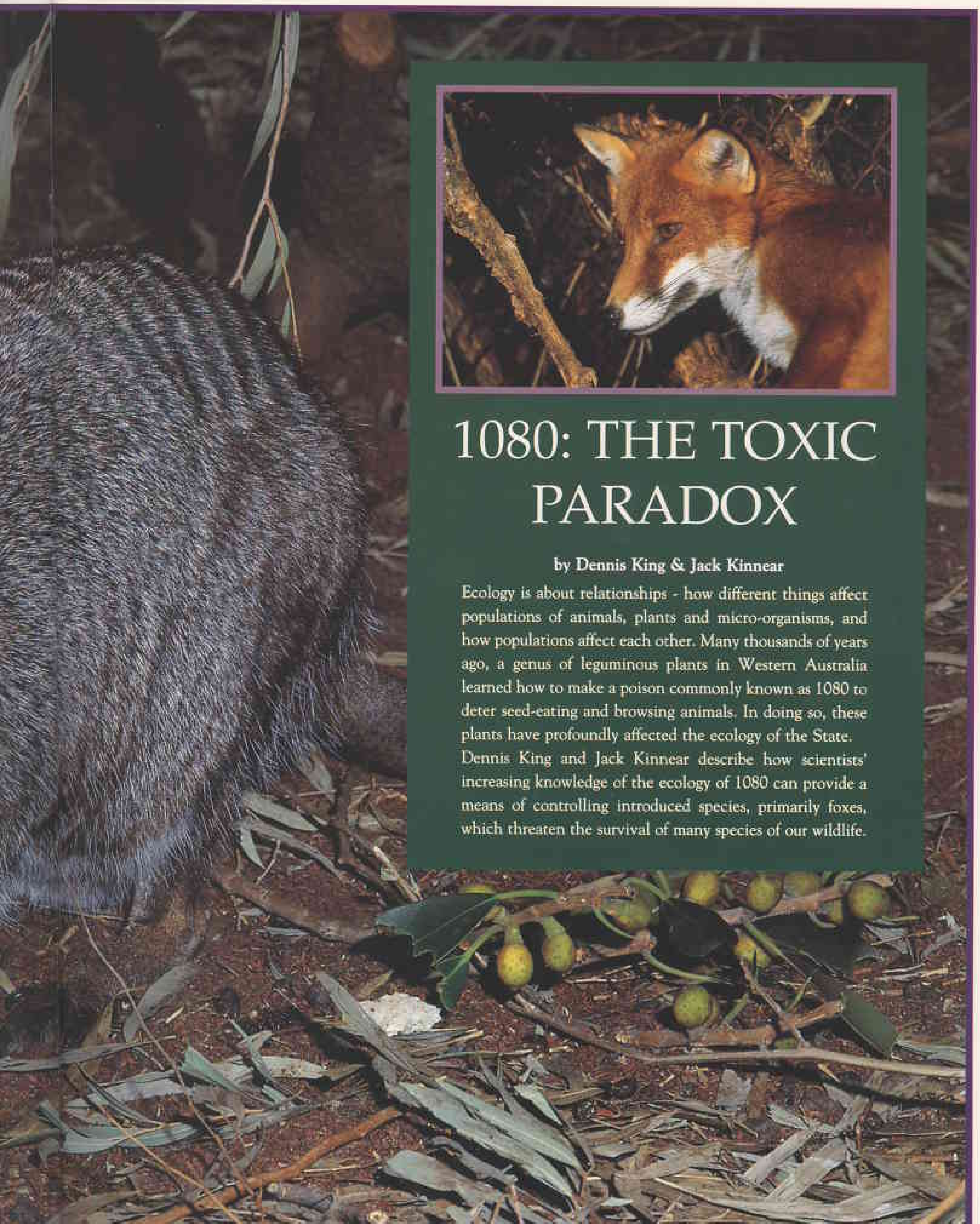

1080: THE TOXIC PARADOX

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.

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

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

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.

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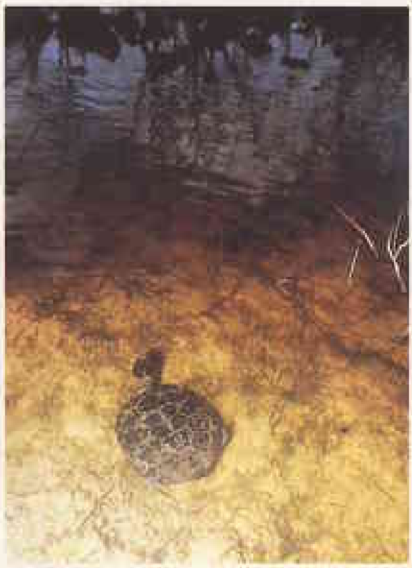
Cloud-capped Bluff Knoll, majestically brooding sentinel of the Stirling Range. Does it hold a secret in its stony heart - perhaps the answer to the missing mammal mystery? See story on page 9.



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.

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.

FEATURES

REGULARS

COVER

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.

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