encountered were the man-eating saltwater crocodiles that lurked in the creeks and rivers, and the numerous biting sandflies and mosquitoes - which drove one navigator so mad that he named his landing site Point Torment.

It was the reports of European visitors that caused a lack of further interest in the area. William Dampier, who anchored in the *Cygnet* in King Sound in January 1688, described the countryside as 'dry and sandy and destitute of water'. When the French began showing an interest in northern Australia, the British

government despatched Lieutenant Phillip Parker King to undertake hydrographic surveys along the Kimberley coast between 1819 and 1821. King was accompanied by botanist Allan Cunningham, and a significant number of plant collections were made and new species described. This provided the first major botanical collection from the Kimberley. Cunningham noted the absence of what he termed 'useful plants', and attempted to rectify this by sowing orange and lemon seeds at Careening Bay north of the Prince Regent River. None survived.

In 1838, as HMS *Beagle* explored the Kimberley coast, Captain Stokes provided evidence that widespread bushfires predated European settlement when he wrote: 'Indeed, during the dry season it not infrequently happens that an immense tract of land is desolated by fire, communicated, either by design or carelessness of the natives, to the dry herbage on the surface.'

European exploration by land began with George Grey's expedition of 1837-38. Following Alexander Forrest's expedition of 1879 the region was named after the Earl of Kimberley, then Secretary of State for the Colonies. As a result of this expedition millions of hectares were quickly taken up in pastoral leases. But even then the rugged terrain, lack of water, the presence of poisonous plants that killed stock and horses, diseases such as cholera and typhoid and hostile Aborigines, all proved an enormous barrier to expansion of the pastoral industry. As early as 1864 a settlement at Camden Harbour on the north Kimberley coast had to be abandoned after one year; the inhabitants succumbed to pestilence and the hostile environment, and perished like flies in a country one settler later described as 'God-forsaken and God-forgotten'! Even so, pastoral pursuits have been the major land use in the Kimberley for nearly a century. Cattle and donkeys are now found throughout the region, and only the most rugged areas of sandstone are free of feral stock.

On some of the offshore islands such as the Lacepedes, mining for guano had commenced in the early 1870s, stripping these islands of their mantle of rock phosphate and disrupting the colonies of breeding seabirds. Turtles were also exploited and an attempt was made to establish an industry on the Lacepedes. Feral pigs have been recorded on Sir Graham Moore and Sunday Islands.

This gradual exploitation of marine and terrestrial ecosystems and their wildlife has been a continuous theme in the Kimberley. We now have the opportunity to design an extensive reserve system whilst large areas remain with their ecosystems relatively intact.

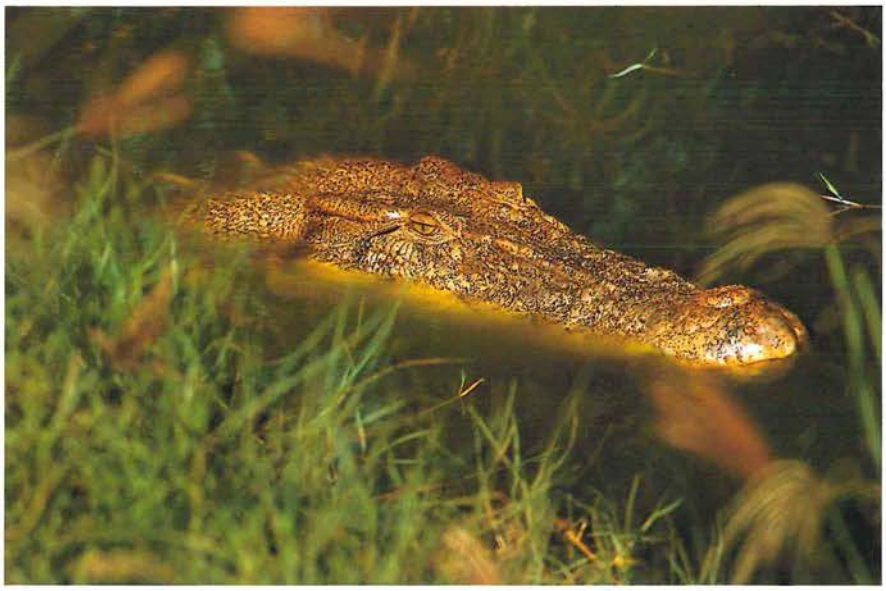
PROTECTION OF REMOTE AREAS

The Kimberley can be divided into six distinct districts, each with different landforms and wildlife communities. The north Kimberley includes the most rugged landscapes in the State, and is the only area of Western Australia where there have been no documented animal extinctions since European settlement. This area features spectacular escarpments, waterfalls, rainforests, palm forests, stately paperbark groves, and picturesque swamps rich in aquatic life.

Major recommendations of *Nature Conservation Reserves in the Kimberley* include extending the Prince Regent Nature Reserve's boundaries to take in marine environments, most of the Hunter River catchment and parts of Mitchell Plateau, then declaring the whole area a national park. Other national parks are proposed at Walcott Inlet, Lake Argyle and Cape Londonderry.

Other recommendations cover the permanent wetlands at Parrys Lagoons in the eastern Kimberley. Their great variety of water birds and aquatic plants can be more easily seen in the proposed Packsaddle Nature Reserve, an extensive network of waterways and swamplands created by damming the Ord River at Kununurra.

In the south-west Kimberley, part of Broome's Roebuck Bay is being proposed as a marine park - a major step in meeting Australia's obligations as a signatory to international treaties that protect migratory wading birds and their habitat. A vine thicket reserve is proposed inland from Broome's Cable Beach, an area containing many plants with edible fruit that are still an important food source for Aborigines. Existing small reserves in the Oscar and Napier Ranges are inadequate and are under increasing tourist pressure. These limestone ramparts formed a barrier reef about 350 million years ago; today they are a treasure-house of endemic species and fossil deposits. It is for this reason that existing and proposed reserves will



The scrambling vine *Caesalpinia major* has a spiny pod which, when cut, reveals two marble-sized seeds.
Photo - Kevin Kenneally ▲

Saltwater crocodiles are now less rare around the Kimberley coast.
Photo - Robert Garvey ◄

In the Kimberley, deeply dissected sandstone gorges create a permanent humid microclimate, allowing dense banks of ferns to flourish.
Photo - Jiri Lochman ◄

Polyalthia australis, a relative of the custard apple, is confined to rainforest.
Photo - Kevin Kenneally ▼◄

combine to create the Devonian Reef National Park.

Extensive red dunefields dominate the southern margin of the Kimberley. They are represented in reserves proposed in the Great Sandy Desert, including the Edgar Ranges, the Mandora Saltmarsh and the McLarty Hills. Gregory Lake on the north-eastern edge of the Great Sandy Desert is a unique arid-zone lake with an enormous diversity of water birds. As a wetland of international importance, the lake and its environs should be conserved.

People may think that areas suffer less from human disturbance if they are remote. But remote is not the same as pristine. At first glance, the size of these ancient, often massive landscapes can mask their fragility. The Kimberley's vast savannas are sparsely settled, but have been exploited by humans for at least 40 000 years. During this period an entire fauna of great mammals disappeared. Other mammals have disappeared since European settlement began about 100 years ago, and many of the region's smaller animals have declined, in number as well as in geographical range. Pervasive damage from cattle, donkeys, feral pigs, cats and inappropriate fire regimes are now apparent in many parts of the region. Experience world-wide has proved that wilderness has few defences against the exploitation of destructive humanity. Establishing conservation reserves in the Kimberley should ensure that future generations will have the opportunity of a wilderness experience and that the untapped genetic diversity of the region will remain. ▣

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Wicked deceptions

By Suzanne Curry

In ancient times,
Greek philosopher Aristotle
claimed that humans
are the best mimics
in all the animal world.
But other animals
can be powerful mimics,
and plants have
powers of imitation too...

Suzanne Curry shows us
how subtle and sometimes
deadly they can be.

The gregarious myna bird is one of the best-known examples of a creature with remarkable imitative ability: the power to mimic the calls of animals, other birds, and humans. Mimicry, however, is much more than this.

Generally, it is defined as the close external resemblance, as if from imitation or simulation, of an animal or plant to some different animal, plant or surrounding object, especially to serve as protection or concealment. Mimicry is essentially deception by trickery.

Although there are several forms of mimicry - and many scientists believe that Western Australian flora and fauna provide numerous examples - they fall within three commonly recognized headings.

Top left:
A male specimen of the native bee (*Leioproctus pappus*). One can easily imagine how they would 'disappear' when stationary on a smokebush.
Photo - T.F. Houston

Albany pitcher plant (*Cephalotus follicularis*) showing the remarkable pitcher leaf, which forms a brightly coloured jug-like structure.
Photo - P. Armstrong ▲

Previous page:
Caladenia barbarossa is one of the dragon orchids whose flower takes on the appearance of a female flower wasp.
Photo - Babs & Bert Wells

Top right:
Flowering branchlet of a smokebush (*Conospermum stoechadis*) showing the 'woolliness' which the native bee mimics.
Photo - T.F. Houston

This beautiful pygmy drosera (*Drosera paleacea*) is only 2 cm in diameter. The red glistening tentacles of the modified leaves are enticing traps for small insects.
Photo - A. Lowrie ▲

Right top and bottom: ▸
A bee fly alights on the triggerplant (*Stylidium scandens*). The floral column or 'trigger' is activated and stamps the fly with pollen on its upper body.
Photos - J. Lochman

BATESIAN MIMICRY

In 1862, the English naturalist Henry Walter Bates published the results of his observations on the butterflies of the Amazon forests. His important conclusion was that there were brightly coloured, apparently unpalatable butterflies flying together with strikingly similar yet unrelated species of palatable butterflies. This phenomenon of the resemblance of a palatable 'mimic' to an unpalatable 'model' is now known as Batesian mimicry. Essentially, Batesian mimicry takes place when one organism obtains a one-sided advantage by imitating another organism, usually more numerous than itself.

Native bees of the genus *Leioproctus* may demonstrate a variation of Batesian mimicry, in this case of a plant by an animal. Some species of these bees mimic the 'woolliness' of the smokebush (plant genus *Conospermum*). The bees have dense white hairs which obscure their black heads, bodies and legs, whitish compound eyes and whitish wing membranes. The hairs of their antennae closely resemble the dark apices of the floral bracts, leaf-like structures which surround the flowers. When settled on the inflorescences (flowering shoots) of the smokebush the bees become almost invisible. Their ability to mimic the plant provides them with excellent camouflage from predators. They obtain pollen and nectar from *Conospermum* and are not known to visit other genera.

The flowers of the well-known donkey orchids (*Diuris* spp.) bear remarkable similarity to the flowers of the native peas known as lamb poisons (*Isotropis* spp.) that they mimic. Successive visits to the orchid flowers by bees in search of nectar and honey - which the orchid does not produce - results in cross-pollination of the orchid. This pollination mechanism, known as floral mimicry, is also a further example of Batesian mimicry.

Several members of the genus *Caladenia*, better known as dragon

orchids, provide extraordinary examples of Batesian mimicry. The flowers are highly modified to look and smell remarkably like flightless female flower wasps. The deceived male wasp alights on the flower in an attempt to fly away with the 'female'. The probing action catapults the male wasp into the pollen-bearing column of the orchid. If the wasp carries pollen from another similar orchid, successful cross-pollination can occur.

Hakea trifurcata is a remarkable species in that it produces three different leaf types: needle-like, three-pronged, and flat and broad. These flattened leaves, which are produced only on mature plants, look remarkably like the fruit. Dr Byron Lamont of Curtin University has suggested that the production of the flattened leaves serves as a protection for the fruit from grain-eating insects such as moths. Female moths damage *Hakea* plants by laying their larvae in the fruit. These moths, which lay at night, become confused between the fruit and the flattened leaves. By having leaves which mimic the fruit, the plant is able to protect a greater number of its fruit from being damaged. It is interesting that these fruit remain green (like the leaves) for an unusually long time. This possible case of Batesian mimicry is rather interesting, as the mimicry is occurring between vegetative and reproductive organs of a single species.

MUELLERIAN MIMICRY

Bates also noticed that occasionally two inedible unrelated butterfly species were amazingly similar in appearance. This resemblance of two species in order to gain protection is based on the idea that the greater the number of individuals that look the same, the lower the losses for each species. This was explained in 1878 by German zoologist Fritz Mueller and has become known as Muellerian mimicry. Generally, Muellerian mimicry occurs when a number of species of similar characters and behaviour and of comparable abundance have evolved to their mutual advantage. The species are both 'mimic' and 'model'.

A few species of triggerplants (*Stylidium* spp.) and the related genus *Levenhookia* provide a possible example of Muellerian mimicry. A common floral shape is used to orientate the insect pollinators to the plant's particular advantage. Dense carpets of ephemeral triggerplants can be found growing in seasonally wet patches. In some carpets, several species, such as *Stylidium ecorne, S. rosea-alatum* and *Levenhookia leptantha,* grow together. These three species have irregular floral parts with two of the four lobes distinctly longer than the others. This asymmetry may serve to orient insect pollinators which visit the flowers for nectar. In these plants, the male and female floral parts are united into a column which carries the pollen-bearing anthers and stigma at its tip. In *Stylidium*, this column is the 'trigger' and is bent down between and below the petals. When the trigger is activated by probing insects, it suddenly jerks up and over to 'stamp' the insect with pollen. It is interesting that the orientation of the trigger varies for each species. Thus the insects passing through the plants will be stamped on different parts of their body by the different species. Perhaps this is an adaptation to minimise interspecific cross-pollination. Because these species mimic each other, they benefit by sharing common pollinators.

PECKHAMIAN OR AGGRESSIVE MIMICRY

Some predators stalk their prey by mimicking an otherwise harmless species, much like a wolf in sheep's clothing. This concept of aggressive mimicry was introduced by E.G. Peckham and has become known as Peckhamian or aggressive mimicry. It differs from the previous categories in that the mimic is the predator.

The Albany pitcher plant, *Cephalotus follicularis* - the only pitcher plant known in Western Australia - seems to provide a good example of aggressive mimicry. It has two kinds of leaves. The conventional leaf is oval shaped, green, fleshy and on a stalk. The pitcher leaf is often brightly coloured with hues of red and purple, forms a jug-like structure and rests on the ground. These 'trap leaves' serve as dummy flowers, bearing flower-like markings and a lid-like flap which has the appearance of a flower. Inside the

pitcher, below the glossy rim, is a white, downward-sloping ridge containing numerous nectar glands. This deception attracts ants, insects and beetles which, in their attempt to reach the nectar, fall into the pitcher where they are broken down and absorbed by the plant.

Sundews (*Drosera* spp.) may be another example of aggressive mimicry. The shoots of many sundews, which bear numerous leaves, mimic flowering shoots. The leaves themselves mimic flowers, especially those of the Myrtaceae family (e.g. *Leptospermum* spp., commonly known as tea tree). These leaves are often circular, the leaf blade shining yellowish green like certain nectar-bearing flowers and with fine hairy tentacles tipped with sticky red glands. These tentacles, radiating from the centre, mimic stamens. They are active traps because they move to enfold their prey. The glands at the tips of the tentacles secrete a glistening digestive juice - a wicked deception to the insect pollinators that visit these plants in search of nectar. The insects alight on the leaf and within seconds are enfolded in the sensitive tentacles. Over a period of days the soluble matter of the prey is reduced to a fluid that is absorbed by the plant. It is interesting to note that one group of insects, commonly known as assassin bugs, appear immune to this deception. They are specific to the sundews and their coloration mimics sundew leaves. They provide themselves with food by pirating the prey caught in the leaves.

SUBTLE DECEIVERS

Plants' powers of mimicry appear to equal those of animals, even if less overtly so. One fine example is that which appears between species of *Pimelea* and *Darwinia*. Normally, the flower structures of these two genera are quite dissimilar. Furthermore, whereas *Darwinia* is generally bird-pollinated, *Pimelea* is generally insect-pollinated. However, in the case of *Pimelea physodes* and *Darwinia macrostegia* a striking similarity between the flower heads can be seen. In both, these nodding heads are surrounded by large overlapping bracts which serve to lure pollinating birds to the flowers. These bird-adapted blossoms of *Pimelea physodes* are unique in the genus. What is more, they occur in the general area of the greatest concentration of *Darwinia* species. Taken together, these observations strongly suggest that an unusual form of Batesian mimicry exists.

The study of mimicry gives us important insights into the course of evolution. In particular, it can illustrate the direction evolution has taken. In cases where humans carry out artificial breeding, we can even see something of the way in which mimetic selection occurs. Whether we consider mimicry as a phenomenon in itself, or as a means to deepen our understanding of evolutionary processes, we can but marvel at nature's work. ▣

An assassin bug nymph (*Cyrtopeltis* sp.) feeding on a cranefly. The green body with red spots mimics the *Drosera* perfectly.
Photo - J.C. Taylor ▲▲

Darwinia macrostegia.
Photo - P. Armstrong ▲

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ENDANGERED!

DIEBACK-PRONE PLANTS OF THE EASTERN STIRLING RANGES

Thirteen species of flowering plants are confined to the thicket vegetation of the upper parts of the high eastern peaks of the Stirling Range National Park (Mt Success to Ellen's Peak). Four of these species are highly susceptible to dieback disease (*Phytophthora cinnamomi*), which is now a problem in the park and is present in their restricted habitat.

These species were mapped in 1986. They are currently being restudied as part of the proposed management plan for the Stirling Range to ensure their continued survival in the face of this threat.

The most widespread of the four species is the giant candle heath (*Andersonia axilliflora*) which, although being decimated on the Bluff Knoll Plateau, is found on several isolated ridges and hilltops which are apparently free of disease.

Top: *Dryandra* sp. nov. Left to right: *Andersonia axilliflora*, *Lambertia fairalli*, *Lambertia fairalli*.
Photos - Greg Keighery

The most restricted species, Fairall's lambertia (*Lambertia fairallii*), is only known from two isolated ridgelines which are fortunately disease-free.

Perhaps the most endangered species are, paradoxically, two plants which were once abundant on the Bluff Knoll Plateau but not found elsewhere. These species (an unnamed species of *Dryandra* and an unnamed species of *Persoonia*, both Proteaceae) have been severely affected by mass deaths caused by dieback.

During the studies leading up to the production of the management plan, all known populations will be resurveyed for dieback status and effects. Dieback-free populations must be protected against accidental introduction of the disease, and all species need to be brought into cultivation and/or long-term seed storage, in case all populations become infected.

These species, always highly restricted in their natural ranges, face a bleak future unless we can protect them from an alien disease that humans brought into their world.

We hope the discovery and protection of dieback-free populations provide the time to research a more permanent solution to the disease.

GREG KEIGHERY

POISON PEAS:
DEADLY PROTECTORS

by Steve Hopper

Poison plants were a major deterrent to early settlers in parts of Western Australia - and thereby helped to preserve some areas of high conservation value. Now, ironically, plants that were for more than a century thought of as pests are endangered. In this companion piece to King and Kinnear's '1080: The Toxic Paradox' in the present issue of *LANDSCOPE*, CALM research scientist Steve Hopper tells the story of some of Western Australia's killer flora.

Because of their toxic effects on stock, poison peas have had to be eradicated during much of Western Australia's agricultural development.
Photo - Jiri Lochman ▲

Previous page: York Road poison (*Gastrolobium calycinum*): the first poison plant identified by James Drummond in 1840 as being toxic to stock.
Photo - A. G. Wells

A woylie (*Bettongia penicillata*), one of several south-west Australian mammals tolerant to the toxin of poison peas, and protected by them.
Photo - Jiri Lochman

Imagine the disillusionment of the earliest European settlers of Perth when some of the few cattle and sheep they had brought with them on a long, cramped and unpleasant sea voyage died suddenly from unknown causes.

This began to happen as soon as farmers moved their animals off the Swan Coastal Plain up into the Darling Range and eastwards towards the fertile valleys near York and Newcastle (later renamed Toodyay). In May 1835, for example, Joseph Harris, pioneer of the Williams district, drove a mixed herd from Guilderton to York; 93 sheep, 14 goats and three bullocks died on the journey. Speculation as to the cause included disease, but Harris was of the view that poisoning was more likely. In November 1836, a certain Captain Whitfield borrowed a number of bullocks to help clear the new route to Toodyay; when they died suddenly on the road, the post-mortem he conducted revealed an abundance of a pea-flowered shrub in their stomachs.

Such stock losses were causing greater problems to the settlers than any other calamity with which their unfamiliar and harsh new land threatened them. Fire, drought, floods, and clashes with Aborigines were all overcome with some difficulty, but replacement of domestic stock was more difficult by far.

The solution to the cause of death of so many animals was resolved, though acrimoniously, in a dispute between the two major plant collectors of the infant Swan River Colony - James Drummond and Ludwig Preiss. Drummond, a Scot, had come with Captain Stirling's first group of settlers to the Swan River in 1829, and ultimately established a farm at Toodyay. His first love was botany, and he delighted in collecting specimens of the diverse south-western flora, many of which were shipped back to England for classification and description by professional botanists. Preiss, a young German botanist, collected extensively in the South West between 1839 and 1841, and sold his specimens to various herbaria in Europe. Between them, Drummond and Preiss discovered the majority of the toxic species.

In October 1840, Drummond and Preiss botanised together around Albany, and apparently fell out. They were called north to Balgarup near Kojonup to investigate yet another case of massive death of sheep. At the time, Drummond suspected Woodbridge poison (*Isotoma hypocrateriformis*), a fleshy annual herb. Preiss disputed this, and no doubt was pleased when no effect at all was seen in sheep that were fed the plant. Next, a pea-flowered plant was tried, which Preiss also believed to be harmless. Drummond did not agree, but departed for home. Shortly afterwards, other members of the party witnessed the sheep die suddenly.

Travelling north to Williams, Drummond stayed with Joseph Harris, who had suffered substantial stock losses. Drummond recognised that the same pea as at Balgarup was present where Harris's sheep had been feeding. This pea was fed to a goat, which died within 14 hours.

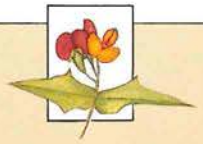
Drummond was convinced, identifying York Road poison (*Gastrolobium calycinum*) as the culprit. He published his observations, and immediately was attacked by Preiss and by settlers interested in promoting the

Prickly poison (*G. spinosum*)
Photo - T.E.H. Aplin

River poison (*G. forrestii*)
Photo - T.E.H. Aplin

Thick-leaf poison (*G. crassifolium*)
Photo - T.E.H. Aplin

York Road poison (*G. calycinum*)
Photo - T.E.H. Aplin



A NEW CLASSIFICATION OF GASTROLOBIUM, OXYLOBIUM, CALLISTACHYS AND NEMCIA

The botanical classification of poisonous Western Australian peas was substantially revised in 1987 by Dr M.D. Crisp of the Australian National Botanic Gardens, Canberra, and Dr P. H. Weston of Sydney's Royal Botanic Gardens. They proposed that all poison peas should be placed in the genus *Gastrolobium*, while related non-toxic species were best placed in *Oxylobium*, *Callistachys* or *Nemcia*. Traditionally, *Gastrolobium* was distinguishable from *Oxylobium* in having only two ovules in the pod, whereas *Oxylobium* has four or more ovules. Defined in this way, both *Gastrolobium* and *Oxylobium* had toxic and non-toxic species within them.

West Australian botanists C.A. Gardner and T.E.H. Aplin were the first to suggest that this approach was unsatisfactory. This view was supported by Crisp and Weston, who argued that placing unrelated species in the same genus and keeping closely related species apart, simply because of differences in ovule number, was undesirable. If all the poisonous species are grouped together in *Gastrolobium*, a more satisfactory classification results. Apart from containing monofluoroacetate, this group of species also have three-lobed bracts, the leaf-like structures subtending the flowers, a bell-shaped calyx, and small egg-shaped or elliptical pods. Thus, Crisp and Weston transferred seven poisonous species of *Oxylobium* into *Gastrolobium*, and removed 20 non-toxic species of *Gastrolobium* to the genus *Nemcia*.

Oxylobium remains a genus of non-toxic species, the classification of which requires further research. The distinctive large shrub of swamp margins, *Oxylobium lanceolatum*, was placed in a genus on its own as *Callistachys lanceolatum*. As now recognised, *Gastrolobium* contains the following 40 species (with thanks to Dr M. Crisp and Mrs S. Patrick for advice):

WESTERN AUSTRALIA'S POISONOUS GASTROLOBIUMS

Scale-leaf poison (*Gastrolobium appressum*)
Cluster poison (*Gastrolobium bennettsianum*)
Heart-leaf poison (*Gastrolobium bilobum*)
Rock poison (*Gastrolobium callistachys*)
Gastrolobium brownii
York Road poison (*Gastrolobium calycinum*)
Thick-leaf poison (*Gastrolobium crassifolium*)
Mallet poison (*Gastrolobium densifolium*)
Wodjil poison (*Gastrolobium floribundum*)
River poison (*Gastrolobium forrestii*)
Spike poison (*Gastrolobium glaucum*)
Wall-flower poison (*Gastrolobium grandiflorum*)
Granite poison (*Gastrolobium graniticum* - was *Oxylobium graniticum*)
Hook-point poison (*Gastrolobium hamulosum*)
Slender poison (*Gastrolobium heterophyllum* - was *Oxylobium heterophyllum*)
Breelya or kite-leaf poison (*Gastrolobium laytonii*)
Sandplain poison (*Gastrolobium microcarpum*)
Runner poison (*Gastrolobium ovalifolium*)
Gastrolobium aff. *ovalifolium*
Champion Bay poison (*Gastrolobium oxylobioides*)
Box poison (*Gastrolobium parviflorum* - was *Oxylobium parviflorum*)
Gastrolobium aff. *parviflorum* (Grass Patch-Salmon Gums)
Gastrolobium aff. *parviflorum* (Fitzgerald River-Ravensthorpe)
Berry poison (*Gastrolobium parvifolium*)
Horned poison and Hill River poison (*Gastrolobium polystachyum*)
Hutt River poison (*Gastrolobium propinquum*)
Round-leaf poison (*Gastrolobium pycnostachyum*)
Net-leaf poison (*Gastrolobium racemosum* - was *Oxylobium racemosum*)
Rigid-leaf poison (*Gastrolobium rigidum* - was *Oxylobium rigidum*)
Gilbernine poison (*Gastrolobium rotundifolium*)
Roe's poison (*Gastrolobium spectabile* - was *Oxylobium spectabile*)
Prickly poison (*Gastrolobium spinosum*)
Narrow-leaf poison (*Gastrolobium stenophyllum*)
Brother-Brother (*Gastrolobium tetragonophyllum* - was *Oxylobium tetragonophyllum*)
Woolly poison (*Gastrolobium tomentosum*)
Bullock poison (*Gastrolobium trilobum*)
Gastrolobium truncatum
Stirling Range poison (*Gastrolobium velutinum*)
Crinkle-leaf poison (*Gastrolobium villosum*)
Gastrolobium sp. (Albany-Esperance).

The most toxic form of prickly poison, *Gastrolobium spinosum* var. *grandiflorum*, showing the small elliptic pods characteristic of all poison peas.
Photo - S.D. Hopper ◄◄

Kite-leaf poison (*G. laytonii*) may grow 6 m tall on granite outcrops in Murchison pastoral station country.
Photo - S. D. Hopper ◄

farming districts where the poisonous pea occurred. Preiss agreed that the pea could kill, but argued that its prickly leaves, hairy pods and woody stems irritated stomachs rather than contained a poison.

The dispute was resolved in May 1841 before a committee of members of the Agricultural Society, with Drummond present but Preiss declining an invitation. Pounded extracts from another gastrolobium (*oxylobioides*, Champion Bay poison) were fed to sheep and goats, all of which died within three hours.

Rica Erickson, in her book *The Drummonds of Hawthornden*, succinctly relates the aftermath:

Following these experiments shepherds sometimes carried branches of the poison plants to help them identify those which must be avoided. Whenever stock became sick while travelling, the drovers searched in the vicinity for unfamiliar pea-flowered shrubs. Before long, parties of men were occasionally employed to clear the poison plants for a chain or so either side of the main roads.

Thus began the selective eradication of poison plants, the bane of agricultural development in south-western Australia throughout much of its short history.

GOLD, PEOPLE AND POISON

Thanks to gold rushes and a population explosion in the nineteenth century, agriculture became a major government focus. By 1880, Western Australia had a small colonial population of 29 500, and public revenue was a mere £180 000 p.a. The discovery of gold brought greater prosperity (£3 000 000 p.a.), and a sixfold increase in population of European descent by 1900.

Consequently, massive expansion of the wheat and sheep industry through government-assisted settlement schemes was undertaken in the 1890s and early 1900s. But poison plants were encountered in most new agricultural districts, and continued to account for heavy stock losses.

The identification of poison plants, weeds and forage species was of sufficient economic importance to warrant the appointment of a succession of government botanists attached to the Department of Agriculture and its predecessor, the Bureau of Agriculture. Constituted in 1894, the Bureau appointed Dr Alexander Morrison in 1897 as its first botanist to catalogue and describe the poison plants of WA for a chapter in a book entitled *The West Australian Settlers' Guide and Farmers' Handbook*. Morrison was retrenched in 1906, but remained active in Western Australian botany until he left the State in 1912. In 1909, he steered to publication Bulletin No. 32 of the WA Department of Agriculture, entitled *The Poison Plants of Western Australia*. Thus Morrison pioneered botanical understanding of the poison plants in the context of rapid agricultural development.

Constant encounters with poison plants by pioneer wheat farmers made it necessary to look for successors to Morrison. One of them, Desmond Herbert, produced a new Bulletin (No. 96) in 1921, entitled *Plants Poisonous to Livestock in Western Australia*. This was revised in 1926, after which two of the editors, Charles Gardner and H.W. Bennetts, worked together on poison plants for 30 years, culminating in the publication in 1956 of a major book, *The Toxic Plants of Western Australia*. This appeared at the start of another major wave of agricultural development arising from the widespread introduction of the bulldozer to rapidly clear land, and the discovery of trace element deficiencies in light sandy soils. More farmers than ever were encountering poison plants on new lands, and needed a ready reference to assist in their identification.

More recently, responsibilities for poison plant botany were assumed largely by Bob Royce and then T.E.H. (Ted) Aplin at the Western Australian Herbarium. Aplin published a number of articles on poison plants over the period 1966-1971, which were collated in a colour booklet, *Poison Plants of Western Australia*, published in 1973 as Bulletin No. 3772 by the Department of Agriculture.

Staff of the Western Australian Herbarium continue to help farmers identify poison plants, but much more of their research these days is directed at conserving native flora. Indeed in 1988, after 91 years of association with the Department of Agriculture, botanists of the Western Australian Herbarium were transferred to the Department of Conservation and Land Management (CALM). The transfer reflected changing community attitudes towards native flora and the need to conserve it. In fact, the succession of government botanists employed by the Department of Agriculture played a big part in achieving recognition of the intrinsic conservation values of wildflowers. Charles Gardner, for example, who was Government Botanist 1929-60, published widely on the flora, and was central to the creation of such important conservation reserves as Kalbarri, Fitzgerald River and Cape Arid National Parks, Jilbadji Nature Reserve, and the Beekeepers' Flora Reserve.

CHANGING ATTITUDES

Even poison plants are now perceived as worth conserving, from several perspectives. In recent years, gastrolobiums have had a more benign public profile. It is now realized that many outstanding conservation reserves of the Wheatbelt would have been cleared long ago were it not for the presence of these toxic shrubby peas. Surveyor A.C. Gregory, for example, in a letter to the Surveyor General in October 1850, described the route chosen for droving stock from the drought-afflicted York and Toodyay areas north to the newly opened pastoral district of Champion Bay (Geraldton):

On the 28th Mr L. Burges came up with his cattle and on the following day we started to decide the best manner of avoiding the Gairdner Range which is impracticable for carts from the rocky nature of the ground and at the same time abounds with a variety of the poisonous plant which renders it unsuitable for travelling with sheep. [The route chosen] involves a detour to the south of the Gairdner range and increases the distance 20 miles but the poisonous plant is so abundant on that part of the range of hills on which Mr Drummond has taken up his licence near Mt Lesueur that stock cannot be driven through it with safety.

Thus, the presence of poison plants was one of the major factors that spared the now famous Mt Lesueur area from agricultural development, and has enabled belated appreciation of its internationally important plant and animal life. A similar story could be repeated for the Stirling Range, Tutanning Nature Reserve near Pingelly, and many other significant areas of remnant native vegetation in the Wheatbelt. Even hilltops, normally too rocky for cultivation but suitable for grazing, were protected from disturbance by the presence of poison plants.

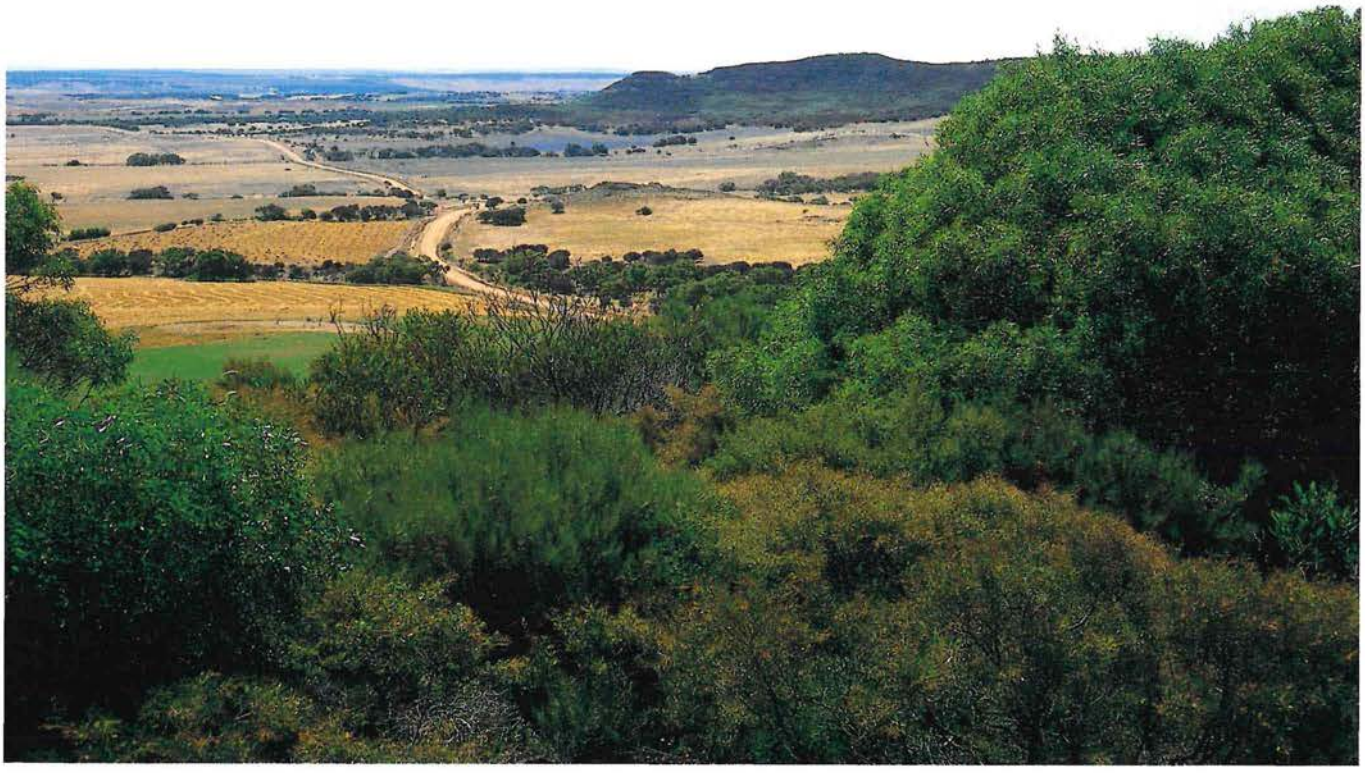
Apart from their important contribution to conservation, poison plants offer a rich palette of stories of intrigue and botanical folk-lore, and a bizarre link to the safe poisoning of introduced feral animals without fear of dispatching native fauna (see box). Moreover, attitudes have changed so much that the active eradication so long practised against poison plants has recently been replaced by growing concern for the conservation of several species now considered endangered.

THE POISON PLANT SURVEY

In 1989 the World Wide Fund for Nature (WWF Australia) and the Department of Conservation and Land Management (CALM) funded a survey for 14 species of the rarest poison plants. Dr Jane Sampson, the part-time coordinator, enlisted 47 volunteer individuals or groups to help in the search.

Fifty-one new records were made by this team, adding substantially to the 200 sites previously recorded for the 14 species. The survey revealed the occurrence of one or possibly two new species. It clarified the identity of previously misidentified populations. And it led to a much enhanced understanding of the conservation status of the species surveyed.

A significant outcome was the recommendation that three species should be added to the State's list of Declared Threatened Flora - rock poison (*Gastrolobium callistachys*), granite poison (*G. graniticum*), and hook-point poison (*G. hamulosum*). Rock poison was found in only three small populations on granite outcrops or laterite ridges between Watheroo and Kellerberrin. Similarly, granite poison was found in only three populations with an aggregate total of less than 50 plants, all near Coolgardie. Hook-point poison was found to be in dire circumstances, with only



Moresby Range, near Geraldton. Remnants of native vegetation on hilltops throughout the Wheatbelt were often left uncleared because they contained poison plants.
Photo - Robert Garvey

Broad-leaf form of York Road poison grows on gravel or granite between Watheroo, Ballidu and Wannamal to the north-east of Perth.
Photo - M. & I. Morcombe

four plants located on a weed-infested road verge near Wongan Hills.

The recommendation for special legal protection of these three species was implemented by the Minister for the Environment by a notice placed in the *Government Gazette* of 1 June 1990. The three newly listed poison plants joined three others that had been so protected earlier - scale-leaf poison (*G. appressum*) from the Watheroo district, spike poison (*G. glaucum*) from Wongan Hills, and woolly poison (*G. tomentosum*) from near Narrogin. As an additional safeguard to protecting wild populations, collections were made of seed of 10 of the species surveyed, then passed on to Kings Park and Botanic Garden and the CALM Seed Centre for long-term storage.

The survey highlighted the plight of the rarer members of this remarkable group of plants. Protection and active management of remnant vegetation in the Wheatbelt will be essential to ensure their conservation in perpetuity.

Some of the additional collections made during the survey have also helped in the naming and classification in progress on these plants. Since the survey, three new species of gastrolobium have been recognised as well as several species of *Nemcia* (the genus to which the non-toxic members of *Gastrolobium* and *Oxylobium* now belong). Our knowledge of this interesting group of plants is by no means complete, which is another reason to conserve them.

Poison plants, for so long an important concern in the affairs of farmers of this State, deserve conservation. They are truly part of our cultural as well as biological heritage. The lessons they have to teach would be sorely missed should they ever disappear entirely from the Wheatbelt.

Steve Hopper is a Senior Principal Research Scientist at CALM's WA Wildlife Research Centre at Woodvale. He can be contacted on (09) 405 5100.

POISON PLANTS HELP CONSERVE NATIVE MAMMALS

All the toxic gastrolobiums are confined to south-western Australia except the northern Australian *G. grandiflorum*. *Acacia georginiae*, found only near the Queensland/Northern Territory border, is the only other native Australian plant known to contain the toxin called monofluoroacetic acid. The sodium salt of this toxin is Compound 1080, a widely used pesticide.

South-west Australian populations of herbivorous mammals such as the western grey kangaroo, the bush rat and the brush-tailed possum have been shown to have tolerances of 1080 intoxification well above the normal range of eastern populations. For example, it takes on average 35 times as much 1080 to kill south-western bush rats as it does for eastern Australian bush rats, and more than 150 times as much for south-western compared with eastern brush-tailed possums. High levels of tolerance are now known to occur in a wide range of south-western animals, including insects, reptiles, birds and both marsupial and eutherian (non-pouched) mammals.

Researchers with the Agriculture Protection Board of Western Australia have proposed that these high tolerances in south-western populations have evolved due to grazing on gastrolobiums. Being legumes, these poison plants are highly nutritious. Some are also abundant, especially after fire (e.g. heart-leaf poison *Gastrolobium bilobum*, and box poison *G. parviflorum*). Many gastrolobiums are soft-leaved and succulent, and produce new growth in autumn at a time when herbivorous forage is limited in south-western Australia. The inclusion of some gastrolobium material in the diet of native mammals would be highly advantageous if resistance to their toxicity has evolved. Presumably, natural selection has followed this path in south-western Australia.

Poisoning of rabbits and secondary poisoning of cats and foxes can occur, therefore, with little risk of adverse effects on indigenous fauna.

It also appears that native fauna is not only largely resistant to the undesirable effects of poison plants, but also benefits by their provision of habitat and shelter from predators such as foxes. So poison plants have an important role to play in conserving native mammals.

DRAGONS *of the* DESERT

BY DAVID PEARSON

The word 'dragons' conjures up visions of massive firebreathing monsters. However, a large group of Australian lizards are known as dragons and include some bizarre and unique reptiles, such as the thorny devil and frill-necked lizard. They are found in habitats as diverse as rainforest and desert.

Ctenophorus cristatus Photo - David Pearson

A little over 60 species of dragon lizards are currently known in Australia, with most living in semi-arid and arid parts of the continent. In desert areas they are particularly conspicuous, and several different species often coexist in the same area. Many species tend to have a strong preference for certain habitats such as rock-piles or even beds of salt-lakes.

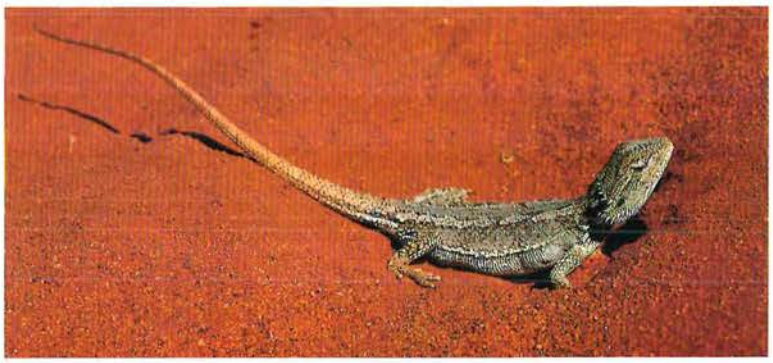
SPINIFEX SPEEDSTERS

Some of the most colourful dragons live in spinifex grasslands, but they can be difficult to follow and observe because they move so quickly when disturbed. Some have the ability to rise up and run on their back legs, often at speeds of up to 20 kilometres an hour, which has earnt *Ctenophorus cristatus* the name of 'bicycle lizard'. This speed, along with their acute eyesight, is needed by dragons to avoid predators and to capture food. Since they are mostly active by day and search for food in the open, birds of prey such as hawks are their main predators.

Most dragon lizards employ a 'sit and wait' feeding strategy - they elevate their heads to get a good view of the surroundings and then wait until a suitable morsel comes into sight. They then race forward, seize their prey with their jaws and gulp them down. Ants and other insects are the main items eaten, although some of the larger species eat large amounts of plant material.

KEEPING HOT

During the cool winter months desert dragon lizards retreat to a burrow and wait for warmer weather. The average summer day for a dragon is largely dominated by the need to constantly shift to maintain its preferred body temperature. Most species like their body temperature in the mid-30s (degrees Celcius), and do a variety of things to keep it at this level, including basking in the sun, seeking shade during the hot part of the day, or changing the orientation of their body relative to the sun by climbing onto a bush or rock. As the sun begins to set, dragons move to sites where they receive radiated heat, such as rock slabs or hot sand.



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Spinifex grassland in the Gibson Desert, home for several species of dragon.
Photo - David Pearson

The thorny devil (*Moloch horridus*), a slow-moving dragon which feeds mainly on ants.
Photo - David Pearson

A bearded dragon (*Pogona minor*) excavating a nest chamber before laying its eggs.
Photo - David Pearson

Ctenophorus rufescens is a dragon known only from a few rocky ranges in central Australia.
Photo - David Pearson

The western netted dragon (*Ctenophorus reticulatus*) is usually found in rocky habitat throughout central western and south Australia.
Photo - Michael Morcombe

Male and female dragons usually differ in colour. Males are brighter, particularly in the breeding season when the belly, chest and inside legs of the males of some species are a brilliant glossy black. Behaviour during courtship often involves unusual displays of head bobbing or arm waving. The purpose of these displays is not understood.

Very little is known about the ecology of most species of dragons. A Department of Conservation and Land Management (CALM) study in the Great Victoria Desert has been looking at how different dragons respond to fires.

An interesting sequence of events, called a succession, follows a fire. The military dragon (*Ctenophorus isolepis*), a lightning-fast species which hunts its food between and along the edges of spinifex hummocks, disappears soon after a fire, probably a victim of the ever-present birds of prey. Other robust-bodied dragons move into the burnt area and quickly breed. Since they operate in an exposed situation, these species have skin colours which blend well with the mottled appearance of the ground surface and build extensive burrows to foil predators. They have acute eyesight and quickly retreat to their burrows when danger threatens. One of them, the small Clay's dragon (*Ctenophorus clayi*), launches an aggressive display when threatened, baring its bright-pink mouth and advancing to inflict a bite.

As the spinifex regenerates after a fire, dragons such as the military dragon are able to reinvade the area and re-establish, provided there are nearby unburnt refuge areas. As spinifex is slow to regenerate, this phase of the succession could take from five to ten years, depending on the unpredictable desert rainfall.

Dragons are fascinating and colourful, but we are still ignorant about a great many aspects of their ecology. If you are planning to visit a desert area, think about going in the warmer spring months so you can observe some of these delightful desert speedsters. ▣

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A spinifex fire in the Great Victoria Desert.
Photo - David Pearson

The aggressive display of *Ctenophorus clayi* is designed to intimidate predators.
Photo - David Pearson

The central netted dragon (*Ctenophorus inermis*) prefers more open habitats such as mulga woodland or recently burnt areas.
Photo - Michael Morcombe

David Pearson is a research scientist at CALM's Wildlife Research Centre at Woodvale. He has been studying lizards and small mammals in desert nature reserves and can be contacted on 405 5100.

URBAN ANTICS!

FROGS

Winter again. Water, wet grass, pools, ponds, puddles ... and frogs.

It's time to be entertained again by those neckless, fat-bellied, goggle-eyed, big-mouthed sons of tadpoles that seem to win their way into our hearts, homes and swimming pools at least once a year.

For ages, the frog has been one of the animals most likely to share in the lives of children. Nursery rhymes, pop songs, squeaky toys in the bath, tadpoles in jars, chocolate Fredos and, most important of all, the King: Kermit with his daily children's TV workshop.

Frogs are amphibians. Most spend part of their lives as water animals and part as land animals. Some live their entire lives in or near water while others never come near water, even to mate.

Only two families of frogs are found in and around Perth's Swan Coastal Plain - tree frogs and ground dwellers (or burrowers). More than 20 species, however, of all shapes, sizes, colours and calling sounds, make up these families.

Most frogs have a thin, moist skin and are also cold-blooded, so they tend to live in cooler places such as leaf-litter, in dense vegetation, wetland areas or underground. It is after summer or autumn rains that humans and frogs most often come into contact. The frogs emerge from their hiding spots to relish the cool cleansing rain, catch a juicy bug and perhaps find a mate. Driving around any of our suburban wetland parks on a rainy night can be quite soul-destroying, as thousands of beasts cover roadways and are accidentally run over.

Throughout suburban Perth there have been a few interesting frog reports of late. One householder was amazed to find his privacy invaded by a couple of slippery characters on his window ledge. Further observation revealed that his visitors were successfully climbing the glass pane to catch insects attracted by the electric light. Even more interesting was the discovery a day or so later of frogs hiding under the leaf-litter in the roof-gutter above the window.

At different times of the year, depending on the species, females respond to the loud calls of males and move towards the source of the noise. Mating occurs and eggs are laid. Recently, moaning frogs have made themselves very unpopular in Booragoon backyards. These stout, burrowing species have been calling before the autumn rain and their loud, low moans have infuriated would-be sleepers. If this happens to you, saturate the area thoroughly with a hose and the culprits will move away.

The rarely seen, bizarre-looking turtle frog has also made an appearance in the metropolitan area, with one being found in Kings park. Another was caught by a dog, which suffered for his trouble with a frothing mouth caused by skin toxins.

All frogs secrete a varying toxicity of poison through glands around their body. Equally, though, human handling of delicate-skinned frogs has a damaging effect on the poor old frog. So be careful!

For more stories on frogs, visit your local library. Better still, rush to your local wetland and, in the solitude of thick vegetation, experience an orchestra of sound from frog calls like you've never dreamed possible.

JOHN HUNTER

DID YOU KNOW?

- *Frogs appeared on Earth about 180 million years ago. About 2 700 species of frogs and toads exist today.*
- *Toads are different from frogs. They have a broader, flatter body and darker, drier, warty skin. No toads occur naturally in Australia.*
- *A frog's eyes bulge out, enabling nearly all-round vision. To aid the swallowing of prey, the eyes sink through openings in the skull and force food down the throat.*

TAKE A WALK ON THE *Wild Side*

Wildflower Country *is the latest release in CALM's best-selling series of nature guide books designed to take a closer look at specific areas of our vast State.*

Wildflower Country *covers all the national parks, nature reserves and other natural attractions from Jurien Bay to Shark Bay and inland as far as Meekatharra, with particular emphasis on the region's outstanding flora.*

It deals with the history, local attractions, flora and fauna of five areas - the northern sandplains, Batavia coast, northern wheatbelt, Murchison, and Shark Bay.

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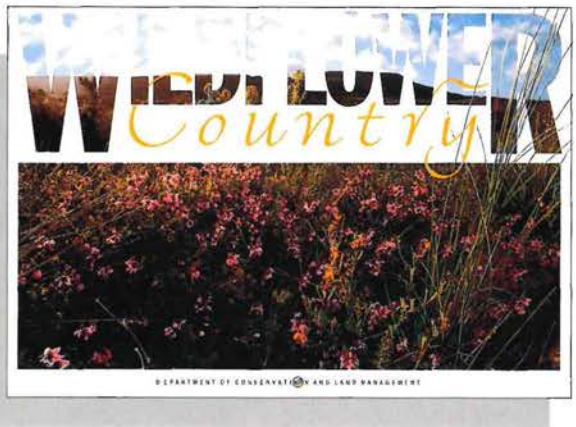

Available from major bookstores or direct from CALM.
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A pygmy possum drops in for lunch,
at a stretch, off *Banksia coccinea*.

Photo - Michael Morcombe