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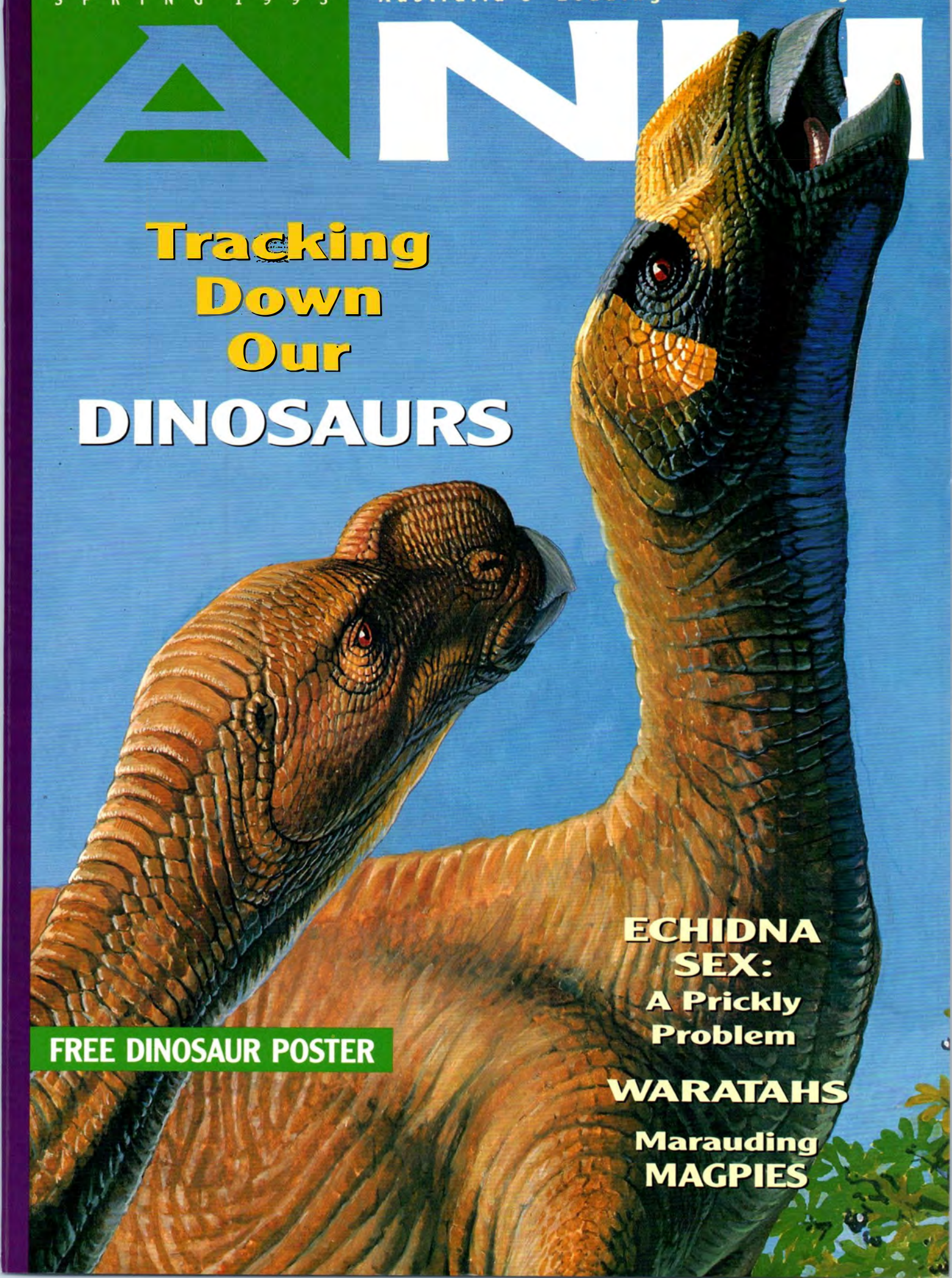
ANIMA

Tracking Down Our DINOSAURS



FREE DINOSAUR POSTER

ECHIDNA SEX: A Prickly Problem

WARATAHS

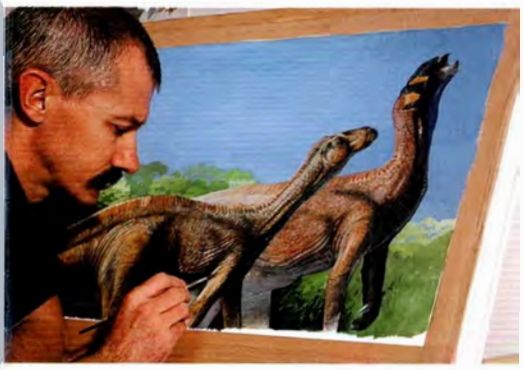
Marauding MAGPIES

Up Front

DOUGLAS ELFORD/W.A. MUSEUM

John Long looking for fossils.

In the future . . . will there be dinosaurs? Could we really recreate dinosaurs from samples of their DNA? It seems to belong more to the realm of fantasy but could the novel *Jurassic Park* by Michael Crichton become a reality? With the release in Australia of the movie "Jurassic Park", dinosaurs are receiving massive publicity and its important we realise that they don't just 'belong' to the Northern Hemisphere. In fact, Australia boasts its own quite unique dinosaur fauna. We asked Dr John Long of the Western Australian Museum to help us shed some light on the "Dinosaurs Downunder". He shares with us the excitement of finding his first dinosaur bone, explains why some of our dinosaurs are challenging current scientific thinking, and profiles the best Australian dinosaur finds to date. And, to show you what one of our best-known dinosaurs might have looked like, we invited scientific illustrator Peter Schouten to create a reconstruction of *Muttaburrasaurus langdoni* based on the most up-to-date fossil evidence available. After some helpful advice from palaeontologists our front cover was 'born'. We are so proud of this magnificent illustration that we have decided to give you the chance to win the original framed artwork. To be eligible to win, all you have to do is be a current subscriber on 17 December 1993!



AUSTRALIAN MUSEUM

Peter Schouten working on the *Muttaburrasaurus* illustration.

Still on fossils, you may have followed the plight of Eric, the opalised pliosaur. For a while it looked like he would be heading overseas but, with the help of Quantum, Akubra Hats and thousands of enthusiastic and generous people, Eric's permanent home is now the Australian Museum. As a special thankyou from ANH we have included a bonus poster of Eric in this issue.

–Jennifer Saunders

ANH

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Front Cover
Discovered in Queensland in 1963, *Muttaburrasaurus langdoni* is a plant-eating ornithopod dinosaur. Here the male is shown displaying both visually and verbally in order to attract the attentions of a female. Illustration by Peter Schouten. (Subscribe to ANH and you could win this magnificent original artwork.)

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LETTERS

The forum for readers to air their views about their concerns, past articles and interesting personal events.

Protecting Coral Reefs

I was stimulated to write this letter after reading Tim Flannery's article "The Diversity Enigma" (ANH Winter 1992). In it, Tim draws analogies between infertile heathlands and coral reefs, pointing out the impressive species diversity of both ecosystems that seems to result from very low nutrient levels. The heathlands of south-western Western Australia exist because they were too infertile to be considered for farming, and were therefore never cleared. However, even in the more fertile soils that we do farm, yields would be very poor if we did not add copious amounts of nitrogenous fertiliser before growing our products.

We accept that we must regularly replenish the soil's nutrients, yet we allow people to fish our coral reefs without any consideration for the consequences of removing huge amounts of protein from the reef system.

The Ningaloo Reef area of Western Australia has in the past enjoyed a reputation as one of the prime fishing areas of the whole continent. Large numbers of visitors spend the winter months camping along the coast and fishing every day. It is estimated by Western Australian Fisheries that 100,000 kilograms of fillets are removed annually. In the last ten years there has been a progressive decline in fish stocks, and the coral reef has suffered severe destruction—ostensibly from a plague of the marine snail *Drupella cornus*. While it is difficult to establish a direct link to the cause of the *Drupella* plague, the pressure from fishing may have contributed, and the *Drupella* plague may not be the sole cause of the destruction.

We only catch the predatory fish of the reef—they are the ones that take the bait. These are also the ones that normally feed on molluscs and coral-grazing fish. Hence, with their removal, we allow proliferation of the coral grazers and therefore greater destruction of the coral. This much is fairly obvious. There may, however, be another factor in the equation. By removing huge amounts of protein from the reef food chain over many years, we may have depleted the ecosystem of sufficient protein for adequate coral growth, and so impeded recovery from the increased grazing pressure.

Thankfully, Ningaloo Reef is now a marine park with several sanctuary zones protecting 20 per cent of the inshore waters, and the Western Australian Fisheries Department has introduced restrictive bag limits to protect the fishery. The taking of predatory reef species by spearfishermen is also banned. But only time will tell whether these measures are sufficient to have an impact at this late stage.

—Geoff Taylor
Exmouth, W.A.

GEOFF TAYLOR

Heavily grazed coral that has survived a plague of the marine snail *Drupella cornus*.

Getting it Right

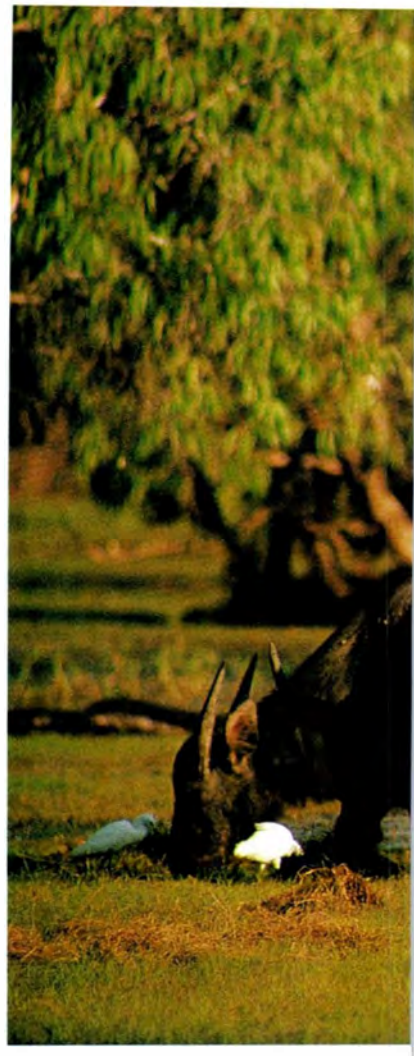
I began to read with great interest Tim Low's article "Italians and Birds, Kanakas and Yams" in the Summer 1992–93 issue of ANH. My interest increased as I read the first and second paragraphs. However, as I read on to paragraphs three and four my (Italian) temper began to rise.

First, "Bamberoo", my old home township, should be Bambaroo. Second, Bambaroo was populated by Italian migrants long before the Kanaka trade ended and, if Mr Low made enquiries, he would find that many descendants of these early migrants still lived in Bambaroo and the Ingham district. I am a descendant of these early migrants and lived in Bambaroo from my birth until 1959, and am still in touch with the locals.

I would like to point out to Mr Low that it was not the general practice of the Italians in the area to eat the species mentioned by John and Toni Truffa. This may have been *their* practice but not the general practice of Italians who lived in the area long before Mr and Mrs Truffa did.

I can recollect that 'scrub turkey', duck and wild pig were eaten but this was mainly as a result of someone's sport, that is shooting, not from necessity. Meat was plentiful and was railed from the butcher at Yuruga to Bambaroo three times a week.

As for his statement "Times were tough for the first generation, and wild birds were an important food", I can only say that the generation he speaks of lived in luxury compared to the early Italian settlers, but the wild birds spoken of by John and Toni Truffa, except for the duck and 'scrub turkey', were not an important food source.



Does the survival of feral herds of Water Buffalo indicate Aborigines were not efficient exterminators of large game?

—Bruna Gugenberger
Boondall, Qld

Talk Turkey

The male brush-turkey builds
a mound
By raking up leaf
litter,
His harlot hen just hangs
around
Inspecting his bed-
sitter.
Should she approve this base
abode
To boost heir population,
A brisk, three-second
episode
Takes care of copulation.
She shoves him off then digs
a hole
Inside his leafy bower,
Then lays an egg, this
rigmarole

Takes scarcely half an hour.
The hapless chap has not a clue
That missus does philander,
And that this egg, her doodle-doo
Is of another gander.
He pecks and belts her on the head,
Then sends his pick-up packing,
To find another male, misled,
As once more she gets cracking.
Pop tends the incubation mound,
He doesn't mind the waiting,
For though he's more or less housebound,
There's lots of chooks for mating.

—Dr Len Green
Vaucluse, NSW

Examining the Aye-aye

The QQC item "Knocking on Wood" on the Madagascan Aye-aye (ANH Spring 1992) was fascinating. However, I do not believe it is necessary to evoke cutaneous sense, or the use of the Aye-aye's middle digit as a resonating device, to explain how it locates grubs in the hollow chambers of tree limbs. Every medical student knows that the four modes of physical examination are inspection, palpation, percussion and auscultation. Percussion is used to elicit physical signs of dullness or resonance in various body cavities, principally the chest and abdomen. Have you ever wondered what the doctor was doing when he tapped the back of your chest during a respiratory examination? The tone of the taps can be used to elicit dullness or resonance and indicate basically whether there is fluid (dull) or air (resonance) in the cavity being examined. Surely, the Aye-aye is practising similar techniques in locating the hollow chambers in which grubs are to be found. The real question remaining is whether the Aye-aye represents the primordial medical student or the first deviation of doctors from the rest of the evolutionary tree!

—Dr Serge Lubicz
Melbourne, Vic.

Tough Game

In his article "Who Killed Kirlilpi?", Tim Flannery suggests that Aborigines played an important part in the extinction of marsupial megafauna (ANH Summer 1989–90). However, I believe the evidence from northern Australia does not support this view.

For example, tribal Aborigines did not exterminate the original feral herds of Banteng and Water Buffalo soon after these domesticated stock became feral. These feral bovines have subsequently become an important source of meat in the diet of Aborigines throughout northern Australia. The custodians of Kakadu National Park insist on the retention of some buffalo in the park to serve as a supply of meat.

The survival of the feral herds may indicate that tribal Aborigines were not efficient exterminators of large game. This view certainly tallies with the recollections of the famous buffalo hunter Tom Cole. In the book *Hell west and crooked* (1988), Cole recounts how, during an expedition into the still remote East Alligator Valley, he had just run out of fresh meat when he met six Aborigines with fresh buffalo. He writes: "When I asked them how they got it they said they'd speared it. I knew their shovel spears were deadly weapons—and looked it—and I had heard of them spearing buffalo but was always doubtful. They said they'd found tracks and followed them for a day, coming up with a buffalo half-asleep under a tree just before sundown. They got two spears into it before it galloped away. They tracked it until dark, camped on its tracks and started at first light. They caught up with it about midday, got two more spears into it and picked one up that had fallen out, which was important—they had to conserve their ammunition. They caught up with it again about mid-afternoon and got another spear into it. This time it didn't gallop away but bailed up, trying to charge its tormentors. They were all behind trees and didn't have much difficulty dodging it. Eventually it went down; it had taken ten spears to kill it and I imagine it had dropped from loss of blood."

Even with helicopters and marksmen it has proven impossible to exterminate Water Buffalo, especially when numbers are reduced by control programs to very low levels. Surely the difficulty current land managers have in exterminating the feral megafauna of northern Australia indicates that Aboriginal people could not have been chiefly responsible for the extinction of the marsupial megafauna.

Aridity during the ice ages is a far more probable primary cause of the marsupial megafauna extinctions.

—D.M.J.S. Bowman
Wildlife Research, Conservation Commission of the NT

ANH welcomes letters for publication and requests that they be limited to 250 words and typed if possible. Please supply a daytime telephone number and type or print your name and address clearly on the letter. The best letter in each issue will receive a $20 gift voucher from the Museum Shop catalogue. The winner this issue is Dr Serge Lubicz.

D. PARER & E. PARER-COOK / AUSCAPE INTERNATIONAL

QUOTES & CURIOS

QUIPS

COMPILED BY GEORGINA HICKEY

Frogs that Talk with their feet

The most common way frogs communicate with each other is vocally. A unique sequence of croaks, ribbets and plonks identifies the caller and attracts mates of the same species. In the early 1980s, however, another form of communication, this time involving foot-flagging signals, was observed in a Bornean rainforest frog. And since then another three species, including the Eungella Torrent Frog (*Taudactylus eungellensis*) from Australia (see ANH Winter 1986), have also been reported to communicate visually. All four species were reported to live alongside noisy rainforest streams and it was suggested that foot-flagging evolved as an alternative method of attracting mates in these environments.

More recently, however, zoologists Stephen Richards (James Cook University) and Christina James (University of Queensland) have observed four more Australian frog species (all tree frogs of the genus *Litoria*) that use their feet to communicate, but it now seems that the foot-flagging behaviour is not what it was originally thought to be.

For a start, all observations were of interactions between male frogs, and so it appears the behaviour is related more to male–male aggression than to any form of courtship. Also, foot-flagging can no longer be thought of as being unique to noisy rainforest stream habitats. One of the frog species in which the behaviour was observed (the Eastern Dwarf Tree Frog, *L. fallax*) is a common inhabitant of open forest. In the light of these observations, the researchers strongly suspect that the previously reported cases of foot displays in frogs may also prove to have an aggressive rather than a courtship function.

Foot-flagging in frogs is not restricted to the hard-of-hearing.

COURTESY STEVE RICHARDS

***Litoria genimaculata*: new-found member of the foot-flagging frogs.**

—G.H.

The Time for Birth

The source of the signal that initiates birth in mammals has long eluded scientists. But, in recent experiments on sheep, researchers have identified a minute part of the foetal brain that seems to be crucial to the process.

In sheep, the 'birth signal' is so precise that gestation varies little from 147 days between individuals. Scientists have understood for some time that labour is preceded by a hormonal chain of events—the release of a hormone known

as ACTH from the foetal pituitary gland leads to an increase in the hormone cortisol from the foetal adrenal gland, which in turn alters the chemical balance in the mother's uterus and starts contractions.

Investigating the trigger for ACTH production, Thomas McDonald and Peter Nathanielsz, from Cornell University in New York, performed brain surgery on nine foetal lambs when their mothers reached 118–122 days gestation. In five lambs, they removed the tiny region known as the paraventricular nucleus on both sides of the brain. The remaining four lambs were used as controls, the researchers performing the same operations but leaving the nuclei intact.

The control foetuses were delivered on time. However, after 157 days, the other five animals were still not born and so were delivered by caesarean section.

The researchers believe this region of the brain continually receives and assesses messages about the development of foetal organs throughout pregnancy. It is thought that at the correct stage of development, it transmits a hormonal message to the foetal pituitary to start producing ACTH and initiate labour.

Understanding the timing controls underlying pregnancy could ultimately have enormous implications for reducing premature human births.

—K.McG.

J. CARNEMOLLA / APL

Who determines when it's time to be born: the mother or the baby?

WADE HUGHES/LOCHMAN TRANSPARENCIES

Fermented nectar can present a problem for beekeepers.

DRUNKEN BEES

Keeping bees for honey production or pollination of crops requires careful management. To prevent bees from wandering when local nectar supplies become scarce, for example, beekeepers feed them with artificial nectar (sugar syrup). But one problem with feeding the bees syrup is that it often ferments before it is utilised.

Effects of alcohol and other products of fermentation on Honey Bees (*Apis mellifera*) were investigated at the University of Queensland Gatton College by Errol Hassan and me. Bees fed fermented sugar syrup consumed less pollen than those fed fresh syrup, and resulted in lower populations of adults. This was due to decreased egg laying by the queen, decreased brood rearing by the worker bees and shortened life spans. Alcohol in the syrup is also suspected to disorient bees returning to the hive and cause rejection by guard bees due to their peculiar behaviour.

Work is currently under way to find out just how much fermentation can occur before normal growth and development of the Honey Bee colony is affected and honey production reduced.

—Andrew Kahenya
University of Queensland
Gatton College

AUSTRALIAN PICTURE LIBRARY

Red lipstick mimics sexual arousal.

red echoes sexual arousal. If you grasp your lip between thumb and forefinger, you can feel blood pulsing through. Lips become bright red during sexual arousal as they fill with even more blood, an effect mimicked by red lipstick.

Cherry asked if other animals kiss like us. The answer: our fellow primates do. In fact, as one surprised zoo keeper found, Pygmy Chimpanzees or Bonobos are well versed in the art of French kissing! One theory about the origins of the human kiss is that it began as a ritualised version of mothers passing chewed food to their offspring by mouth-to-mouth contact.

Effie concluded by saying that, while we "may be the only species to have evolved the office party...we are not the only creatures to be obsessed with our mouths during courtship".

—C.A.

The Science of Kissing

In one of the wacky Christmas issues of *New Scientist*, "agony aunt Effie Petting" answered readers' questions about the dangers and delights of smooching.

One reader, Rosie, was worried about the diseases she might catch from fellow workers at the office party. Saliva, reassured Effie, contains chemical weapons to fend off foreign microbes by dissolving their cell membranes and disrupting their metabolism. (This might also be the reasoning behind the idea that kissing a sore makes it better.) In one test, only one out of 13 people caught a cold from kissing an infected partner.

Ruby wondered why she was subjected to an "endless stream of slobber" when all she wanted was a "dry dutiful peck". Effie explained that that's partly because the average mouth generates enough saliva to fill two milk bottles a day! Also, it is pretty difficult to swallow when you have your mouth open. Enthusiastic kissing partners need to be encouraged to stop for a rest now and then.

Rufus confessed to buying his girlfriend red lipstick for Christmas every year. Effie's comment on his colour choice:

JULIO C. REYES

Peru's new whale species.

New Whale for Peru

Marine scientists have identified a new whale species, the first for nearly three decades. *Mesoplodon peruvianus* was described by Julio Reyes of the Peruvian Centre for Cetological Research and colleagues, from ten dead specimens washed up on the Peruvian coast. Drift gill nets set for sharks were responsible for six and perhaps seven of these. The other three resulted from strandings.

Mesoplodon peruvianus is a member of the family Ziphiidae—the beaked whales. This family accounts for nearly a third of the toothed whales but relatively little is known about its members. Most information comes, as it has done for its latest addition, from carcasses washed up on beaches.

Beaked whales have reduced numbers of teeth, and the genus *Mesoplodon* is charactersied by adult males having only two functional teeth located on the lower jaw.

The new species is the smallest so far described for the family. The longest adult specimen measures 3.72 metres. All ten specimens had uniformly grey bodies that lightened slightly towards the underside. Other key characteristics include a small skull and relatively small teeth (31–65 millimetres long).

Only four new whale species have been described in the last 50 years.

This is only the eleventh new whale species to be described this century, all of which are toothed whales. Seven are the elusive beaked whales and six of these are in the genus *Mesoplodon*. Although the number of new species of whale being described has definitely slowed in the last half of this century (only four new species have been described in the past 50 years), marine scientists still do not consider that all species have been discovered. They believe, for example, that there is at least one more spe-

cies of *Mesoplodon* to be described. This stems from a number of sightings of a distinctive and unrecognisable species of beaked whale in the eastern tropical Pacific.

—K.McG.

The Case for Female Promiscuity

Males in the animal kingdom have, in the evolutionary sense, a pretty good excuse for promiscuity: frequent matings offer them greater reproductive success. It has not been as simple, however, to explain female promiscuity, which is common in some species. Because it only takes one sperm to fertilise an egg, multiple partners are unlikely to improve a female's reproductive success.

Now, results from a ten-year field study of Adders *(Vipera berus)*, led by Thomas Madsen of the University of Lund in Sweden, provide the first experimental evidence that female promiscuity can improve the survival of offspring.

Each year throughout the study, the researchers intensively monitored a small Swedish population of Adders during the three-week spring mating period, collected the pregnant females in mid-summer, maintained them in the laboratory until they delivered, and then took detailed measurements of their offspring.

The female snakes were found to mate with an average of three different males each season. The researchers found no relationship between the number of matings and litter size or the size of individual offspring. But they did find a clear relationship between the number of mates and the number of stillbirths in litters.

The snake population studied by Madsen and his colleagues was small and isolated, with a high potential for inbreeding. The resultant low genetic variability within the population was responsible for a large proportion of stillbirths. The Swedish study found that this proportion was "strongly reduced" by promiscuity in females, suggesting that multiple matings benefited the genetic quality of offspring.

The forces of natural selection, it seems, play a powerful role even within the walls of the female Adder's reproductive tract. Madsen and his coworkers believe that multiple matings would result in intrauterine competition between sperm from different males, with only the fittest achieving fertilisation.

—K.McG.

Carrie Arkinstall (education officer at the Australian Museum) and Karen McGhee (freelance science writer living in Newcastle) are regular contributors to QQC.

For a female Adder, one male is not enough.

N.H.P.A. / ANT PHOTO LIBRARY

Warning: Cannibalism is a Health Hazard

JEAN-PHILIPPE VARIN / AUSCAPE INTERNATIONAL

The study of Tiger Salamanders may help explain why cannibalism is such a rare behaviour.

Cannibalism is one culinary taboo that transcends most human cultures and animal species. Even in animals facing limited food supplies, the behaviour is very rare.

The reason is probably a combination of several factors. Following recent experiments with Tiger Salamanders (*Ambystoma tigrinum*), zoologists David Pfennig, Michael Loeb and James Collins from the Arizona State University believe pathogens (disease-causing organisms) may be one of those factors.

Because many lethal viruses, bacteria and parasites are adapted to only one host species, it is thought that cannibalism could lay a direct path for transmission of pathogens from infected individuals. The US researchers chose Tiger Salamanders to test the theory because they occur naturally in two distinct forms—as cannibals and non-cannibals.

In the laboratory, cannibals were shown to readily prey upon diseased members of their own species, but many of these predators later died from diseases. Dissections also revealed that cannibals tended to have more bacteria and parasites than the non-cannibals.

When Pfennig and his colleagues investigated wild Tiger Salamander populations in ten different lakes, they found the presence of disease seemed to relate to the distribution of cannibal and non-cannibal types. Lakes with lower bacterial levels had more cannibals, while lakes with higher bacteria had less cannibals. This implied that, where disease was more prevalent, cannibals succumbed more easily than non-cannibals.

Cannibalism may prove to be a route for disease transmission.

Human case studies also suggest that cannibalism provides a route for disease transmission. Kuru, normally a very rare human brain disease, is found widely among New Guinea highland tribes in which the women sometimes eat the brains of defeated enemies. The fact that the incidence of the disease is higher

A GOOD YEAR?

In 1841, after striking a rock in Port Phillip Bay, the *William Salthouse* sank to the bottom of the sea with its cargo. In 1983, more than 140 years later, the wreck was excavated by a team of archaeologists from the Victoria Archaeological Survey's Maritime Archaeology Unit. Among the artefacts in the cargo were 87 'champagne style' bottles, with their liquid contents intact. Just what sort of beverage was being imported into the early Australian colonies?

COURTESY VICTORIA ARCHAEOLOGICAL SURVEY

In collaboration with Carlton United Breweries, forensic scientist Margaret Baron analysed the samples by looking at alcohol content, depth of colour, pH range and mineral content. The results were more suggestive of wine than beer but they weren't conclusive. What was needed was a final test that would tell exactly what the liquid was.

Paper chromatography is a relatively simple and cheap technique used to separate the components of a solution on special paper. The individual components appear as bands on the paper with the most soluble components moving the farthest. Margaret used this method to compare some of the *William Salthouse* samples with those of standard wine and beer, and confirmed that they were, in fact, wine. While paper chromatography was used successfully to analyse these historic alcoholic beverages, human taste alone must decide whether or not 1841 was a good year!

—C.A.

among the women of these tribes than the men supports the theory that cannibalism is responsible for its transmission.

—K.McG.

Newcastle Earthquake

Australia often gives the illusion of being an ancient and quiet continent—relatively untroubled by the sometimes devastating natural disasters that plague other regions. That illusion was shattered on 28 December 1989 by the Newcastle Earthquake. It took almost everyone, especially Newcastle residents, completely by surprise, as related by Cynthia Hunter in her book on earthquakes in the Hunter Valley.

Dr Lin Sutherland, a senior geologist at the Australian Museum, was not as surprised as some. He and other geologists already knew that Newcastle is in a 'suspect' earthquake area. But the Newcastle Earthquake made them step up their research to find out what the ancient and quiet continent was doing.

Australia is on a slab of the Earth that is moving north. It moves very slowly, about seven centimetres per year, over the Earth's mantle. The mantle is made of dense rock. Sometimes heat from the deeper mantle rises up towards the Earth's surface. This upwelling is called a 'hot spot'. If the rising heat melts an area of mantle that is under tension, where the rock is being pulled apart, molten rock may erupt to form a volcano. If the heat meets layers under compression, where the rock is being pushed together, the pressure build-up may cause rock to move and break, causing an earthquake. Volcanoes and earthquakes form as the Australian plate moves slowly north over the hot spots.

To find out where the hot spots are now, Lin looked for chains of old volcanoes along Australia's east coast. He found three chains of volcanoes that end at the southern part of the mainland, indicating there are three main hot spots; other evidence points to their likely sites as being under north-western Tasmania, north-eastern Tasmania and the Tasman Sea. These in turn are possible sites for future earthquakes or volcanoes.

Which brings us back to Newcastle. How does Lin's work help us to understand what happened on that fateful December day in 1989? After the earthquake, Lin looked north of Newcastle for evidence of a hot spot. Sure enough he found it—a weak line of past volcanic activity heading south. But the hot spot near Newcastle is only a small one. That was why the earthquake wasn't so easy to predict.

As more evidence is uncovered, Lin and other geologists will be able to get a much clearer picture of what's happening under our feet. That will make future rumblings of our 'ancient and quiet' continent much easier to prepare for.

—C.A.

J.M.DELAGE/SYDNEY FREELANCE

Damage caused by the Newcastle Earthquake.

P.S. LANE

Red Crab consumimg a Giant African Land Snail.

Red Crabs Hold their Fort

The spectacular annual mass breeding migration of Christmas Island's Red Crabs from the rainforest to the sea has earned these crustaceans a reputation for tenacious determination. That tag now seems even more deserved than was first thought.

Christmas Island is a tropical paradise located south of Java in the Indian Ocean. Except for pockets opened up by phosphate mining and human settlement, it is covered by tall, dense rainforest. The endemic Red Crab *(Gecarcoidea natalis)* dominates the forest floor. This is despite the introduction of the island of the *(Achatina fulica)*, a successful opportunistic colonist with a generalised diet, which has already become well-established, and indeed a pest, on most tropical mainlands and many Indo-Pacific islands.

Two Australian researchers, Sam Lake and Dennis O'Dowd, from Victoria's Monash University, recently investigated the distribution of the invading snails and the Red Crabs on the island. They found an inverse relationship between the distribution of the two species, with Red Crabs dominating the rainforest, and land snails the disturbed sites.

One likely reason for the snails' failure to successfully colonise the rainforest became clear when the researchers tethered the large molluscs in experiments. When tied up in rainforest, most of the snails were quickly killed and eaten or removed to burrows by the omnivorous Red Crabs.

There is a widely held view that biotic resistance to invasion on oceanic islands is weak, mainly because island life forms are not as well 'steeled in competition' as their mainland cousins. The so-far successful resistance by the Christmas Island Red Crabs to the Giant African Land Snail invasion proves this is certainly not the case on all oceanic islands.

—K.McG.

STEVE PERKINS

Is there more to the Zebra's stripes than meets the eye?

The Zebra and the Tsetse Fly

The relationship between Zebras and tsetse flies evokes thoughts of Aesop's Fables. The Zebra (*Equus burchelli*), with its strikingly precise body markings, is one of Africa's most beautiful creatures. In contrast, the voracious blood-sucking tsetses are among Africa's villains. They spread disease among cattle and the deadly sleeping sickness among humans, and few mammals are safe from their attacks . . . with the notable exception, it seems, of Zebras.

In 1930, a theory was raised that the Zebra's stripes somehow protected it from the bites of blood-sucking flies. Support for this intriguing hypothesis comes from a recent field study coordinated by Gabriella Gibson, a biologist from London's Imperial College of Science, Technology and Medicine.

In a Zimbabwean valley, well populated with game animals (including Zebras) and two species of tsetses (*Glossina pallidipes* and *G. morsitans*), Gibson set up five different tsetse 'targets' made of cotton cloth and terylene netting. These were coloured with black, white, grey, vertical stripes and horizontal stripes. Flies were attracted to the targets by a mixture of carbon dioxide and acetone designed to simulate the odour of herding game animals.

Gibson found that horizontally striped targets attracted less than ten per cent of the number of flies caught by any other target, and that tsetses actually appeared to avoid horizontally striped objects.

Do the Zebra's stripes protect it from the bites of blood-sucking flies?

The lower portion of a Zebra is horizontally striped, as is much of its head when the animal is bent over and grazing. And at least one species of tsetse is known to feed preferentially on the lower portions of cattle.

Gibson concluded that Zebra's stripes might well have evolved to limit tsetse attacks. However, it remains unclear whether relief from fly bites is the only factor that maintains the stripes in a Zebra population.

—K.McG.

Plants that See

To many of us, plants are those passive green things that die if they are not watered. But the microscopic plant *Chlamydomonas rheinhardtii* is challenging our view of plants by having a view of its own. That is, it can see.

Chlamydomonas is a single-celled plant (algae) less than one-hundredth of a millimetre

across. If exposed to a bright flash of light, it propels itself away using its two whip-like flagella. Two German biologists, Hartmann Harz and Peter Hegemann of the Max Planck Institute for Biochemistry, have provided an explanation for the plant's response with the discovery of a light-sensitive eyespot, containing a similar photoreceptor (rhodopsin) to that found in humans and other animals.

When light falls on the eyespot, the chemical nature of the rhodopsin changes. This produces a faint electrical current in the cell, which in turn causes the flagella to beat and the organism to move away from the light. The biologists were able to detect the faint current less than one millisecond after the plant was illuminated, a response that's about 100 times faster than occurs in the human retina.

This fascinating discovery of a visual system in plants suggests that seeing may be much older than we thought, dating from before the time the plant and animal kingdoms split.

—C.A.

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QUICK QUIZ

1. In which body of water would you find Christmas Island?
2. Name the Fellow of the Australian Academy of Sciences who was killed in 1992 in a plane accident.
3. What is a gastrolith?
4. In which State of Australia does the world's largest freshwater crayfish exist?
5. To the nearest five million years, how long ago did the dinosaurs become extinct?
6. What is a monotreme?
7. At approximately what rate is the world's human population increasing each year: 10 million, 100 million or 1,000 million?
8. Is Pangaea the name of an Old World scaly mammal, or an ancient landmass?
9. What is an EIS?
10. 'Yellow rain', once thought to have been an agent of chemical warfare, was later found to have less toxic origins. What is it?

Answers in the Questions & Answers Section.

The Magpie is so determined to sell you an impression of power, it is prepared to beat you over the head to help make the point.

PIES FROM THE SKY

BY STEVE VAN DYCK

THERE ARE TWO BLACK-AND-WHITE life forms I've always found a little intimidating . . . nuns and employees of David Jones. When I was young, nuns were a mystery as befittingly inexplicable as the Virgin Birth, and people who worked in David Jones as predatory as the nuns were pure. But until I was asked to write this essay about Australian Magpies (*Gymnorhina tibicen*) I'd never bothered to consider what these birds and their human analogues might share, apart from just a habit of wearing unambiguous black-and-white coats.

The common thread, it would seem, lies in what the uniform, with its flagrant contradiction of colours, does for both wearer and onlooker. Take the nun or the retailer and you find someone who is going out of their way to radically stand out from the crowd and who, at the same time, is trying to sell you something, whether it be religion or cosmetics. Take the Magpie and you find a bird designed in total defiance of camouflage, striking enough to be seen anywhere on a golf course, and so determined to sell you an impression of power, that if the colour scheme doesn't work, it is prepared to beat you over the head to help make the point.

Whether it be on the nun, DJs shop assistant or Magpie, the colour scheme seizes the senses of the observer and creates a striking impression of unity in the ranks. Members of this black-and-white fraternity make an all-round sacrifice of personal identity for an ultimate impression of corporate strength and purpose. Muscle, purpose, power and success have for so long been associated with Magpies that there is hardly a town in Australia without a football team named after them.

This vision of the Magpie seems a long way from our romantic notion of it piping mellow warbles across frost-crusted paddocks. But the romance that goes with old Maggie is so much sweeter than the reality. In truth, life for most Magpies is . . . hell.

This is because of the nature of life in the collective. In order to defend a 2–18-hectare home base that provides all the good things of life (shelter, food and nursery facilities), Magpies may band together into a uniformed security firm. As many as 24 birds might pool their efforts into the flying squad, which is fledged for high-profile visibility, and pledged to sell the impression of strength by much loud singing, fighting and the occasional postman's scalp.

But even with all this brawn, in large groups most of the babies die young, most of the males only get to feed gaping mouths and not to father them, and usually only one female in the group gets to see her eggs hatch. Evidently the effort of defending the territorial border, stoking the individual boilers and maintaining the status quo of the in-house hierarchy doesn't allow for too many personal comforts. And then, if the average of one surviving young per group per year (perhaps) finally outgrows its welcome in the group, it faces the dismal prospect of either being hit by a car, eaten by a cat or having to set up its own territory. If it avoids the first two but can't manage the last, it may join the scruffy flock of non-land-holding celibates that make life a misery for the rest.

But Mother Nature sheds few tears for the individual, and a breeding strategy that may mean a life of hell for one, results in such a success for the species that our lucky country almost overflows with Magpies.

So common are they that we often fail to appreciate their incipient influence on Australian culture. Somebody has recently hinted that Ned Kelly's armour was really constructed to protect him from Magpie bombings, and it is said that the Johnny-come-lately legislation on wearing bicycle helmets was finally precipitated more by threats of the impending spring nesting season than by any worry from cars.

Even the name 'Magpie' has become so entrenched that, in our thrust toward republicanism and a national identity, we forget that 'Magpie' is just a copy of the name of an unrelated Magpie (*Pica pica*) from Europe. The 'mag' bit came from that bird's constant prattling of "Mag, Maggie, Margaret" and the 'pie' from the Latin *pica* for a jay.

The great Australian naturalist Crosbie Morrison once commented on the cold reception met by early attempts to change our Magpie's name to something more exclusive. Zoos, for example, tried to promote the name 'Piper' to distinguish it from its European namesake. One of the baked enamel labels in a major Australian zoo proclaimed the 'Black-backed Piping Crow', but visitors looked into the aviary and remarked, "There is only an old Maggie in there. I suppose the piping crow's dead!"

Masters of the skies but not of disguise, Magpies are dressed to be seen by all but worms and weevils.

B. CHUDLEIGH / ANT PHOTO LIBRARY

N.N. BIRKS

Early days for a head count! The success of a Magpie pair or group is not measured in eggs laid and hatched, but by the number of these little peckers that grow up to feed young of their own.

It really is unlikely that our Maggie will ever be known by any other name as long as there are wooden fence posts, misty mornings and bleeding heads. And for as long as baby Maggies continue to fall out of nests there will always be squawking mouths for our own children to fill.

On this matter, a sweet letter to *Wild Life* magazine in 1944 from Miss H.E. Pawsley mentions Magpie feeding. One day while she was sitting and reading on a garden seat, she was suddenly aware of a large insect close to her face and found that her pet Magpie was trying to thrust a cricket into her mouth. Not wanting to hurt the bird's feelings, she turned her head aside and, after various attempts, Maggie climbed down and up the other side to see if that would be better. As she refused to accept the choice morsel, Maggie looked puzzled and thoughtful, and finally ate it herself. "Another day, finding my brother flat on his back on the lawn, she tried very earnestly to put a fat worm into his mouth. When he gently but firmly refused the gift, Maggie stuffed it in his ear as the next best thing."

But now is the season of conundrums, anticipated by hormone-inspired Magpies and cringing wildlife officers around Australia. It's time for carols without Christmas, bombings without explosions, umbrellas without rain and complaints without ceasing. Affable cousins of Heckell and Jeckell suddenly become the appalling brothers Hyde, and mag-proofed children go off to school looking like Bill and Ben. Still it puts a little mystery and a little danger back into the bush we like to think made Aussies tough. So enjoy the spring for its paradoxes; it's probably the only time of the year when the issue of Magpies really is a shade off black and white. ■

KEN GRIFFITHS

If Magpie evolution had selected birds to be literate or gullible, springtime in Australia would not be nearly so exciting for school children and posties.

Steve Van Dyck is in charge of the Mammal Section of the Queensland Museum where he has worked since 1975.

Introduced plants rapidly displaced native grasslands, destroying the animal communities they supported.

GOLDEN SUN MOTH

BY TED EDWARDS

IN PAST DECADES ENDANGERED species conservation has concentrated heavily on vertebrates. Invertebrates were poorly understood and knowledge about them was lacking. Today, for a very few, information is becoming available that indicates many are in danger of extinction.

One such species is the Golden Sun Moth (*Synemon plana*). It belongs to an ancient family of moths, the Castniidae or sun moths, which are day-flying and, like butterflies, have well-developed clubbed antennae. Adult Golden Sun Moths have a wingspan of about five centimetres and are active in the hottest part of sunny days between mid November and mid December. They inhabit grasslands dominated by certain species of wallaby grass (*Danthonia spp.*). In Canberra this is Short Wallaby Grass (*D. carphoides*). The males patrol the grasslands flying rapidly and searching for females. When a patrolling male flies over an unmated female she flips her cryptic dark grey forewings forward exposing her golden orange hind wings to which the male responds by alighting beside her. After mating the females scuttle from tussock to tussock inserting their eggs deep into the bases. The wings of the females are reduced in size so, although they can fly, they rarely do so unless frightened and then they only fly for a short distance. In this respect the species is unique in its family.

The adult moths have no mouthparts and so cannot feed or drink. They do not live long and probably die within a few days of emergence. All the feeding is done by the caterpillars which, after hatching from the eggs, tunnel in the soil feeding on the underground parts of the wallaby grass. How long they remain caterpillars is unknown but two years is the most likely period. When fully grown they prepare a vertical tunnel to the surface through which the pupa travels just before the moth emerges.

At the time of European settlement suitable grasslands inhabited by *Synemon plana* were found from Bathurst (New South Wales) through central Victoria to the South Australian border. These grasslands were prime areas for agriculture and were quickly occupied. Fortunately wallaby grass was one of the native grasses most resistant to heavy grazing by introduced stock and the grasslands survived, although probably in an altered state.

In the 1950s the use of chemical fertilisers and more vigorous introduced pasture grasses and clovers became almost universal in the areas where suitable *Danthonia* grasslands grew. These introduced plants rapidly displaced the grasslands, destroying the animal communities they supported. *Synemon plana* was once very common in the grasslands but today is known from only ten sites in the inner urban areas of the ACT, and two sites in Victoria. The largest known surviving site is the Belconnen Naval Station in Canberra, an area of some 100 hectares now under imminent threat of development, but some of the sites are no larger than a few hundred square metres.

The Golden Sun Moth is a robust survivor and can be common in these tiny

TED EDWARDS

areas, some of which have been isolated and at their present size for several decades. Nevertheless the moth is endangered because the grassland it inhabits is endangered.

None of the known sites is in a national park or part of a large reserve, and all are vulnerable to various threats. Housing and office development in Canberra threaten some of the surviving sites and invasion by introduced weeds is another major threat. *Danthonia carphoides* grassland survives best where it is lightly grazed or occasionally subject to high mowing. Without grazing or mowing the low-growing natives can become shaded and eventually choked out by taller exotic plants. Clearly at least two adequate reserves are necessary, and these would need to be carefully managed with minimum disturbance except for grazing or mowing, if the moth is to survive. Much more needs to be known of the biology of the moth and the characteristics of the grassland if they are to be successfully conserved.

The female's wings are reduced in size so, although they can fly, they rarely do.

The Golden Sun Moth is a species of some scientific interest. It was once an extremely successful moth, common over a large area of south-eastern Australia. It has the advantage of being relatively resistant to grazing and mowing, and possibly also resistant to fires. It has the disadvantage of being confined to a single plant community suited to and vulnerable to modern agriculture. It has the further disadvantage of being unable to recolonise an area distant from an inhabited site because of the relative immobility of the female. These characteristics have brought it to the edge of extinction.

Although this article is about one conspicuous species, it is important to stress that it serves as a figurehead or focus for the many invertebrates as yet unstudied that are also confined to these grasslands and also in danger of extinction. All these invertebrates play an essential role in the balance of the grassland. While many of the individual plant species in the grassland are not yet endangered, the grassland community itself is. ■

Ted Edwards is a scientist at the Australian National Insect Collection in the CSIRO's Division of Entomology in Canberra. He has been studying the taxonomy of moths for the last 23 years.

A willingness to taste wild plants, including weeds, is a feature of Aboriginal culture.

THE CURIOUS FOODS OF TASMANIA'S ABORIGINES

BY TIM LOW

IN LAUNCESTON LAST YEAR I ENJOYED a meal of kangaroo-tail soup and damper with people once rudely dismissed as "extinct". Only recently has white Australia realised (with some guilt) that Tasmanian Aborigines are still among us. The Launceston community traces ancestry to women who settled with sealers in the Furneaux Islands of Bass Strait.

Tasmania's Aborigines are striving to redefine and reassert their identity in the 1990s, and they welcomed my request to interview the older members about foods and medicines. At the lunch I rushed about with pen and paper and pictures of plants, scribbling down the remembrances of the older women. Their testimony was remarkably detailed and full of surprises.

One of their most fondly remembered foods was the "shoke apple". It took some head-scratching before I realised they were referring to the young cone of a she-oak (*Allocasuarina* species). Pat Troman (among others) told me she used to "Boil that and eat with sugar. That'd be like a fruit to us . . . At lunch (at school) we used to go up to the she-oak trees and take a bag of sugar. You could eat 'em raw but you had to dip 'em in sugar." Others said the sour-tasting cones were usually boiled before eating, and that they tasted "beautiful".

Another informant, Terry Maynard, remembered eating "twirly things on top of she-oaks, a bit like a flat curled snake". These oddities, presumably galled branchlets, were chewed for an hour or so until the taste went out of them.

The women remembered eating a number of wild fruits that thankfully, were easier to identify: Cranberry (*Astroloma humifusum*), native cherries (*Exocarpos cupressiformis, E. strictus*), Cheeseberry (*Cyathodes glauca*), Kangaroo Apple (*Solanum laciniatum*), "Kanegong" (*Carpobrotus rossii*) and "currants" (*Leucopogon parviflorus*). Also remembered was the eating of Bracken rhizomes (*Pteridium esculentum*), bulrush inner stalks (*Typha* species), Coast Wattle seeds (*Acacia sophorae*) and grasstree "bread" (*Xanthorrhoea* inner trunk). These are all well-known Aboriginal foods.

But other plants told to me were not of the same heritage. Thistles, Kikuyu Grass (*Pennisetum clandestinum*), rose hips (presumably from Sweet Briar, *Rosa rubiginosa*), "prickly box" (African Boxthorn, *Lycium ferocissimum*), dandelions (*Taraxacum officinale* or *Hypochoeris radicata*), dock (*Rumex* species), and Watercress (*Rorippa nasturtium-aquaticum*) are introduced weeds. Rose hips, dandelions and Watercress were settlers' foods, but I have not heard of anyone eating thistles or Kikuyu Grass.

Pat Troman confided that "scotch thistle" petals were her chewing gum. Another woman said she had never tried thistle petals, but ate the little green "bulb" at the base of the flower, structurally equivalent to the heart of an artichoke (a cultivated thistle bud). I was baffled by the lack of consistency in the way these weeds were used. Leonie Leffler, the only one who mentioned eating dock, admitted she had discovered this food herself, simply by boiling up the leaves and tasting them.

I think what happened is this: the Bass Strait communities were poor. To supplement a plain diet, the children munched on local plants, including weeds, and discovered their own snack foods. Their parents gathered some of the weeds themselves, making jam and chutney from boxthorn berries, syrup from Sweet Briar, vegetables from Watercress and dock, and medicines from dandelion flowers, thistle heads, a wild garlic (*Allium*

Cheese-berry was a snack food remembered by Veris van Eckert, who grew up on Barren and Lady Barren Islands.

PHOTOS TIM LOW

Rose hips, almost certainly from Sweet Briar (a common weed in Tasmania), were boiled down with sugar into a syrup.

ampeloprasum) and other plants. As well, some Aboriginal foods were remembered from past generations, and these too were harvested, although not always in traditional ways.

Some of the latter are very significant. "Kanegong" (a type of pigface) is unique as the only plant food remembered by its Aboriginal name, suggesting it was especially significant. This is confirmed by the journal of French explorer Labillardiere, who in 1798 observed that "This fruit is a delicacy among the New Hollanders, who seek for it with care, and eat it as soon as they find it".

Pat Troman has charming childhood memories of eating not only the fruits of kanegong, but the leaves and parts of the flowers: "We used to take a little bag of sugar to school. We'd eat the kanegong leaves with sugar. We'd be late for school because we'd be going around having a feed". The broken leaves were also rubbed on ant stings as a remedy.

Bracken was probably a staple food in Tasmania, but its starchy underground stems were mentioned by only one informant, Maureen West, who admitted it was no longer eaten. "They reckon if you fry it, it tastes just like peanuts", she told me.

An archaeologist could argue that the weeds remembered by these women are not Aboriginal foods, and as such are not worth documenting. I disagree. Aboriginal culture is changing, has always been changing, and has every right to change. A willingness to taste wild plants, including weeds, is a feature of Aboriginal culture, and contrasts strongly with the traditional phobia of poisoning shown by Europeans. Many Australian explorers and pioneers suffered pointlessly from scurvy because they were unwilling to try wild foods. The Tasmanian Aborigines showed admirable adaptability, and thistle chewing gum and boxthorn chutney should now be accepted as part of Tasmanian Aboriginal culture alongside kanegong and Bracken. ■

Spear thistle (*Cirsium vulgare*) was probably one of the thistles eaten by Tasmanian Aborigines. The base of the bud tastes delightfully like artichoke.

Suggested Reading

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Tim Low is a Brisbane-based environmental consultant and the author of four books on wild foods and medicines.

Brightness is a very iffy and likely unprovable justification for protection.

ANIMAL IQ: SHOULD IT MAKE A DIFFERENCE?

BY ROBYN WILLIAMS

HAVE YOU SEEN WHALES reading books? The last time I was in Vancouver I visited their magnificent aquarium, set among the trees of Stanley Park. There were two purposes in going there: one was to entertain my kids, although their reluctance in being dragged to yet another museum or wildlife park was unrelenting, and I wanted to talk to Dr John Ford about his studies of Killer Whale (*Orcinus orca*) dialects.

The aquarium, as ever, was irresistible, even for the Williams grumps. After watching the Killer Whales cavort in the thrice daily show, and being squirted with water aimed right between my eyes by a cheeky Beluga Whale, we repaired to Dr Ford's office in the basement.

It was below ground for a very good reason. One wall was entirely made of strong glass. Through it we could see the enormous Orca tank in which the three Killer Whales, between acts, glided gracefully. I began my interview for radio, and my son and daughter stood by the glass and watched the huge beasts swim.

I was learning all about the population of hundreds of Orcas along the coast of North America and how their 'songs' had been recorded. These vary subtly with location and are passed on through families. They can also be quite different in other habitats a long way away – just as languages vary between countries.

It was at that point I noticed that the largest Killer Whale, weighing 6.5 tonnes, had paused by the glass. He'd lingered there for some minutes with his eye just inches on the other side. "What's he doing over there?" I asked my interviewee, tape still rolling.

AUSTRALIAN PICTURE LIBRARY

Should the Killer Whale's suspected intelligence be the driving force for its conservation?

"Oh, he's reading a book. When he wants the pages turned, after five minutes or so, he'll give a squeak."

"Hang on", I objected, "you are on national radio, cut the whimsy, what's he really doing?"

"No really", says Dr Ford, and he took me over to the glass wall, "here are four books we have open and he reads them, or looks at the pictures". The books were all about whales. There were pictures of other Orcas. Could this be the cetacean equivalent of Madonna's *Sex* book?

The discovery of Killer Whale 'reading' was accidental. The follow-up of its implications will join the list of other mysteries of cetacean cognition and intelligence. Whenever I hear debates about protection of whales based on their special 'brightness' I remember the Vancouver Aquarium.

Should we make a particular case of whales and dolphins because they may be clever? They certainly have big brains, as you'd expect in large mammals with complex constant movement. That their cerebral cortices, the seat of intelligence, are also large leads many to believe there may be undiscovered brain power to match our own.

But Dr Margaret Klinowska, a psychologist working on dolphins in Cambridge, says that the cetacean brain is, kilo for kilo, often smaller that you might expect, depending on species, for such large mammals. She also notes that dolphins, despite their large cortices, do not have rapid-eye-movement (REM) sleep – that component needed to 'clear' brains so that more information may be processed. The big brain may be required to make up for lack of dreams and be based on the same need as hefty old-generation computers: comparative primitiveness. So the sheer size need not be a direct indicator of IQ. Dr Klinowska points out that echidnas seem to be overendowed with cerebral cortex, but we don't praise these Australians for their quick-wittedness. So why whales? And if their behaviour is not much more complex than many less celebrated herd animals, does this mean we should be less protective of them?

Well I don't think it's useful to make comparisons between creatures and people. We find whales and dolphins to be delightful in many ways. That their intelligence may be about that of a dog is no insult – my own dog (a border collie) performs intellectual feats of astounding cleverness. But I want her to be doggish, not human. I have enough contact with humans!

Whales can be admired, and protected, on their own merits, whatever the intelligence or doltishness of any particular species. Besides, there is no compelling economic reason to hunt them. Hunting causes obvious distress, both to them and us, and the products can easily be obtained elsewhere. The Japanese excuse of 'scientific' whaling is an insult.

Brightness, as such, is a very iffy and likely unprovable justification for protection. Whatever the animal, it should be treasured for its zoological uniqueness and studied accordingly. Any decisions about protection should be a combination of scientific knowledge *and* a regard for our positive feelings for them. ■

Robyn Williams is Presenter of Radio National's Science Show. His work brings him constantly in contact with the changing trends in science.

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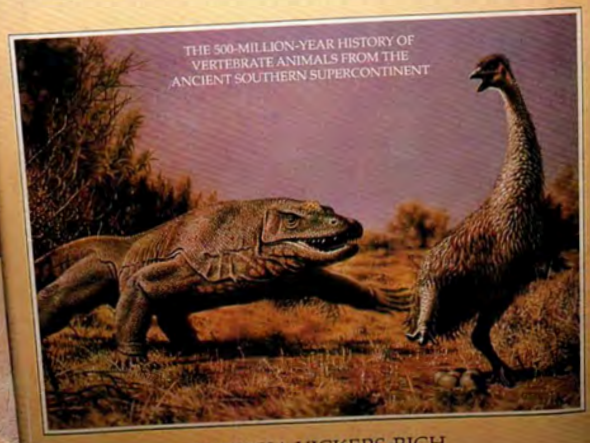

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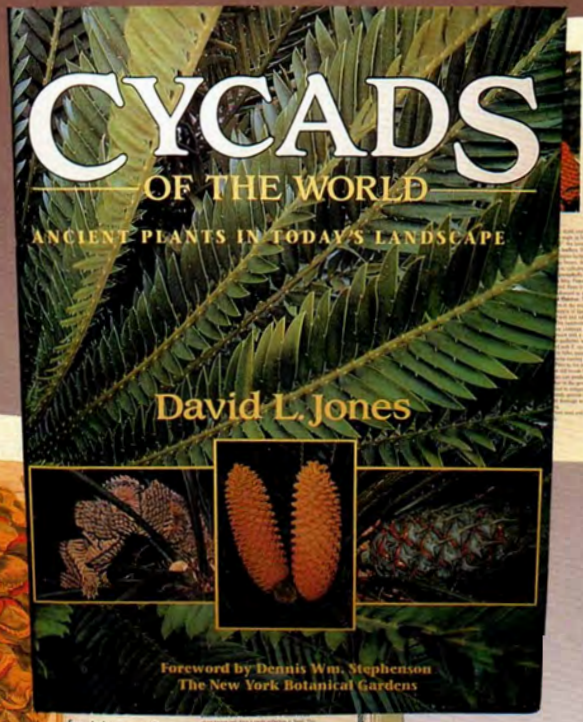

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OVERCOMING A

JIRI LOCHMAN / LOCHMAN TRANSPARENCIES

For most of the year an echidna is a loner, but survival of the species demands that even loners get together!

PRICKLY PROBLEM

BY PEGGY RISMILLER

HOW DO ECHIDNAS MAKE LOVE? THE standard half-joking answer has always been, "very carefully". Yet the truth of the matter is that, until recently, no-one had reported this observation on wild, free-ranging echidnas.

The elusive echidna has been known and studied for 200 years, yet we do not know how many there are, or if populations are stable, growing or diminishing. Fascinated by these inconspicuous spiny egg-layers, I decided to live in the field and observe Short-beaked Echidnas (*Tachyglossus aculeatus*) in their natural environment, from conception to adult. To date, the thousands of hours invested searching thick bushland, following echidnas day and night through winter hail and summer heat, have been rewarded with magical glimpses and new insights into the cryptic lives of these ancient battlers of the bush.

Echidnas and echidna researchers can be found throughout Australia (there are, however, comparatively fewer of the latter). The Pelican Lagoon Research and Wildlife Centre on Kangaroo Island (off the coast of South Australia) was chosen as my long-term study site and home. The island offers field biologists unique and valuable opportunities. It is free of many introduced pests and predators, such as rabbits and foxes. There are still

large areas of nearly pristine habitat as well as human-altered terrain surrounded by native scrub. The echidna occupies most of these habitat types. Mike McKelvey, wildlife photographer and biologist, became my coworker in the quest to research echidna population dynamics and document photographically 'the echidna story' from egg to adult.

Radiotracking has been a standard tool for field mark-and-recapture studies for many years and echidna researchers across Australia use this technique in various ways (see article on echidna hibernation, ANH Summer 1990–91). Before tracking can begin, however, the first task is finding the secretive echidna. At the Pelican Lagoon study site we search on foot.

Echidnas are quiet and reclusive. They have highly sensitive hearing and a good nose. In mallee country most echidnas become motionless and silent at the snap of a twig underfoot or the scent of a human. The natural camouflage of their spines and body-form blends in with the bush. Some use the powerful front digging claws in a rotational movement to disappear straight down into the ground. A flick of the spines places dirt and leaf litter on top and the vanishing act is complete. Finding an echidna means continually listening, looking and being in the right place at the right time. Volunteers can become discouraged after spending hundreds of hours walking in areas of known echidna activity, without finding any. But when one is found, the thrill of discovery is so great, that enthusiasm is quickly regained.

Each echidna is weighed, sexed and given an individual ID using small coloured tubes. These tubes are slipped over one or more spines on a selected body part. Hence, echidna YBC is 'Yellow Back Centre' and RTR is 'Red Tail Right'. A small tracking transmitter is attached to the back spines of some animals. Each transmitter has a specific frequency, like a radio station, and can be dialled up on a receiver. Marking and recapture of animals is a way of determining population size. Radiotracking is used to unobtrusively find and then observe and record activities of individual echidnas on a routine, round-the-clock basis, 52 weeks of the year.

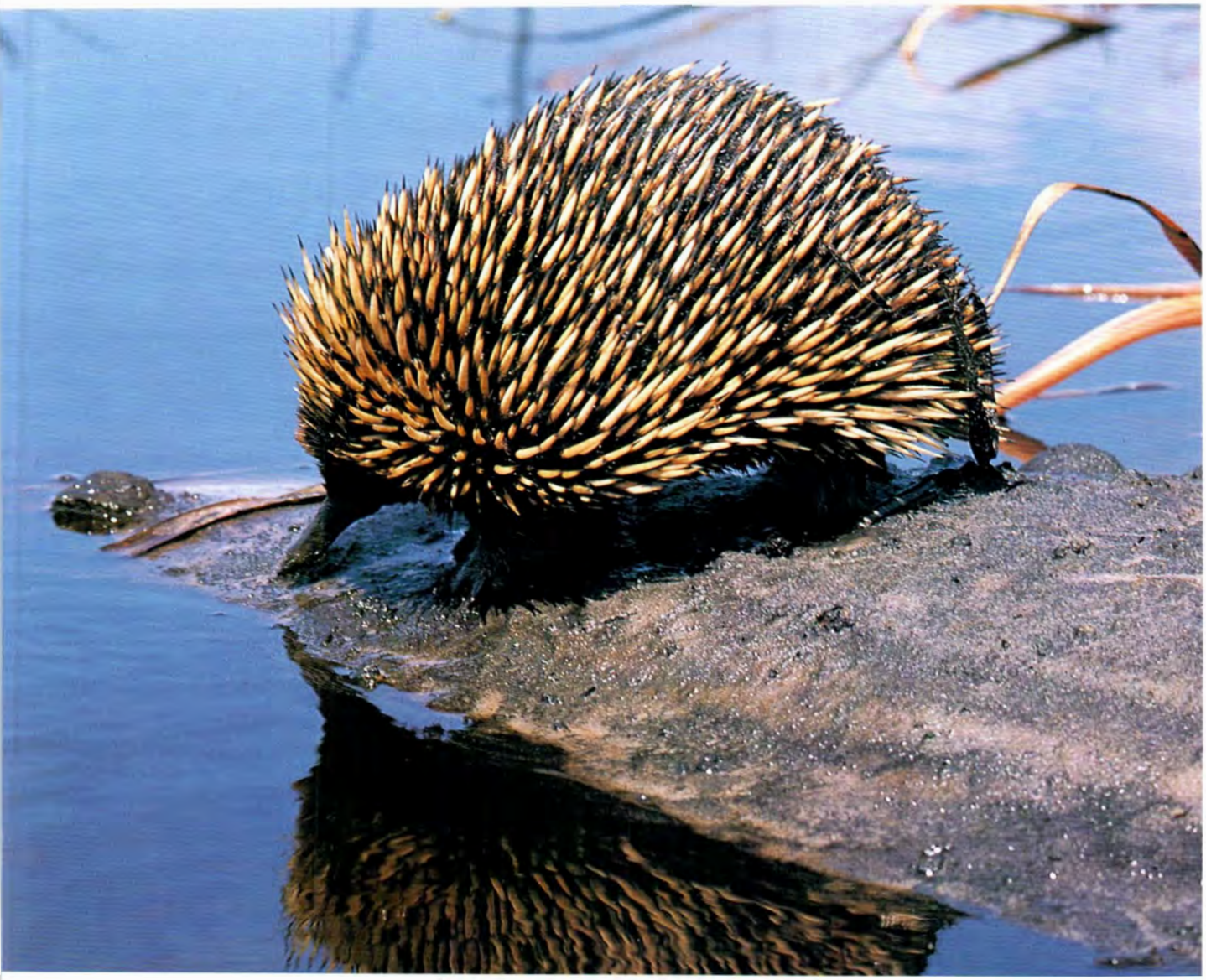
Volunteers were having difficulties remembering an animal's colour code and frequency, so they started christening the echidnas as they were found. Some of our longer-known males include Casey, Casanova, Canon and Wurm. Among the females are Big Mama, Nikki, Zoey, Fluff and Olive.

Determining the sex of an echidna is not a simple task. The sexual organs of both females and males are internal. All that can be seen on the furry belly side is the cloaca, the single opening through which digestive, urinary and reproductive products all pass. There may or may not be a pouch. Both male and female echidnas can form one by contracting the longitudinal muscles around the belly region.

The spurs on the inside of hind feet are the most common characteristic used to sex echidnas, but this also has its drawbacks. All juvenile echidnas (both males and females) have spurs. These are non-venomous, in contrast to Platypus spurs, which are venomous and found only on males. In theory, the female echidna loses her spurs at maturity, whereas the male spurs change slightly in form and are retained. Hence, presence or absence of

spurs is often used to distinguish a sexually mature male from a female echidna. However, I have found that 25 per cent of mature females have at least one 'well-developed' spur, and 25 per cent of males have lost one. Nonetheless, the spur is a good indicator of sex during the breeding season. At this time a thick, sticky excretion oozes out around the base of spurs in sexually mature males. No female or subadult with spurs has shown this trait. At other times of the year there is a solid talc-like mass at the spur base. Platypus researchers report a secretion from the male Platypus spur during the breeding season that correlates with increased levels of the hormone testosterone. At present we can only assume it is the same with echidnas. Still, just why and for what purpose the echidna has spurs remain to be learned.

Outside of the breeding season I find the best way to determine the sex of an echidna is by 'palpation' (feeling). When an echidna is partially curled in a ball the stomach muscles are pulled together forming a 'pouch'. The animal is uncurled just enough to reach and feel inside the pouch at the cloacal end. In males, the penis lies along the side of the pelvic bone



MARIE LOCHMAN / LOCHMAN TRANSPARENCIES

Echidnas are quiet and reclusive animals with highly sensitive hearing and a good sense of smell.

and is detected as a slight bulge. This technique takes some practice, but has proven to be very accurate!

FOR MOST OF THE YEAR AN ECHIDNA IS a loner, but survival of the species demands that even loners get together! CSIRO monotreme expert Dr Mervyn Griffiths determined that echidnas all over Australia 'get together' and breed during the winter months. It's at this time that we observe sexually active male echidnas going beyond their normal home ranges in search of females and forming what is called a 'train'. In 1975 Dr Mike Augee from the University of New South Wales reported finding a group of six echidnas together in Victoria. Only one was a female. And in his classic book, *The biology of the monotremes,* Griffiths describes five incidences from different parts of Australia of echidnas walking "Indian file nose to tail" fashion. All observations were made during the months of July and August.

An echidna train looks like a family out for a walk. On Kangaroo Island, the largest animal is in the lead and the smallest animal brings up the rear. The first animal in the train is a female and all other animals following are males. The small echidna bringing up the rear is often a subadult male. The formation of a train actually signalises the beginning of courtship and the breeding season.

RISMAC

The presence of a spur on the hind foot is not a reliable indicator of gender as previously believed.

The number of males in a particular female's train ranges from one to ten (the maximum reported so far on Kangaroo Island), and may vary day to day. Males

often join several trains during the courtship period and spend time on their own 'between trains'. Volunteers found Casanova with Zoey on two consecutive days before his tracking signal suddenly disappeared. He showed up three days later two kilometres away, with Nikki, and another ten days and a further two kilometres away he was found with Big Mama. During Casanova's six weeks of courting he lost 800 grams, nearly 25 per cent of his body mass. He then returned to his old territory but did not fully regain his old body weight until summer.

Just how the female attracts males and exactly how long the courtship period lasts is not clear. Throughout the year echidnas have a distinctive odour that can even be detected by the human nose, but during the breeding season females sometimes emit an additional scent. In 1894 Richard Semon, who was working in Queensland, first recorded that both male and female echidnas gave off a pungent odour during the breeding season. Recently, Lyn Beard (University of Queensland) reported a "musty smell" from a female dug out of her hibernation burrow in the Snowy Mountains during the month of August.

RISMAC

The four-headed echidna penis, well documented by 18th-century field biologists, is still a mystery today.

Between 1988 and 1991 I was in the right spot on three different occasions to have the chance to smell this distinctive 'other echidna odour'. One time, while lying on the ground and observing a train of echidnas at rest, I suddenly noticed a pungent musky smell coming from the direction of the female. The four males, who were positioned to one side and as far as two metres away from the female, all became restless and began moving around. Some years ago Griffiths speculated that olfaction (smell) may help to bring echidnas together during the breeding season. Observations made in recent years support the theory that echidnas use pheromones for attracting the opposite sex, although their actual nature, composition, dispersal and effective range have yet to be determined.

On Kangaroo Island we have recorded trains and other courtship behaviour lasting between 14 and 36 days. During this time the males follow, rest and pursue the female, making advances by nudging her side or tail with their nose. An unreceptive female either completely ignores the male or simply curls up in a spiky ball. Towards the end of the courtship period, however, the female becomes receptive and mates with one of the individuals in her train.

During mating the female lies flat on her stomach, often with her head and front legs partially dug in at the base of a shrub or small tree. The male or males begin digging along either side of the female. If more than two males are present, they push each other aside, digging not only along the female, but also around the vegetation. At some point one of the males will turn to his opponent and begin a head-on-head pushing contest until only one remains in the dug-out trench around the female. This male continues to dig on one side of the female, stroking her spines and attempting to lift her tail end with one of his hind feet. He finally succeeds in raising her enough to be able to place his tail under hers while lying on his side. This 'foreplay' may take up to four hours.

Once in position the male extends his penis (which may be up to seven centimetres in length) out of his cloaca and into hers. The unusual echidna penis has a cauliflower-like head with four openings. The function of this bizarre structure has yet to be discovered; it may be important for directing sperm into the female's internal reproductive passage. During the actual mating process, both animals push their tails against one another, tensing and relaxing the spines. Coupling is completed after 30 to 180 minutes and the animals go their separate ways. All that remains after the mating activities is the 'mating rut' which can be doughnut-shaped, if more than one male was involved, or a simple straight trench. The deepest mating rut measured so far was 20 centimetres.

Echidna researchers have yet to observe a female mating more than once in a season, although this cannot be discounted. We do know that within a day or two of mating, all males have left the female. She goes back to a solitary lifestyle, while the males may join another train. Several researchers have reported that the gestation period, the time between mating and egg-laying, is about 21 to 28 days.

RISMAC

Radio telemetry helps researchers follow the activities of individual echidnas both day and night.

VOLUNTEERS AND ECHIDNAS

Earthwatch volunteers joining the 'Echidnas On Kangaroo Island' project come from many different countries and occupations. They share a common interest in nature, enthusiasm to learn something new, and a willingness to work. Field teams receive days of intensive training in orienteering, map reading, use of radio telemetry equipment and animal observation techniques.

Volunteer tasks include searching for animals, conducting foraging transects, tracking and observing individuals. Sometimes echidnas are only active by day, but when animals start moving at night, so do the trackers. Without the aid of volunteers, 24-hour observations on moving animals would be impossible.

Earthwatch provides opportunities for people from all walks of life to become constructively involved in scientific field projects. Contact Earthwatch Australia, Level 1, 457 Elizabeth Street, Melbourne Victoria 3000. Telephone: (03) 600 9100. Earthwatch is an ANH Associate Society.

A female echidna may be followed by a train of up to ten suitors as part of the pre-breeding courtship behaviour.

NO-ONE HAS ACTUALLY SEEN AN echidna laying her egg. One bit of echidna lore is that the female retires to a 'maternity burrow', lays her egg and remains there for ten days until it hatches. I had been tracking Yellow, a very blond female echidna, which kept coming and going from the same burrow. During the 1960s Griffiths determined that the incubation period of an echidna egg was 10 to 10.5 days. So on day ten, when Mike and I spotted Yellow at the entrance of her burrow, we decided to pouch check her for an egg, 'just in case'. I had become quite adept at quickly and gently checking the pouch, which is usually dry and warm. To my surprise the pouch was wet and sticky. We uncurled her further and were amazed to see a minute, wriggling, pinkish blob clinging to the hairs in the pouch. The egg shell was still there too. Few researchers have witnessed the wonder of a freshly hatched echidna in the wild. This was our first chance to document the phenomenon so, after carefully returning Yellow to her burrow, we went to confer with Griffiths.

During Casanova's six weeks of courting he lost 800 grams, nearly 25 per cent of his body mass.

Twenty-four hours later, acting on Griffiths' advice, we weighed and measured the tiny translucent 'puggle' (pouch young echidna), which now had milk in its stomach. It was 13 millimetres from snout to tail (about the length of my little finger nail) and weighed 0.322 grams (about one sixth of an Australian five-cent coin). The front legs were well developed with tiny claws, whereas the back limbs were merely buds.

The newly hatched young must pull itself from the deep pocket of the pouch at the cloacal end up to the milk patch for its first drink; a distance six times its own body length! Echidnas have no teats on to which the puggle can attach. Instead it must grasp onto the hairs in the mother's pouch. The milk is secreted by glands that open at the base of specialised mammary hairs where the puggle suckles. Griffiths was the first to measure the extraordinary growth rate and shown that

RISMAC

RISMAC

Hatchling echidnas weigh less than 0.5 grams. To stay in their mother's pouch they use well-developed front feet to hold onto the soft belly fur. This wild hatchling is one of several being studied from conception to maturity.

the puggle can increase its body weight over 500 fold (from 0.32 to 178 grams) in the first 45 days of its life! At this time the hair and spines begin to appear above the skin. The puggle is soon too large and prickly for the female to carry, so she digs a nursery burrow in which to place it.

During the 1980s at Tidbinbilla (ACT) Griffiths observed that a female echidna returned to the nursery burrow only every five to ten days to suckle the young. On Kangaroo Island we find that mother echidnas visit the burrow young every five to six days, carefully closing the entrance each time she leaves. At about six months of age we have seen young echidnas begin their first short expeditions away from the nursery burrow. Studies from various areas in Australia report that echidnas are weaned at about seven months. What happens then remains to be learned. The years between weaning and sexual maturity probably pose the greatest survival challenge for an echidna.

Although we now know how echidnas in the wild make love—an event that has provoked the imagination of many people for many years—it is only one small part of the animal's lifecycle. We still need to find out when an echidna becomes sexually mature, how often females reproduce, how many young are hatched each year, and how many survive to adulthood. Researchers around Australia continue to address the diverse mysteries surrounding the Short-beaked Echidna. Understanding the ecology of this ancient and hardy species may give insight into the history of others that have not made it in our changing world. ■

JIRI LOCHMAN / LOCHMAN TRANSPARENCIES

Suggested Reading

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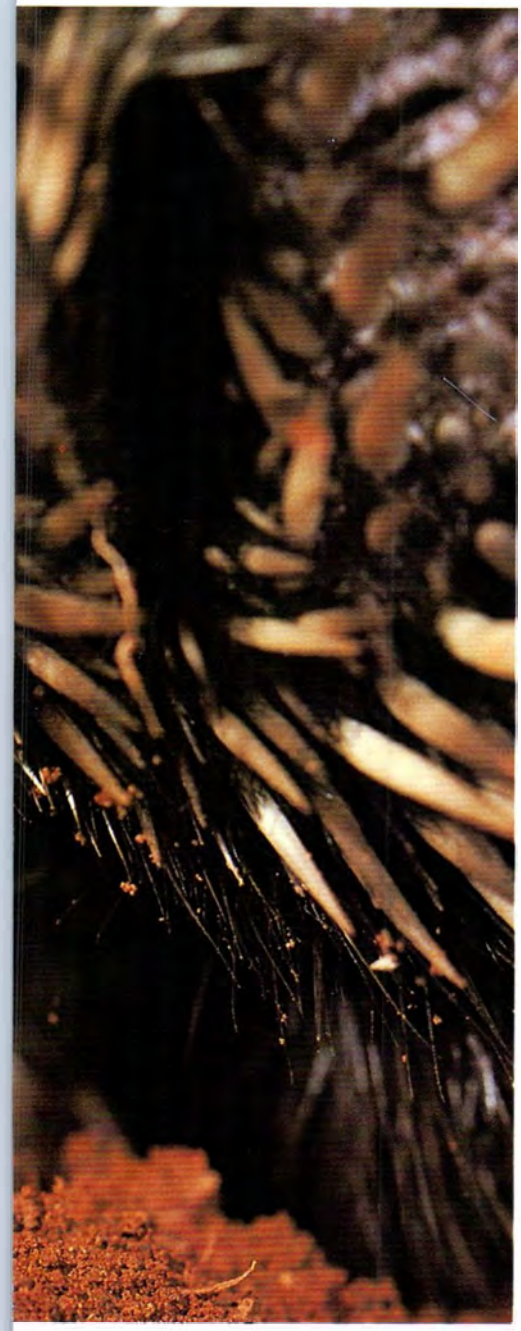
Born in Ohio, USA, Dr Peggy Rismiller studied and received her biology degrees in Germany. She immigrated to Australia in 1988 and, as an environmental physiologist, is currently a visiting research fellow at the Department of Anatomy and Histology, University of Adelaide. Together with biologist/wildlife photographer Mike McKelvey she lives and works full-time in the field, studying and documenting life history, ecology and whole-animal biology of the Short-beaked Echidna on Kangaroo Island, South Australia.

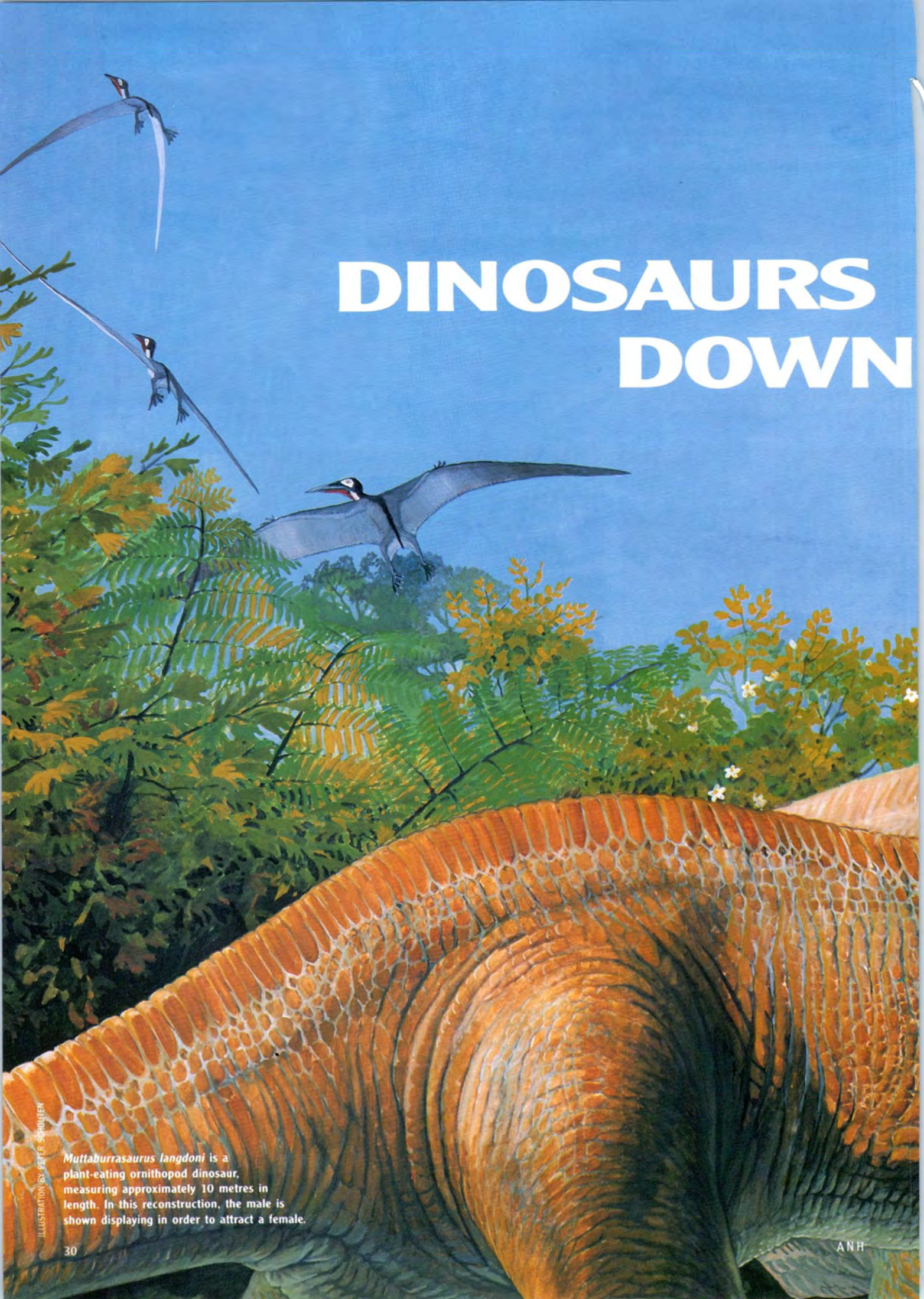
Despite being studied for 200 years, many aspects of the Short-beaked Echidna's life still remain a mystery.



This 45-day-old echidna is changing colour from pink to grey as hairs and spines begin to grow.

RISMAC

DINOSAURS DOWN



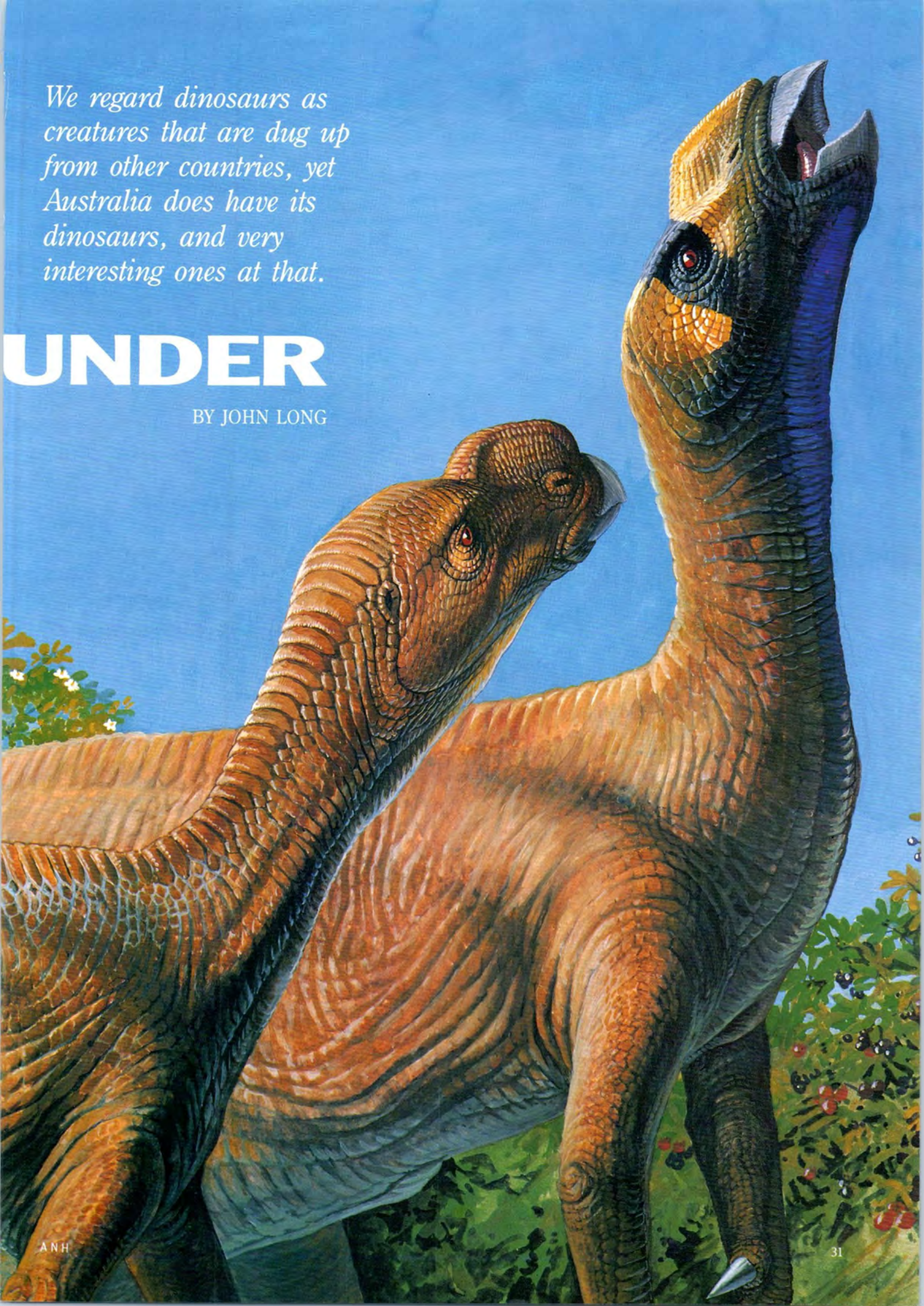
Muttaburrasaurus langdoni is a plant-eating ornithopod dinosaur, measuring approximately 10 metres in length. In this reconstruction, the male is shown displaying in order to attract a female.

ILLUSTRATION BY PETER SCHOUTEN

We regard dinosaurs as creatures that are dug up from other countries, yet Australia does have its dinosaurs, and very interesting ones at that.

UNDER

BY JOHN LONG



I'LL NEVER FORGET THAT DAY AS LONG as I live—the day I found my first dinosaur bone. It was a blustery day in November 1978. My cousin Tim Flannery, Rob Glenie and I headed down to the Gippsland coastline to hunt for dinosaur bones. Within ten minutes of climbing down the cliffs I found a small bone in a rock. We were amazed at how quickly we had found the fossil and, within a few hours, we had found another three bone fragments. This was the first dinosaur bone to be found in Victoria since the turn of the century and, it was to spark off a number of major discoveries, resulting in hundreds of dinosaur bones being uncovered from the coastal cliffs of southern Victoria.

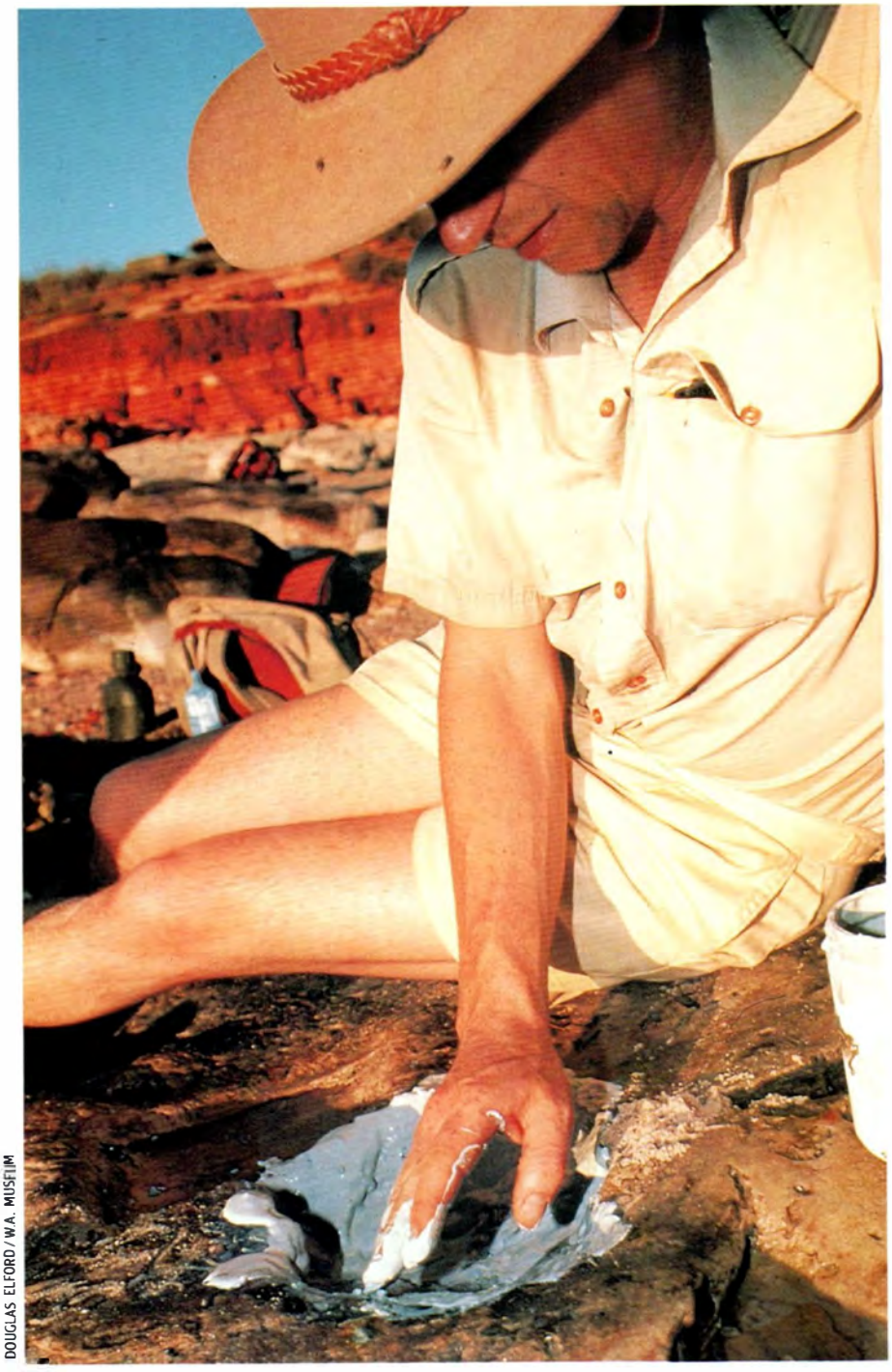
Whenever we think of dinosaurs, images of the giant lumbering *'Brontosaurus'* (now officially known as *Apatosaurus)*, ferocious *Tyrannosaurus*, or even the three-horned *Triceratops* spring to mind. Interestingly, one thing all these share is that they lived in North America. We usually always regard dinosaurs as creatures that are dug up from other countries, not Australia. Yet the land downunder *does* have its dinosaurs, and very interesting ones at that. They represent an until recently unknown antipodean dinosaur fauna, some forms of which actually lived within the Antarctic Circle, surviving long annual periods of cold and 24-hour-a-day darkness.

Although Australia has only a few large and spectacular dinosaurs, our many small dinosaurs, and their footprints, are filling the gaps in the story of dinosaur faunas of the southern continents. At the beginning of the Age of Reptiles, in the Triassic Period (about 230 million years ago), Australia formed the eastern extremity of Gondwana, the great southern supercontinent, consisting of Antarctica, Australia, New Zealand, India, Arabia, South America and Africa. During the Triassic, Gondwana lay in close proximity to the northern supercontinent of Laurasia, containing Europe, Asia and North America.

The first dinosaurs appeared about this time in South America. Land bridges enabled dinosaurs to migrate freely into all continents. By the early part of the Jurassic Period (about 200 million years ago) Gondwana began to drift apart. South America and Africa had left Gondwana and by then many of the major dinosaur groups had evolved. By early Cretaceous times (about 100 million years ago) dinosaurs reached their peak of diversity, and only Australia and Antarctica remained joined to form the last remnant of Gondwana. Dinosaur groups that appeared late in the Cretaceous in the Northern Hemisphere, such as the duck-billed hadrosaurs, couldn't migrate into Australia because the continents were then separated by the newly formed oceans. However, dinosaurs undoubtedly reached Australia through Gondwana sometime between the late Triassic and early Jurassic. Evidence for this migration comes from Antactica, where the remains of a large carnivorous (meat-eating) dinosaur, among others, have recently been discovered.

I'll never forget the day I found my first dinosaur bone.

AUSTRALIA HAS AN INTERESTING history of dinosaur discoveries. Some of our larger specimens were uncovered in Queensland during the 1920s. The Queensland Museum did not have funding to send scientists into the field, so the large bones had to be packed up and sent in by graziers. This is how *Rhoetosaurus*—our largest dinosaur known from a partially complete skeleton—was found. Fifty years after the original bones were forwarded from Durham Downs Station to the Museum, a team of scientists revisited the site, and to their amazement, uncovered a nearly



DOUGLAS ELFORD / W.A. MUSEUM

John Long makes a rubber latex cast of a stegosaur footprint. The fossil trackway from Broome is so far the only evidence of *Stegosaurus*-like dinosaurs in Australia.

MAJOR DINOSAUR GROUPS

Saurischia

(lizard-hipped dinosaurs)

THEROPODA

Bipedal, agile, carnivorous dinosaurs with relatively large heads and long, sharp teeth, large legs, small arms, e.g. *Tyrannosaurus**, Rapator, Allosaurus, Kakuru, Tyrannosauropus* tracks, *Megalosauropus* tracks, *Skartopus* tracks.

SAUROPODS

Quadrupedal with elephantine legs, large bodies, long neck and tail, small head, peg-like teeth, plant-eating, e.g. *Apatosaurus**, Brachiosaurus**, Rhoetosaurus, Austrosaurus.*

Ornithischia

(bird-hipped dinosaurs with horny beak for cropping plants)

STEGOSAURIA*

Quadrupedal, paired bony plates or spines along the back, four tail spikes, large legs, small arms, small head, leaf-shaped teeth, plant-eaters, e.g. *Stegosaurus***

ANKYLOSAURIA

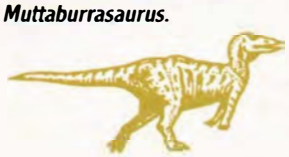
Quadrupedal 'armoured' dinosaurs having thick bony plates or denticles set into the back, often with clubs developed on tail, e.g. *Minmi.*

ORNITHOPODA

Bipedal plant-eaters with large legs and smaller arms. Includes *Wintonopus* tracks and the following groups:

HYPSILOPHODONTIDAE—small and agile, e.g. *Fulgurotherium, Leaellynasaura, Atlascopcosaurus.*

IGUANODONTIDAE—large forms with sharp thumb spikes, e.g. *Muttaburrasaurus.*



*HADROSAURIDAE***—duck-billed dinosaurs, e.g. *Edmontosaurus.*

MARGINOCEPHALIA

Frill structure developed around back of head. Includes:

*PACHYCEPHALOSAURIA***—bipedal forms with thick bony skulls and weak frill, e.g. *Pachycephalosaurus***

*CERATOPSIA**—quadrupedal horned dinosaurs often with large bony frill, e.g. *Triceratops**.*

**Groups possibly present in Australia (evidence scarce).* ***Groups not found in Australia.*

ALEX RITCHIE

At Lark Quarry the flat beds of Cretaceous sandstone, approximately 100 million years old, have preserved more than 3,000 dinosaur footprints belonging to three different species.

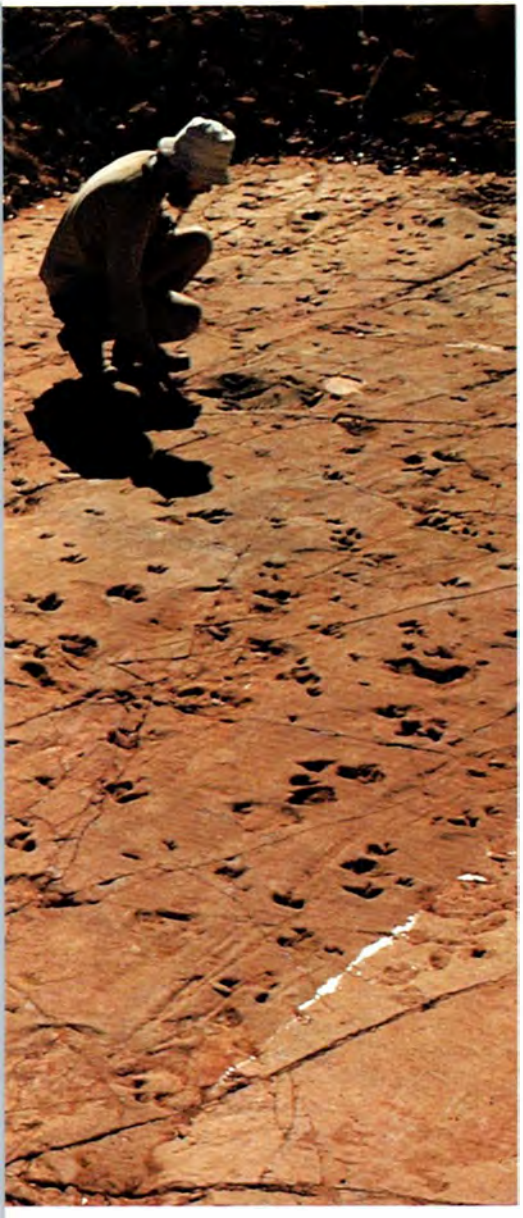
complete foot of the same beast as well as several other pieces of bone. *Rhoetosaurus* belonged to the long-necked group of dinosaurs known as sauropods (see box on major dinosaur groups) and is estimated to have been 15 metres long and up to 20 tonnes.

Another giant sauropod, *Austrosaurus*, was described from some isolated vertebrae sent in from Clutha Station, near Maxwelton in northern Queensland. More material thought to belong to *Austrosaurus* was later found near Winton. The forelimbs were relatively long and slender, most like the older Jurassic sauropods from North Africa. It seems likely that *Austrosaurus* was a late survivor of a primitive family, the Cetiosauridae, and was of a similar size to *Rhoetosaurus*.

But what was Australia's biggest dinosaur? The answer lies in one fragmentary neck bone found near Hughenden, Queensland. It closely resembles that of the well-known gigantic African, American and European sauropod *Brachiosaurus*, and suggests that the Australian monster was up to 22 metres

BARRY SLADE

Scenic view of the outback Queensland landscape around Lark Quarry, near Winton. It was here that herds of small dinosaurs once stampeded to escape the jaws of a large predatory dinosaur. Today, only their fossilised footprints are left to tell the tale.



But what was Australia's biggest dinosaur? The answer lies with one fragmentary neck bone found in Queensland.

long. However, as the neck vertebrae of *Austrosaurus* are not well known, this find could possibly have come from *Austrosaurus* rather than a brachiosaur.

More Australian dinosaurs came to light during the opal-mining fever of the early 20th century. During the early 1900s the British Museum of Natural History obtained a small collection of opalised dinosaur bones from the 100-million-year-old white sandstones of Lightning Ridge, New South Wales. Included was a thigh bone (femur) from a small (one to two metres long) plant-eating hypsilophodont dinosaur named *Fulgurotherium australe* (meaning 'southern Lightning beast'), and a hand bone (metacarpal) from the carnivorous theropod *Rapator ornitholestoides*. *Rapator*, which means 'predator', was probably a large animal of eight or nine metres length.

In the late 1970s fragments of opalised dinosaur bones were also found near Andamooka, in South Australia. The bones were from a new type of slender, bird-like theropod dinosaur, probably about three metres long, whose shin bone (tibia) was of similar proportions to that of a heron or crane. It was named *Kakuru kujani* from the Aboriginal myth of the rainbow serpent and the name of the local tribe, the Kujani. The original bones were not donated to any museum but were sold at auction and have tragically been lost to science. Fortunately, casts of the specimen were made which are now held in the South Australian and other museums.

Australia's most spectacular dinosaur skeleton emerged in 1963. Large bones were found in a cattle yard on the Thompson River, near Muttaburra, Queensland.

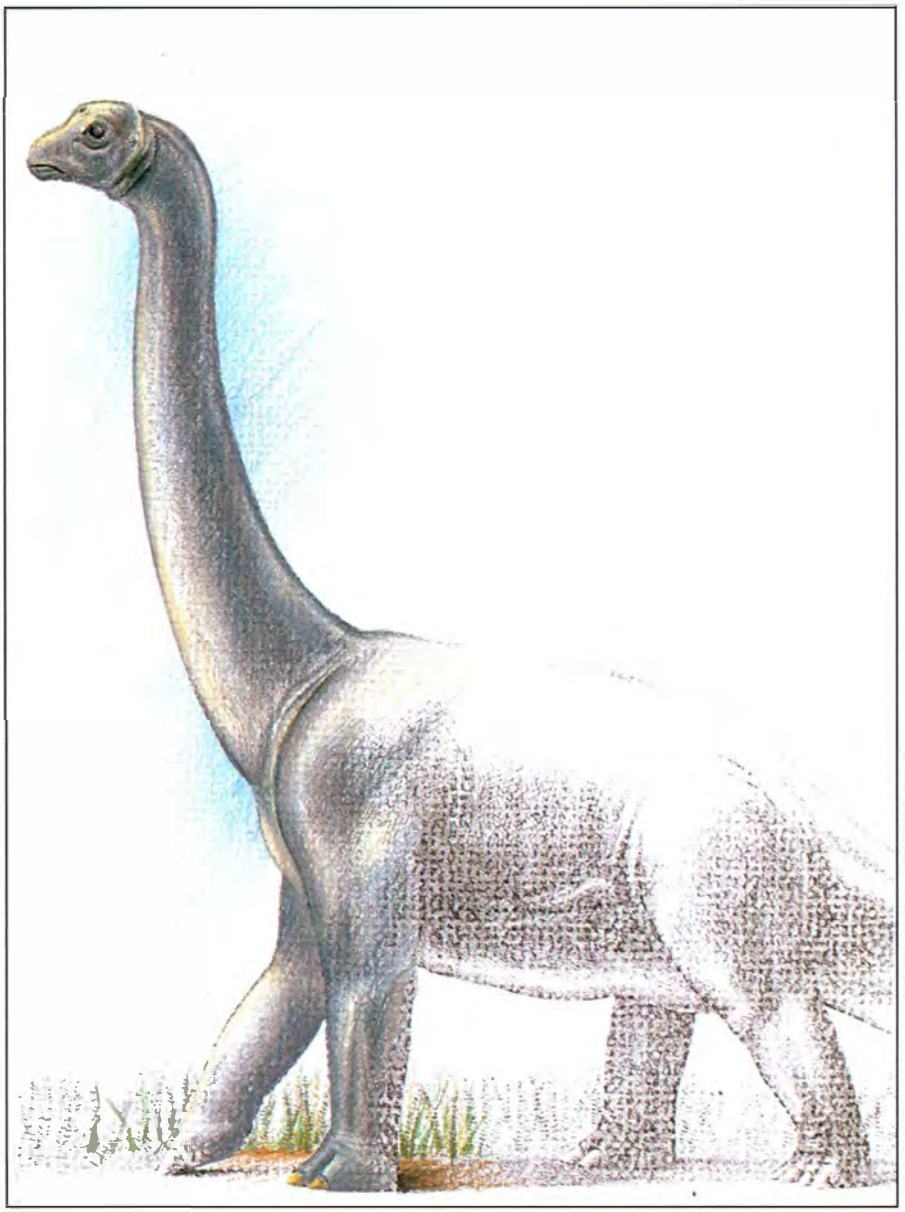


ILLUSTRATION BY PETER SCHOUTEN / COLOURED BY VICTORIA McNEILL

A large long-necked sauropod like this one left its huge footprints in the sandy river sediments near Broome approximately 100 million years ago. Some of the individual prints measure 1.2 metres in length, suggesting the owner was a gargantuan creature of 20 metres or more in length.

QUEENSLAND MUSEUM

The new skeleton of *Minmi* found near Richmond, Queensland, is one of the best dinosaur skeletons ever found in Australia. *Minmi* was a small plant-eating ankylosaur that lived about 100 million years ago. The bony scutes that protected the back can be seen preserved intact between the ribs.

These turned out to belong to a plant-eating ornithopod dinosaur named *Muttaburrasaurus langdoni*, measuring approximately ten metres in length.

The skull of *Muttaburrasaurus* bears a balloon-like expansion of the snout. One suggestion is that this may have supported a fleshy organ for making sounds. Its teeth are unusual in that the tooth crowns appear to have all erupted together, differing from the normal dinosaur condition in which teeth erupted sequentially. The jaws could shear food like scissors, and there were large jaw muscle attachments giving great strength to the animal's chewing ability. As in other members of its family (Iguanodontidae), *Muttaburrasaurus* probably possessed a sharp thumb spike thought to have been used in defence against attackers.

One dinosaur sticks in everyone's memory. It is *Minmi*, a small armoured ankylosaur dinosaur with a delightfully short name, taken from its discovery site near Minmi Crossing, southern Queensland. The first specimen was found in 1964 and includes a series of vertebrae, part of the foot, and several hundred small round, bony platelets that were set in the skin around the belly. Also found were unusual struts linking the processes on the vertebrae, perhaps necessary to support the weight of the belly. In early 1990 a new, nearly complete *Minmi* skeleton was found near Richmond in Queensland (see ANH Spring 1990).

Queensland is home to Australia's most famous dinosaur footprints. A spectacular find of many thousands of dinosaur trackways was discovered near Winton in the early 1900s. Careful excavation of the bed revealed nearly 3,300 individual prints belonging to three kinds of dinosaurs (see ANH Summer 1979). One set of tracks, named *Wintonopus latomorum*, was made by a small to moderate-size ornithopod with a stubby asymmetric three-toed footprint. Another, named *Skartopus australis*, was made by a small predatory dinosaur with sharp claws on each of its three toes. The third was from a large three-toed carnivore of gigantic size, leaving footprints up to 58 centimetres in length and aptly named *Tyrannosauropus* (meaning 'foot like *Tyrannosaurus*').

The Winton trackways give us a fascinating glimpse into prehistory, telling the story of what happened in ten seconds of time about 100 million years ago. It appears that the two herds of small dinosaurs were coexisting harmoniously. The ornithopods may have been feeding on plants while the small predators caught the insects and animals that fled from the disturbed vegetation. Suddenly the two dinosaur herds were interrupted by a giant meat-eating monster. In desperation they tried to escape but were cornered in a closed valley and had no choice but to run past the big predator. The tracks show *Tyrannosauropus* closing in on the desperate, stampeding pack. Estimates of the speeds of the dinosaurs are 20 kilometres per hour for the swift ornitho-

pods, 12 for the small predators and seven for the big meat-eater.

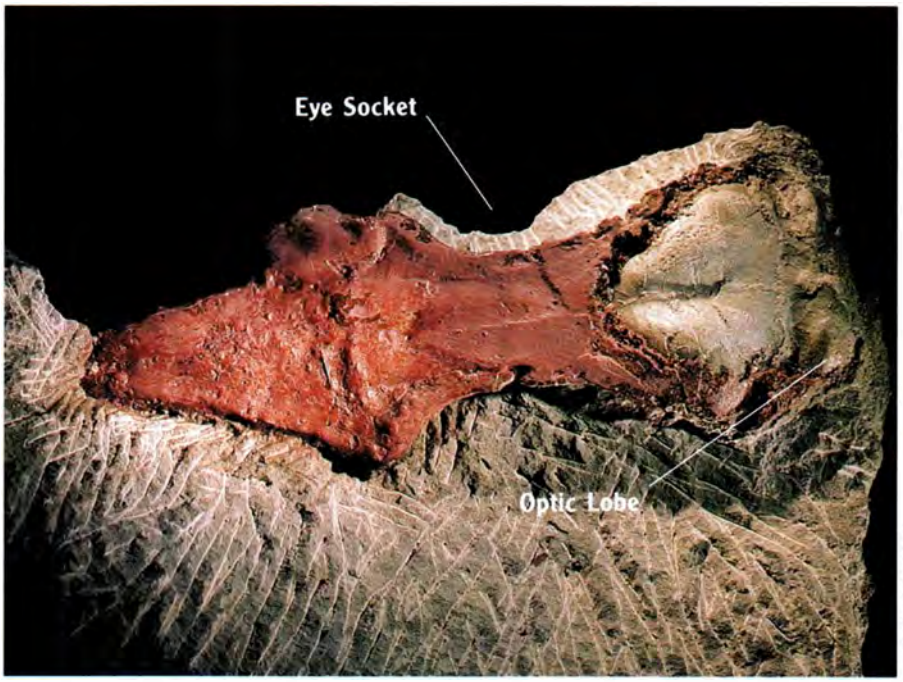
There was no record of dinosaurs from Western Australia until the 1950s when dinosaur footprints were reported on a rocky beach near Broome. The three-toed footprints, named *Megalosauropus broomensis*, were up to 37 centimetres long and belonged to a theropod about six metres long. Many new types of dinosaur footprints were discovered in the mid-1980s by a local naturalist, Mr Paul Foulkes, who walked the rocky beaches during low tides. At least six different kinds of dinosaur species are represented, all of which once inhabited the ancient river valley around Broome. These include two forms of gigantic sauropods (the largest footprints are just over a metre wide); large predators like *Megalosauropus* with footprints up to 53 centimetres long (indicating a beast of around nine metres); small ornithopod dinosaurs, including *Wintonopus;* and a possible stegosaur—the first record of this group of dinosaurs in Australia. The stegosaur trackway is characterised by stubby, asymmetric five-fingered hand prints associated with a robust three-toed footprint. Such a combination is unique among dinosaurs and is only found in some stegosaurs.

Perhaps the most exciting of all recent dinosaur finds in Australia are the extraordinary discoveries from southern Victoria, where Drs Tom and Pat Rich (from the Museum of Victoria and Monash University) have unearthed 3,000–4,000 bones over the last decade. But what led to these finds? How did the scientists know where to dig for these dinosaurs?

AT THE TURN OF THE CENTURY A small claw from a carnivorous dinosaur was found near Cape Patterson in Gippsland. Then no further finds were made until 1978 when Tim, Rob and I found more bones at the same locality on that unforgettable November day. Later field work by Tim, the Riches and others led to the discovery of many new sites along the coasts in Gippsland and the Otway Ranges (western Victoria), including the discovery in 1983 of 'Dinosaur Cove'—a rich site that has so far yielded many good dinosaur bones of late-early Cretaceous age. Most belong to small hypsilophodonts—agile dinosaurs that ate plants and had no specialised features for defending themselves apart from their ability to run fast. So far there are at least four different types, including *Fulgurotherium australe*, also found at Lightning Ridge. *Leaellynasaura amicagraphica*, named after the Riches' daughter Leaellyn, is the most complete hypsilophodont dinosaur known from Australia. It was probably up to a metre in length. Large eye sockets and enormous

Left: Dinosaur Cove, western Victoria, was discovered in 1983 and has been the site of many exciting dinosaur discoveries.

Below: Skull roof of *Leaellynasaura amicagraphica*, a small plant-eating hypsilophodont dinosaur from Dinosaur Cove, Victoria. The bone covering the brain case has been lost, exposing a cast of the brain cavity and revealing enormous optic lobes. The large eye sockets and optic lobes suggest that this dinosaur may have been able to 'see in the dark'.



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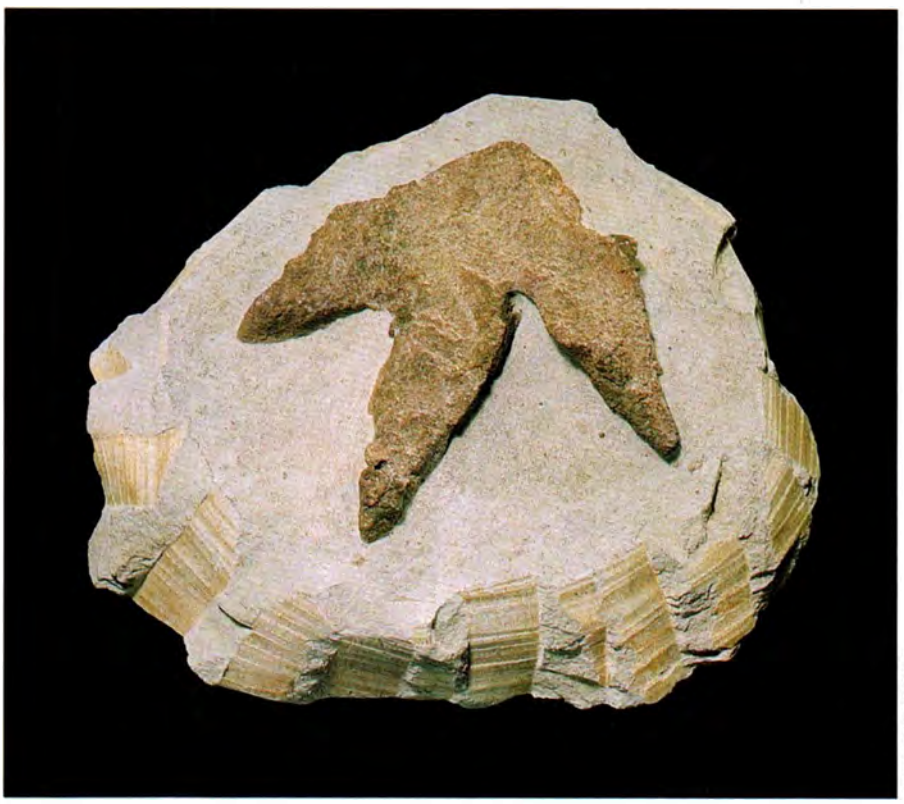

MUSEUM OF VICTORIA

Footprint of a small carnosaur, approximately two metres long, found in the Cretaceous rocks on the south coast of Victoria.

MUSEUM OF VICTORIA

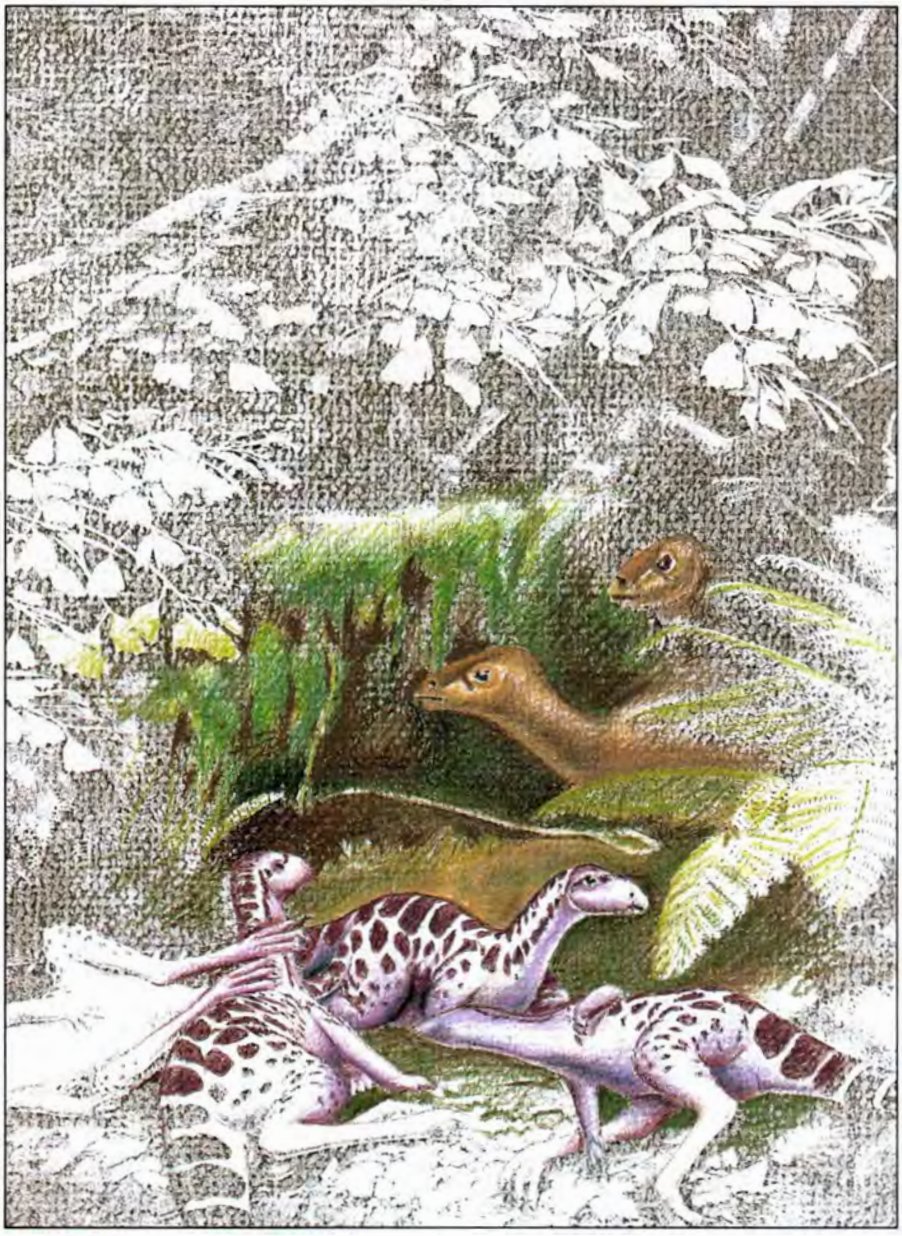

ILLUSTRATION BY PETER SCHOUTEN / COLOURED BY VICTORIA McNEILL

Several different species of hypsilophodont dinosaurs have been recovered from the coastal rocks of southern Victoria. These dinosaurs must have been adapted to life in a polar climate at a time, approximately 100 million years ago, when southern Australia was well within the Antarctic Circle.

How did Victorian dinosaurs, living within the Antarctic Circle, cope with the cold and dark polar conditions?

optic lobes of the brain suggest it might have been able to 'see in the dark' during the three months of the year that Victoria was in darkness due to its close proximity to the South Pole (within 75° S). Another hypsilophodont, *Atlascopcosaurus loadsi*, was named after the Atlas Copco Corporation, which generously donated mining equipment to help excavate the bones. It was probably about two or three metres maximum length, and its teeth were well adapted, perhaps for slicing up the tough coniferous plants that grew in the ancient cold river valley.

One footbone (an astragalus or anklebone) from the Gippsland coast has been identified as belonging to *Allosaurus*–the same large predator that grew to 12 metres in the Jurassic Period of North America. The Aussie *Allosaurus* was smaller (around five or six metres long), yet more robust. Luckily, although only one bone was found, the astragalus is perhaps the best small bone from the whole skeleton for identifying these dinosaurs, and proves beyond doubt that they survived in Australia for at least 50 million years later than in the Northern Hemisphere.

One of the most unexpected finds from Victoria is the bone of a possible horned dinosaur (a ceratopsian). These dinosaurs, which include the large rhinoceros-like *Triceratops*, were thought to have lived exclusively in the late Cretaceous in places such as North America and Asia. However an arm bone (ulna) found in the Strzelecki Ranges appears to be close to that of a small, primitive ceratopsian, and comes from Lower Cretaceous rocks! Although it is currently regarded with suspicion by its finders Tom and Pat Rich, they have suggested the possibility that the group could have had origins in Gondwana and only afterwards migrated to the Northern Hemisphere.

The most fascinating aspect of the Victorian dinosaur story is that these dinosaurs lived within the Antarctic Circle. How did they cope with these cold (less than 5°C) and dark polar conditions? One theory is that they were warm-blooded and could generate the necessary heat from within their own bodies. However, in order to keep warm, they would probably have required some specialised body covering, such as down feathers or even fur or possibly, as the Riches have suggested, a layer of fat. Some pterosaurs (ancient flying reptiles) are known to have possessed hair or fur, so other archosaurians (the reptile groups including crocodiles, pterosaurs, dinosaurs and birds) may have already had the ability to develop this sort of covering.

The last known giant amphibians (labyrinthodonts) have also been found in the deposits containing the Victorian polar dinosaurs. As modern amphibians are not warm-blooded, it suggests that enough sunshine might have come into the area to sustain cold-blooded life, or alternatively that the animals were specially adapted to cold conditions like some present-day cold-blooded creatures that survive in polar climates. Examples of these are Antarctic fishes that have antifreeze enzymes in their blood, or the giant Japanese salamanders that survive winters in near frozen streams.

A number of scientists who have studied dinosaur physiology from their skeletons believe many were most proba-

STEVE MORTON, FRANK COFFA / MONASH UNIVERSITY

Finer extraction of fossil bones is performed with the use of a hammer and chisel.

bly 'warm-blooded', in that their body temperatures remained high despite low environmental temperatures, but the heat necessary for this was not generated from internal sources (as in true endotherms). The larger the animal is, the less energy it requires to maintain high temperatures. A special term—'gigantothermy'—has been coined to explain this type of heat regulation in large animals (see ANH Autumn 1992). It explains how a large, supposedly 'cold-blooded' reptile like the Leatherback Turtle can survive in cold Arctic waters while maintaining a body temperature of over 25°C. In other words, a gigantic dinosaur may have retained a high constant body temperature without having the same in-built endothermic generator as mammals or birds do today.

Still, smaller dinosaurs would have had a hard job managing their constant body temperature in such cold climates. Unlike the bigger dinosaurs or large amphibians, they would have required a much higher metabolism to generate and maintain enough body heat to survive the cold, dark polar winters. Thus there is a strong argument for at least the small Victorian dinosaurs being true endotherms.

The mystery of how the Victorian dinosaurs of the twilight zone managed to keep warm may never be fully resolved, but at least we are slowly piecing together the fantastic story of the type of dinosaurs that inhabited Australia. This not only satisfies curiosity about such things, but continues to fuel the growing industry that dinosaur-mania has spawned. Dinosaurs are now a multimillion dollar industry around the world. Books, films, museum exhibitions and travelling displays, robotic dinosaurs and theme parks—they all start with the palaeontologist digging up the bones and carrying out research. Let's hope that Australia continues to reveal more dinosaur discoveries each year—it could be just the thing we need to boost an ailing economy! ■

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MIKE MORWOOD

ANH

When does graffiti at Aboriginal rock art sites become vandalism and when does it become part of our cultural heritage?

A MARK IN TIME

BY MIKE MORWOOD & GRAHAME WALSH

THE WORD 'GRAFFITI' COMES FROM the Greek 'graphien' meaning to mark, draw or write. Put simply, graffiti are drawings or words written on walls. The urge to leave such personal marks for posterity. appears to be a basic human trait. In fact, studies have shown that this was one of the motivating factors when Australian Aborigines decorated the walls of rock shelters. Aboriginal artists are known to have used hand stencils at a site to record a visit, and such 'signatures' could serve as a memorial to be mourned over after the artist's death.

Writing on walls also has a long history. For instance, archaeologists have found many inscriptions on the walls of the city of Pompeii, which was buried by a volcanic eruption in 79 AD. In some cases these graffiti were names. Others expressed sentiments like "Romula tarried here with Staphylus". They present a real insight into ancient Roman life, values and humour. Such graffiti is also one of the main types of deliberate damage by visitors to Australian Aboriginal rock art sites, and therein lie the roots of a problem.

Australia is a signatory to the International Council on Monuments and Sites Charter, which stipulates that, in taking steps to conserve a site, *all* aspects of cultural significance should be taken into account and that the contribution of *all*

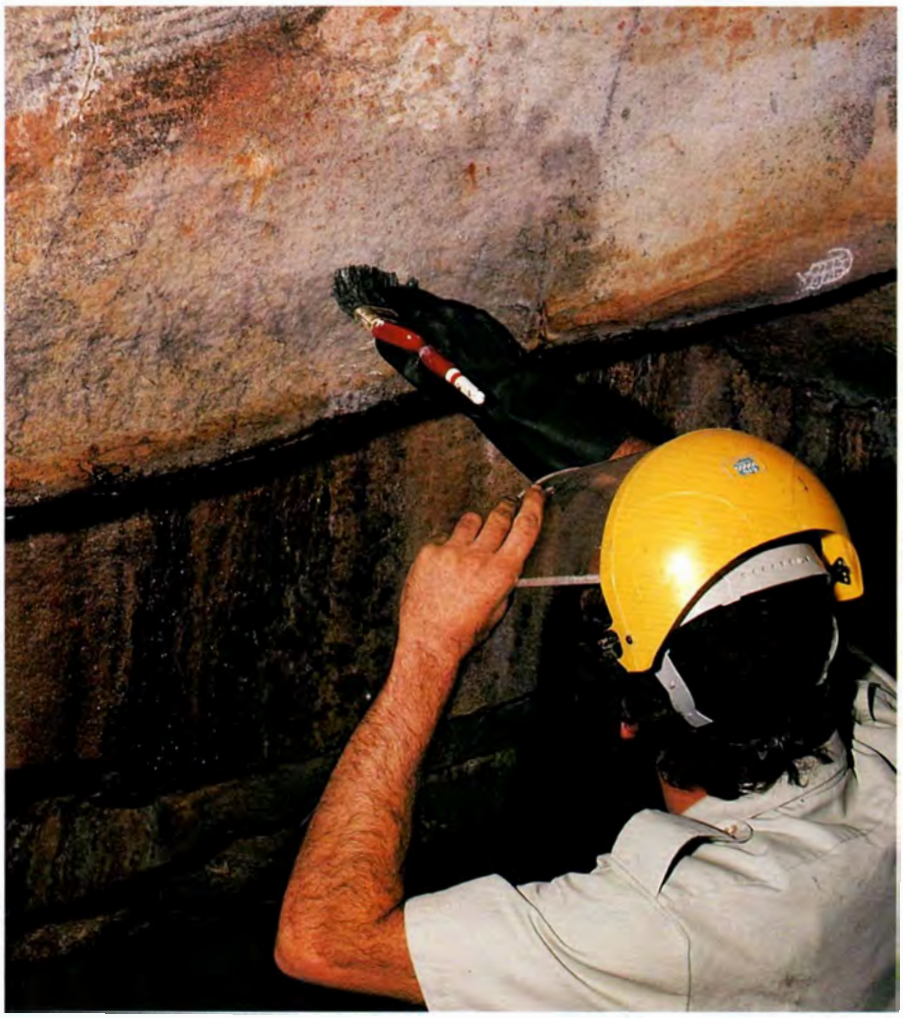
Black's Palace, in central Queensland, has suffered extensive vandalism since the time of first European settlement.

Where should the line be drawn in deciding what graffiti should be left and what removed?

periods of site use must be respected. At the practical level this is impossible, for often there are conflicting priorities by which steps taken to conserve one aspect of cultural significance have damaging effects on other aspects. Graffiti at Aboriginal rock art sites provide a good example of such conflicting priorities.

Removal of graffiti from defaced rock art sites is now a standard practice used by all Australian State authorities. Such basic restoration work enhances the visitor experience and facilitates respect for the site and Aboriginal culture. Removing graffiti also minimises the risk of 'copycat' behaviour, which has potential to escalate and bring about the rapid destruction of rock art at a site. The famous Kenniff Cave art site, in Mt Moffat National Park (Queensland), is such an example. Until 1967 this site had only a few names of Aboriginal stockmen and station workers added in charcoal. But in one day, members of an organised local pony club ride effectively destroyed the rock art panels with their graffiti. Such defacement of Aboriginal sites is now illegal in all States, with heavy penalties prescribed for offenders.

But some graffiti at rock art sites are themselves of historic importance. For instance, most people would agree that graffiti left by the explorer Ernest Giles and his party in central Australian rock art galleries in October 1872 are culturally significant and should be preserved. Similarly, in central Australia the graffiti left by Aboriginal stockmen at rock art sites are important indicators of both cultural continuity and the disruption that has occurred since European settlement.



MIKE MORWOOD

So when does graffiti become vandalism? Where should the line be drawn in deciding what graffiti should be left and what removed? Are examples older than 50 years significant, or should 100 years be the minimum age? With ever-increasing pressures being placed on cultural heritage managers, these questions are important. All manner of people have visited or lived in rock shelters since European settlement, including explorers, convicts, bushrangers, camel drivers, hermits, miners, stockmen, Dingo trappers, possumers, local identities and the destitute. Many of these people recorded their presence on the walls—in some cases with considerable flair and skill. These records are of historical significance. Some warrant preservation.

It could also be argued that all graffiti are potentially informative and, at the very least, they should be recorded before removal is contemplated. This is because such defacement at rock art sites can provide a range of information useful in their long-term management.

In a recent review of the impact of tourists on places of cultural significance, Fay Gale and Jane Jacobs, of the University of Adelaide, noted that information on the way people use rock art sites is an essential prerequisite for planning the construction of facilities such as boardwalks. These researchers also list a range of techniques for measuring visitor pressure on sites. The techniques include counting of visitors, observation of their behaviour, questionnaires and interviews. All provide information on visitor impact and attitudes, but only over a fairly limited time period.

Changes in visitor impact and attitudes over a longer time period also need to be taken into account, otherwise measures taken may be a response to past rather than present patterns of visitor behaviour. For instance, progressive stages in the 'public awareness' of a site tend to attract different types of visitors, each with their own management problems. At many sites graffiti appear to date largely from a time when visitor numbers were low and attitudes to Aboriginal rock art were different. In such cases, graffiti may no longer be a problem, even though previous defacement may still be very evident and obtrusive.

Over the past 20 years there has undoubtedly been a shift in community attitudes towards conservation of cultural and natural resources, some of which may have stemmed from legislative changes by the States and some of which led to legislative changes. Clearly, methods for monitoring the long-term effectiveness of conservation procedures would be useful. Comparative studies undertaken at specific sites at regular intervals have provided such management data, for ex-

Defacement of Aboriginal rock art sites is illegal in all States. Dave Lambert removes graffiti from Kenniff Cave in Mt Moffat National Park, central Queensland.

ample, in the way visitor numbers have increased at Carnarvon Gorge, Kakadu and Uluru National Parks. Unfortunately, no Australian study was ever undertaken for the important period from the mid-1950s, when visitor numbers expanded significantly, through to the 1970s, when all States passed laws protecting Aboriginal sites and the State agencies responsible for overseeing these laws were established.

One possible method for monitoring long-term changes in social attitudes towards Aboriginal art sites is to make use of dated graffiti; as case studies from the central Queensland Highlands and New South Wales illustrate.

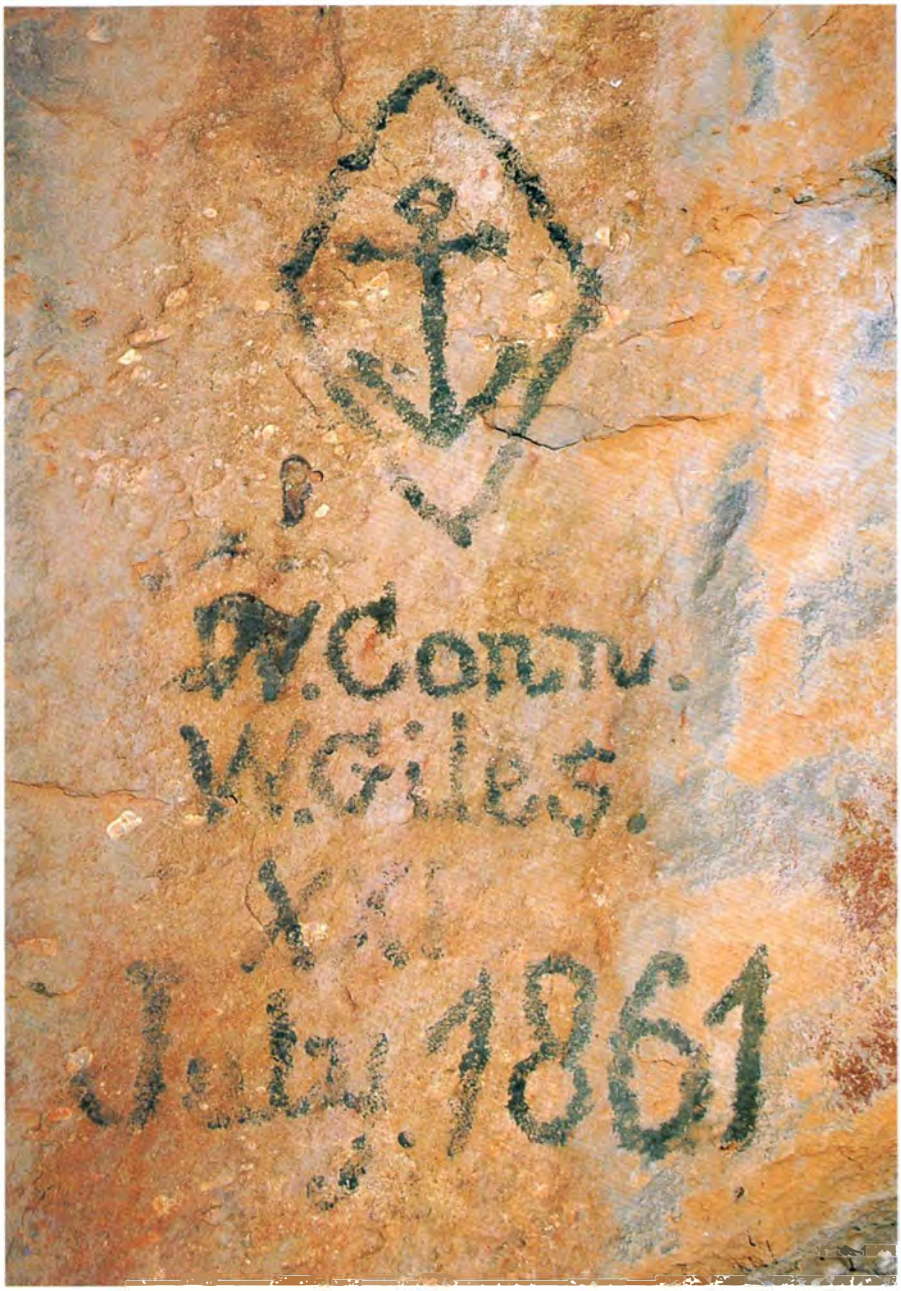
THE CENTRAL QUEENSLAND SANDSTONE Belt is widely known for its large number of Aboriginal rock art sites. Unfortunately, the soft sandstones are easily marked and many of the sites have been defaced by vandalism. This has been occurring almost since the time of first European settlement in the region. For instance, at Black's Palace, which is probably the most heavily vandalised site in Queensland, one of the first official reports was by Staff Surveyor W.G. Drane, who wrote to the Queensland Surveyor-General in 1918: "I am forwarding per parcel post a painting of a hand". This had been literally cut from the wall. Later in 1935, J. Bergin, Acting Land Commissioner, complained that at this site: "Visitors persist in defacing the work by carving their names over the drawings, and worse still by scattering the bones out of the caves".

When dated graffiti were recorded from Black's Palace and other sites on the upper Barcoo, Warrego and Comet Rivers on the western side of the Highlands, a close fit was found between the frequency of vandalism and the history of European land use in the region. Specifically, from European contact until the last recording in 1982, the rate at which sites were vandalised can be related to general changes in population mobility and attitude.

Huge pastoral holdings in the central Queensland Highlands were first taken up in the early 1850s and from this time Europeans must have encountered Aboriginal rock art sites during stock work. However, apart from T.W. Parrot, who in 1888 wrote of his discovery of a rock art site in the Expedition Range in 1864, very few of such early encounters were ever published. The earliest dated graffiti recorded are by J. Hunt who carved his name at a number of art sites in the Black's Palace region between 1890 and 1893. Local tradition records that Hunt was a brumby runner and, judging by the occurrence of his name inscribed in a number of rock art sites over a wide area of the central Queensland Highlands between 1890 and 1919, he must have ranged extensively as part of his occupation.

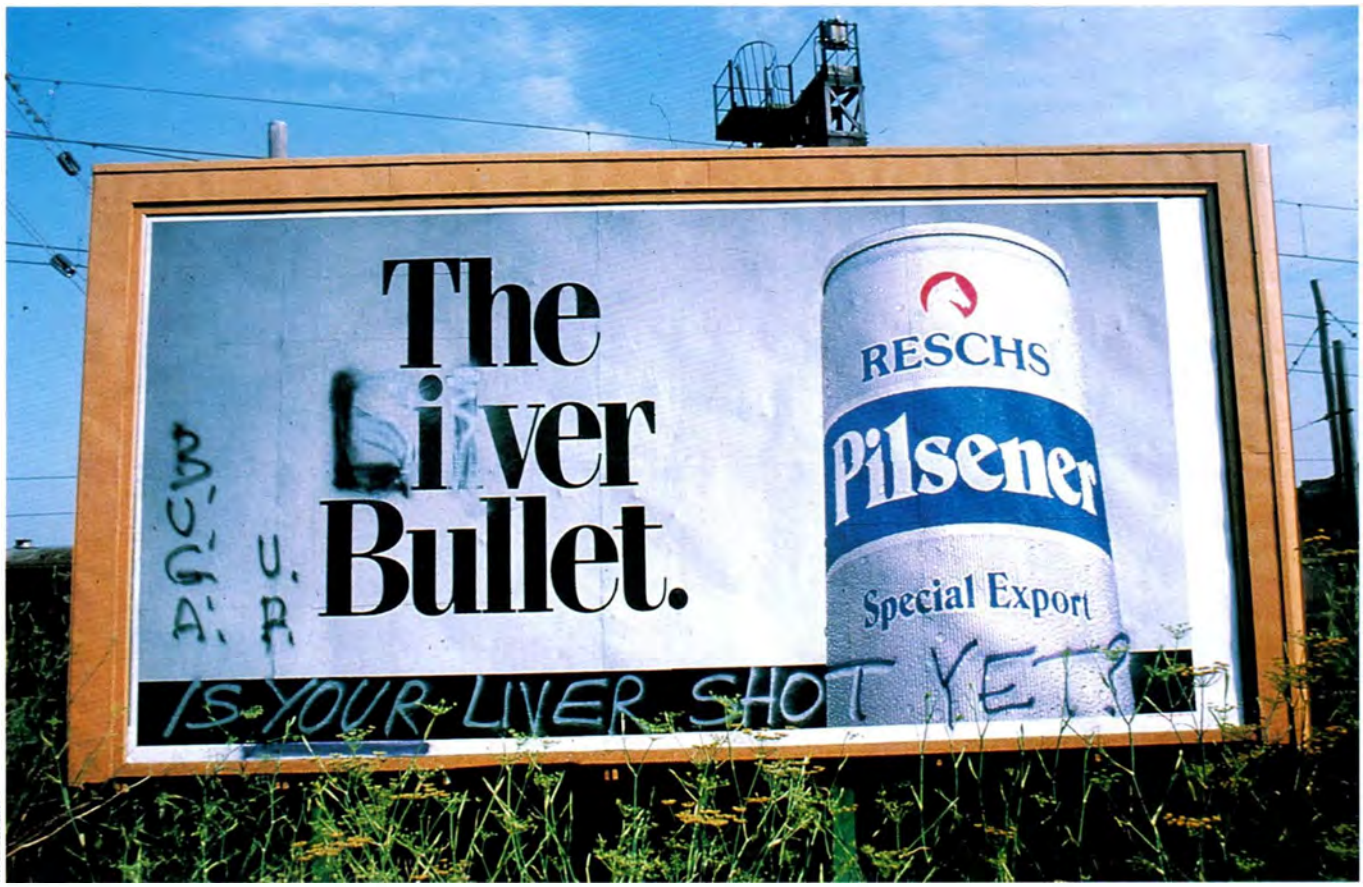
Towards the end of the 19th century European knowledge of the region steadily increased, as did the number of reports on local Aboriginal rock art sites. This period is not well represented in dated graffiti. Possibly the high rate of illiteracy among station workers at the time was a factor. Elsewhere in the central Queensland Highlands, graffiti in Aboriginal rock art sites date to the massive man-hunt through the region for the notorious Kenniff brothers, who murdered Police Constable Doyle and Mr Dahlke, manager of Carnarvon Station, in 1902 and then went bush. The Kenniffs and the influx of people associated with the man-hunt are represented in local graffiti.

From 1908 there was a definite peak in graffiti at rock art sites as the country became more densely occupied. This peak continued through World War 1. To the east the earliest evidence for European knowledge of rock art sites in Carnarvon Gorge comes from this time. "E. Ward 22/2/1918" is inscribed at Cathedral Cave and is said to have resulted from use of the rock shelter by two local draft dodg-



MIKE MORWOOD

Has this graffiti left by explorer Ernest Giles become as culturally significant as the rock art itself?



RIC BOLZAN

The urge to leave personal marks for posterity appears to be a basic human trait.

Early European graffiti often consisted of images important to the lifestyle of the time. This cattle brand was from Babbiloora Station on the upper Warrego River, central Queensland Highlands.

MIKE MORWOOD

ers, the Ward brothers, who were of German extraction and went bush to avoid the proposed conscription. A depiction of a World War 1 type airplane with German markings at one Aboriginal rock art site in western central Queensland is likely to date to the same era.

Some names found inscribed in central Queensland rock art sites from the early 1900s are those of well-known Aboriginal stockmen of local descent, indicating that the traditional significance and respect for rock art sites had been lost by this time. While many examples of post-contact Aboriginal graffiti feature only names, dates and simple statements, such as "Remember the happy days", others are more interesting. A well-known Aboriginal stockman, named George Fraser, painted images in red ochre at a traditional Aboriginal rock art site on the upper Nogoa River. His paintings, which were signed and dated as 13 March 1912, included pairs of figures boxing; a five-pointed star, common to Star tobacco tins of that period; and a man riding a bucking horse, which was a trademark of the *North Queensland Register* newspaper.

Some examples of early European graffiti in central Queensland are also accompanied by depictions of horses, cattle, saddles, station brands and other images important to the lifestyle of this fascinating period of local history. A similar range of motifs are found in rock art sites of the Victoria River District in the Northern Territory, painted by Aborigines living in a traditional state, but observing the intrusion of European goods and stock. On the basis of their graffiti/art on rock shelter walls, early European settlers and the last traditional Aborigines in central Queensland during this transitional period seem to have shared many aspects of lifestyle, as well as aspirations.

The second peak in dated vandalism coincides with the Great Depression of 1929–1939 when many Europeans survived on incomes gained from bounties paid on Dingoes, and from the trapping of possums and Koalas for their skins. Queensland was the last State to have an open season on Koalas: 584,738 skins were gathered in the one-month season of 1927. Possum hunting continued until the last legal season in 1936, and proved to be a very lucrative industry, supporting many families through the lean depression years. In the one-month season of 1926, a total of 2,485,876 skins were taken, with the price range, from 60 cents

to $30 per dozen, reflecting a quality range from 'red rumpers' to 'Carnarvon blues'. Scalpers, 'bear' hunters, possumers and doggers often made use of rock shelters for residence and storage, continuing a tradition practised by Aborigines in the region for at least 20,000 years. Some of the graffiti are associated with these activities.

Located on the crest of the Carnarvon Range, Wanderers' Cave served as a seasonal home to one of our families (Grahame's) from 1920 until 1961. During this period, the men would operate out of this base, pursuing whatever skin or scalp trade was legal at the time. Their campfire ashes mingled with those of the preceding Aboriginal occupants who used the site for at least 4,300 years. On the walls of the cave, the names of Bertie, Billy and Herb Sidney, Alby Garland and the 'X' of an illiterate partner are superimposed over Aboriginal rock art. It could be argued that these additions, painted in traditional red ochre by the European inhabitants, represent a continuation of a long-established 'graffiti' tradition at the site. Certainly, they are an essential part of the site's cultural significance.

From the 1950s an increase in affluence, leisure time and number of motor vehicles led to more visitors at Aboriginal art sites, especially after the advent of four-wheel-drive vehicles in the 1960s. This period is marked by a steady increase in the graffiti at rock art sites in central Queensland, which peaked in the mid-1960s. The subsequent decrease in the frequency of vandalism, despite continued increases in visitor numbers, seems to mark a major change in general public perception about the cultural value of Aboriginal rock art. The decrease coincided with the passing of the Queensland Aboriginal Relics Protection Act of 1967, indicating that the Act has been very successful in defining proper visitor behaviour at sites.

A SMALL NUMBER OF PEOPLE HAVE continued to deliberately desecrate rock art sites in the central Queensland Highlands since the Aboriginal Relics Protection Act was passed. Useful data for the design of preventative measures may be gained by establishing the identity and personal characteristics of this minority. In at least one case, when a name was carved over Aboriginal engravings at the Bull Hole site on the upper Barcoo River, the offender was found to be a local juvenile in an unsupervised group of her peers. Gale and Jacobs have previously noted that children, poorly led groups and locals are all in the high-risk visitor category, and the Bull Hole incident involved a combination of all these. In this case penalties stipulated by the Act were not sufficient, but a well-placed warning sign may have prevented the damage.

A particularly interesting finding originating from the study of dated graffiti at Aboriginal rock art sites, was that general trends in the Sydney–Hunter region of New South Wales closely mirror those from the central Queensland Highlands. This indicates that a similar range of determinates was operating in each State; namely the closer pattern of European settlement of many areas from the early part of this century, the effects of the Great Depression on European land use, an increase in general population mobility and leisure time over the past 30 years, and the effects of changing community attitudes and legislation.

In both States, however, the peak in dated graffiti does not occur until after 1967, when legislation protecting Aboriginal sites was first passed. This suggests that the passing of heritage legislation led, rather than followed, a major change in community attitudes towards Aboriginal sites. In fact, the continued extent of vandalism at archaeological sites, especially around the Sydney region, prompted amendments to the National Parks and Wildlife Act in 1974, with stricter penalties and provision for restricting access to Aboriginal sites.

As the excavators of Pompeii realised, graffiti is an artefact with historical significance, research potential and management implications, and should be treated as such. Given the numbers of people who now visit Aboriginal rock art sites, however, the minority who continue to deface sites with names or comments do so with selfish disregard for the preservation of the art or for the rights of others wishing to see and appreciate it. The removal of graffiti and development of strategies for preventing future defacement is clearly a necessary conservation measure at many Aboriginal rock art sites, but visitors' books still allow people to legitimately comment and 'leave their mark' for posterity. ■

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Dr Mike Morwood, a Senior Lecturer in the Department of Archaeology and Palaeoanthropology, University of New England, teaches and researches on the archaeology of Australian Aboriginal art. Grahame Walsh, of the Takarakka Rock Art Research Centre, has undertaken extensive recording of Aboriginal rock art throughout Australia.

BRETT GREGORY

When in full bloom, the dripping nectar polishes the already glossy flowers to a startling brilliance.

THE MAGNIFICENT WARATAH

BY CATHY OFFORD

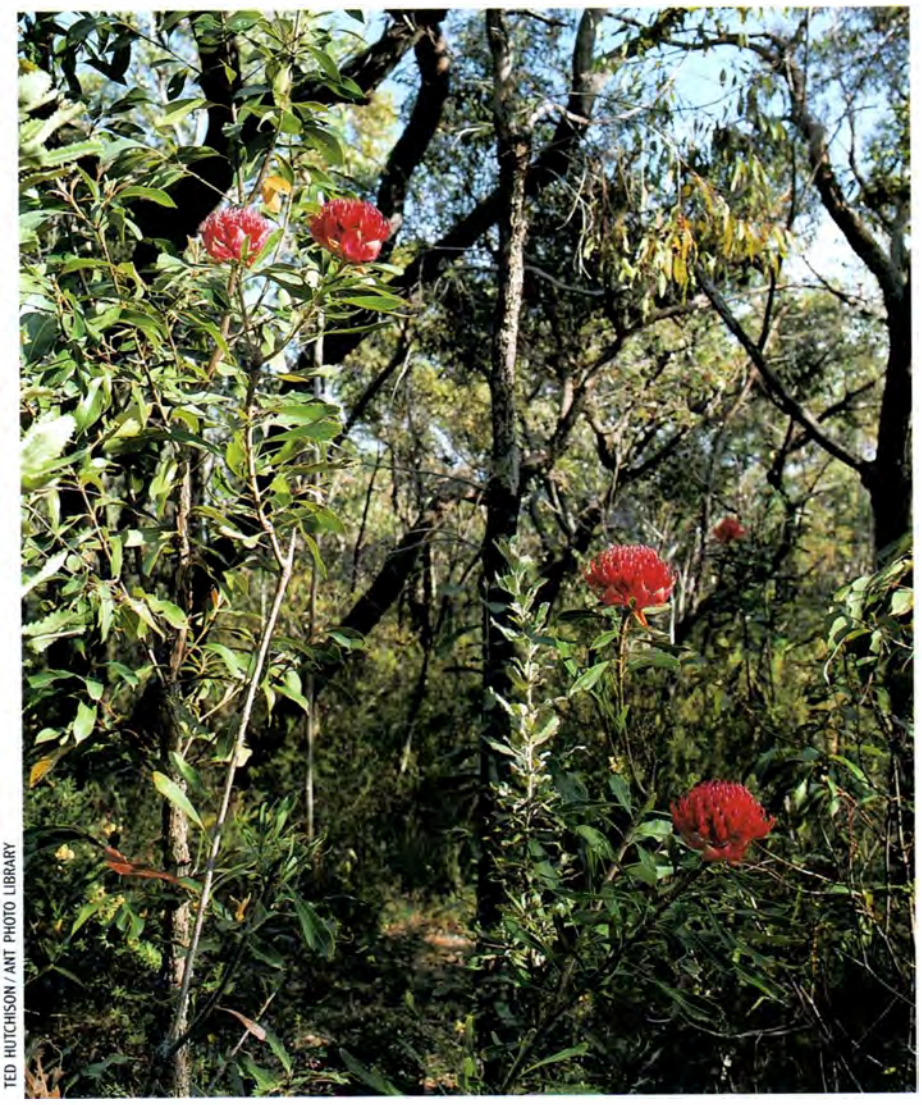
"THE MOST MAGNIFICENT PLANT which the most prolific soil of of New Holland affords is, by common consent both of Europeans and Natives, the waratah." So wrote Sir James Smith, President of the Royal Society in 1793. Since that time botanists, gardeners and artists have continued to enthuse on the grandeur of the Waratah, which has become arguably the most famous and recognisable of Australia's flowering plants.

Waratahs feature in Aboriginal legend (see box) and lifestyle. Early colonial accounts say that the Aborigines were often seen sipping nectar directly from the flowers or soaking them in water to make a drink. At the time of European settlement Waratahs were numerous in the Sydney region and feature prominently in the recorded histories of Australia. The flexible, new-growth branches were used by early European settlers for basket making and by blacksmiths to wrap around their implements when working with hot iron.

Waratahs are depicted in paintings, on pottery, incorporated into furniture, company logos and architectural ornamentation. There have been towns, steamships and even football teams named after them. In fact the Waratah's iconic significance is so strong that around the turn of the century there was a bitter cam-

KEN GRIFFITHS

From Aboriginal legend, through early European writings, to its present-day position as the New South Wales floral emblem, the Waratah has become one of Australia's most recognisable flowering plants.



TED HUTCHISON / ANT PHOTO LIBRARY

Although once abundant in many areas of Sydney, the Waratah now owes its existence to national parks, reserves and inaccessible areas of bushland.

THE LEGEND OF THE FIRST WARATAH

Long ago there lived a beautiful Aboriginal maiden named Krubi. She made herself a cloak of the red skin of the wallaby, and ornamented it with the redder crests of the Gang-gang Cockatoo. It was said to be the only cloak of its kind in the world.

Krubi knew a young man who was far enough removed in blood to be encouraged in his love for her. She always chose a cleft between two great weathered sandstone rocks on the top of a ridge to await the return of her man from the hunt. The red figure was the first object to strike the eyes of the returning hunters and the red cloak was the only object looked for by the young man. One night Krubi's heart was saddened. She learned that men from another tribe had been seen in the valley and there was to be a great corroboree, during which her man would be taught what to do in war. The day of the battle, Krubi stood in the sandstone cleft and watched for the return of the warriors. She heard the yells of war. In the afternoon she saw her scattered tribe of men return, but no lithe young figure stepped out from the others to greet her.

Krubi stayed for seven days waiting, and her tears formed a little rivulet. Then Krubi went back to the camp, but it was deserted and the ashes were cold. Krubi returned to the ridge, and willed herself to die. She passed into the little cleft of weathered sandstone, and up came the most beautiful plant. The stalk was firm and straight, without a blemish, just like the man Krubi died for. The leaves were serrated and had points like a spear. And the flower was red, redder and more glowing than any other in Australia.

paign to instate the Waratah bloom as the floral emblem of Australia. However, despite its obvious aesthetic and symbolic qualities, the natural distribution was considered too limited. The widely distributed Golden Wattle (*Acacia pycnantha*) instead became Australia's floral emblem and the Waratah is now firmly and appropriately entrenched as the State emblem of New South Wales.

Waratahs belong to the botanical family Proteaceae, named after the Greek god Proteus who could change his shape at will, referring to the varied and remarkable flower types found in this family (others include grevilleas and banksias). Aboriginal Australians endowed the Waratah with its common name meaning, simply, 'red-flowering tree'. There is, however, more than one species of waratah. The Waratah, used as New South Wales' State emblem, is known botanically as *Telopea* ('seen from afar') *speciosissima* ('most beautiful') and it certainly deserves these epithets. It is to most people 'The Waratah' and it may come as a surprise to learn there are others. The other 'waratah species', which all grow on Australia's eastern seaboard and have smaller and less spectacular blooms, are the Braidwood Waratah (*T. mongaensis*), the Gippsland Waratah (*T. oreades*) and the Tasmanian Waratah (*T. truncata*).

Telopea speciosissima grows naturally in patches of sandy loam on ridges and plateaus in the Sydney geological basin, the Central and South Coast districts, and in the Blue Mountains of New South Wales. It was once abundant in many areas of the Sydney metropolitan area, and the species survival is now due to its existence in national parks, reserves and relatively inaccessible areas. A subspecies of *T. speciosissima*, distinctly different to the type that occurs around Sydney, grows in the Gibraltar Range, in north-eastern New South Wales. After isolation for millions of years, this population is now so different that it may be classified as a separate species.

The closely related tree waratahs (*Alloxylon* species, known until recently as *Oreocallis*), which occur in eastern Australia and New Guinea, are similar in appearance to the *Telopea* waratahs, differing mainly by their larger size and absence of the distinctive petal-like bracts surrounding the flower head. Other close relatives live in South America, namely the *Oreocallis* species in Peru and Ecuador, and *Embothrium coccineum* in Chile. All these species are so closely related that at one time they were taxonomically grouped within the one genus *Embothrium*. The current orthodox view is that 135 million years ago, Australia and Antarctica and South America were part of one large continent, Gondwana. The

The Tasmanian Waratah grows in shrublands and wet sclerophyll forests from sea-level up to sub-alpine regions and can easily survive temperatures as low as −28°C.

KATHIE ATKINSON

ancestors of the modern species evolved during this period, probably in what is now Antarctica, which formed a bridge between the other two land masses. The continents have since drifted apart and new species have evolved in relative isolation, although they retain similar features.

These days *T. speciosissima* is important as a horticultural plant and, although commercial interest in the species is rapidly growing, there is much to learn about its biology and cultivation before it can truly take its place in the garden with roses and camellias. Waratah blooms make an excellent cut flower; they have a long vase life (about two weeks) and make a spectacular central feature in floral displays. Many blooms are exported, particularly to Japan, the USA and Europe. Although there are some commercial operations, many blooms available on the market today are picked from the bush, under strict licence from the New South Wales National Parks and Wildlife Service. Bush picking is a practice that should not be encouraged. On a large scale it depletes natural seed reserves and often

The blooms of the Gippsland Waratah are less compact than the New South Wales Waratah and their flowers open from the centre outwards.

JAIME PLAZA VAN ROON / AUSCAPE INTERNATIONAL

P. GERMAN / ANT PHOTO LIBRARY

The 'Wirrimbirra White' Waratah was cultivated from a rare, naturally occurring white form.

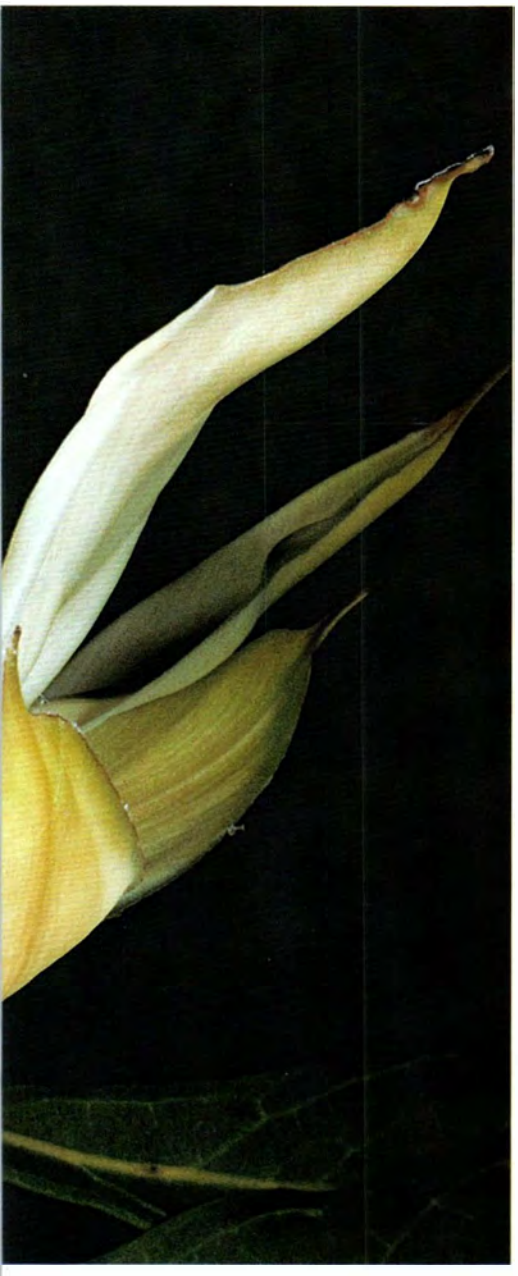
the blooms are of poor quality compared with those from well-grown cultivated plants.

WARATAHS FLOWER OVER A SIX WEEK period in Spring (September to October in the Sydney region), but there are differences between areas due to environmental variation, with flowering generally occurring later in cooler climates. Size and shape of *T. speciosissima* blooms may vary considerably, from delicate flattened blooms through to enormous cones, and the floral bracts surrounding the flowers may also vary in size from barely visible to whorls like dinner plates.

The flowers come in a range of naturally occurring colours, although the majority are red and pink. There have been many reports of white flowering *Telopea speciosissima* occurring naturally in the Sydney region. To my knowledge only two of these reports have been substantiated and other sightings may be due to the pale colour of the developing bud, even up to a short time before flowering. There is a commercially available white variety known as 'Wirrimbirra White', which is not true white but a creamy yellow or greenish colour.

Waratah flowers produce copious amounts of nectar and, when in full bloom, the dripping nectar polishes the already glossy flowers and leaves to a startling brilliance. Birds are the main pollinators of Waratahs, being attracted to the nectar and bright colours.

There are reports of individual Waratah shrubs producing up to 200 blooms in one year but usually the figure is much less. The blooms are actually a composite of between 90 and 250 individual flowers. These flowers are arranged in whorls on the flowering stem and open sequentially over a period of about two weeks. Seed pods take about six months to mature at which time they turn brown and split open. The seeds inside are winged for wind dispersal and there may be more than 250 seeds on one flower head in a good year.



Waratah blooms make excellent cut flowers and many are exported, particularly to Japan, the USA and Europe.

D. THOST

Birds, such as this New Holland Honeyeater *(Phylidonyris novaehollandiae)*, are the main pollinators of waratahs.

KEN GRIFFITHS

Waratahs have some special adaptations that enable them to survive in their natural environment. They are large, long-lived shrubs that can regenerate from a lignotuber. This contains dormant buds, at or below ground level, which become active after some damage to the plant. The plants usually grow to about three metres tall, but may reach five metres in the absence of fires that are common in their natural habitat. Taller plants have fewer flowers and set less seed. Cultivated waratahs therefore require pruning to produce numerous flowers (see box).

Found naturally in well-drained sandy loam, Waratahs dislike having 'wet-feet'. If the soil around the roots is too wet, there is not enough aeration and the plants become susceptible to root rot diseases. Paradoxically, Waratahs also love water and need regular watering in cultivation. A water deficit can predispose plants to root rot diseases to the same extent as too much water. The sandy loam soils that Waratahs enjoy have a clay content that, coupled with organic matter in the

SOW AND GROW

The easiest way to propagate Waratahs is from seed, the fresher the better but it is also possible to strike Waratahs from cuttings. Seedling plants take about five years to flower, while cuttings may take only two.

Sow seeds in a pot filled with a well-drained seed raising mix; cover with a fine layer of mix and water well. Transplant the seedlings into a freely draining potting mix that does not contain any added nutrients. Add some slow-release low-phosphorus fertiliser several weeks later. Keep the potted Waratah in partial shade off the ground for at least one year, ensuring it is watered regularly.

Transplant in autumn, to an area protected from the wind. A partially shaded position with morning sun is best, although they will grow in full sun. Waratahs grow particularly well in the dappled shade of eucalypt trees. Plant at least one and a half metres apart or into very large pots. Mulching the soil with composted leaf mulch helps to stop the roots from drying out. Water regularly and ensure that water is draining freely from the root zone. Fertilise with a low-phosphorus slow-release fertiliser or 'blood and bone' in late winter or early spring but not immediately after transplanting.

Waratahs are susceptible to many pests and diseases. The most damaging are the root rot diseases, caused by the introduced Phytophthora fungus. This disease is characterised by desiccated light brown leaves and a withered stem. Over- and under-watering and excessive use of fertiliser can predispose plants to these diseases. Destroy affected plants immediately.

Be vigilant for insect infestations. Moth-borers, which bore into the flower buds and destroy the developing flowers, are most active during the autumn and winter months. White Palm Scale (*Phenacaspis eugeniae*) is active during warmer times of the year. Ask at your local nursery for a suitable treatment.

Waratahs must be pruned once a year, preferably within one month after flowering finishes. Cut them back very hard, usually by about three quarters. Leave some short vigorous stems intact as these often bear next years blooms. Pruning off any weak stems will stimulate vigorous re-shooting.

KATHIE ATKINSON

Six months after its formation a seed pod turns brown and splits open, revealing seeds that are winged for dispersal.

form of humus, helps to keep the right amount of moisture around the roots.

A specialised root system enables Waratahs to live in nutrient-deficient soils. After spring and summer rain, they develop structures on the main root system known as proteoid roots. These are tightly clustered balls of short roots that greatly increase the root surface area and are efficient in absorbing nutrients (especially phosphorus). In fact, poisoning may occur when plants are fertilised because the proteoid roots absorb excess phosphorus.

Waratahs remain an elusive plant for many gardeners. The special adaptions that make them hardy in the wild can make then difficult to grow in domestic situations, unless conditions are just right. The future of the Waratah depends on the development of a range of dependable varieties for horticulture and, more importantly, on the conservation of natural populations, freed from the effects of urbanisation. ■

Suggested Reading

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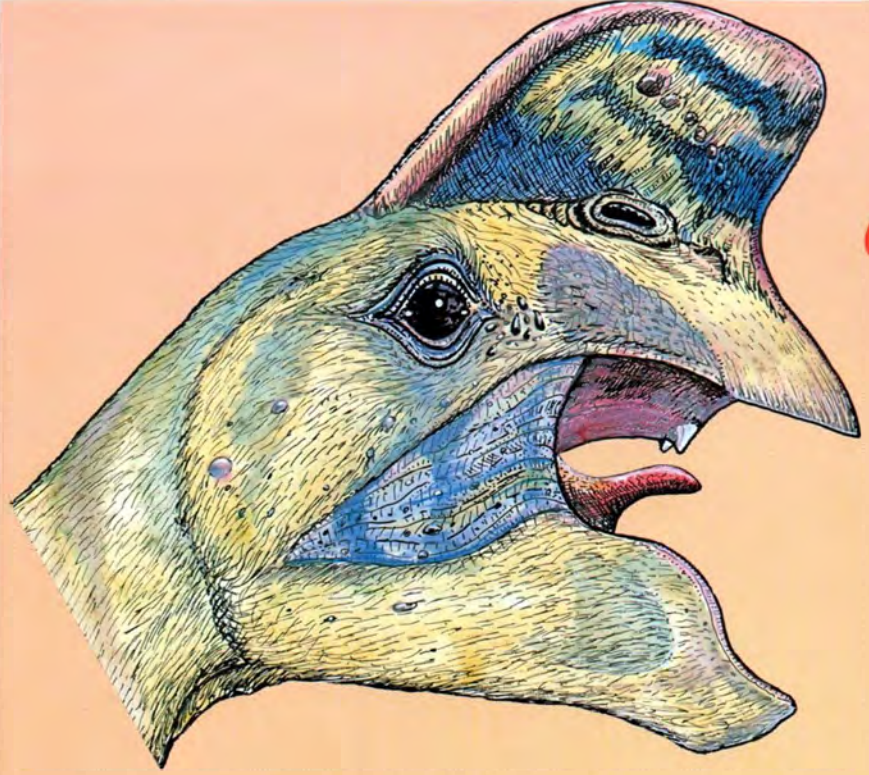
Cathy Offord is the Horticultural Research Officer for the Royal Botanic Gardens Sydney and is based at Mount Annan Botanic Garden (south-west of Sydney). She has worked on the cultivation of Waratahs for the past eight years and continues to be involved in conservation and horticulture of Australian plant species.



Oviraptor, an egg-eating dinosaur

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Recent research has shown that some small predatory dinosaurs had brains of comparable size to birds or some small mammals....

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Townsville, Qld 4811

Text, design, graphics and artwork by J.A. Long, Western Australian Museum

Trilobite beetle *(Duliticola* sp.),
Mt Kinabalu, Borneo.

P H O T O A R T

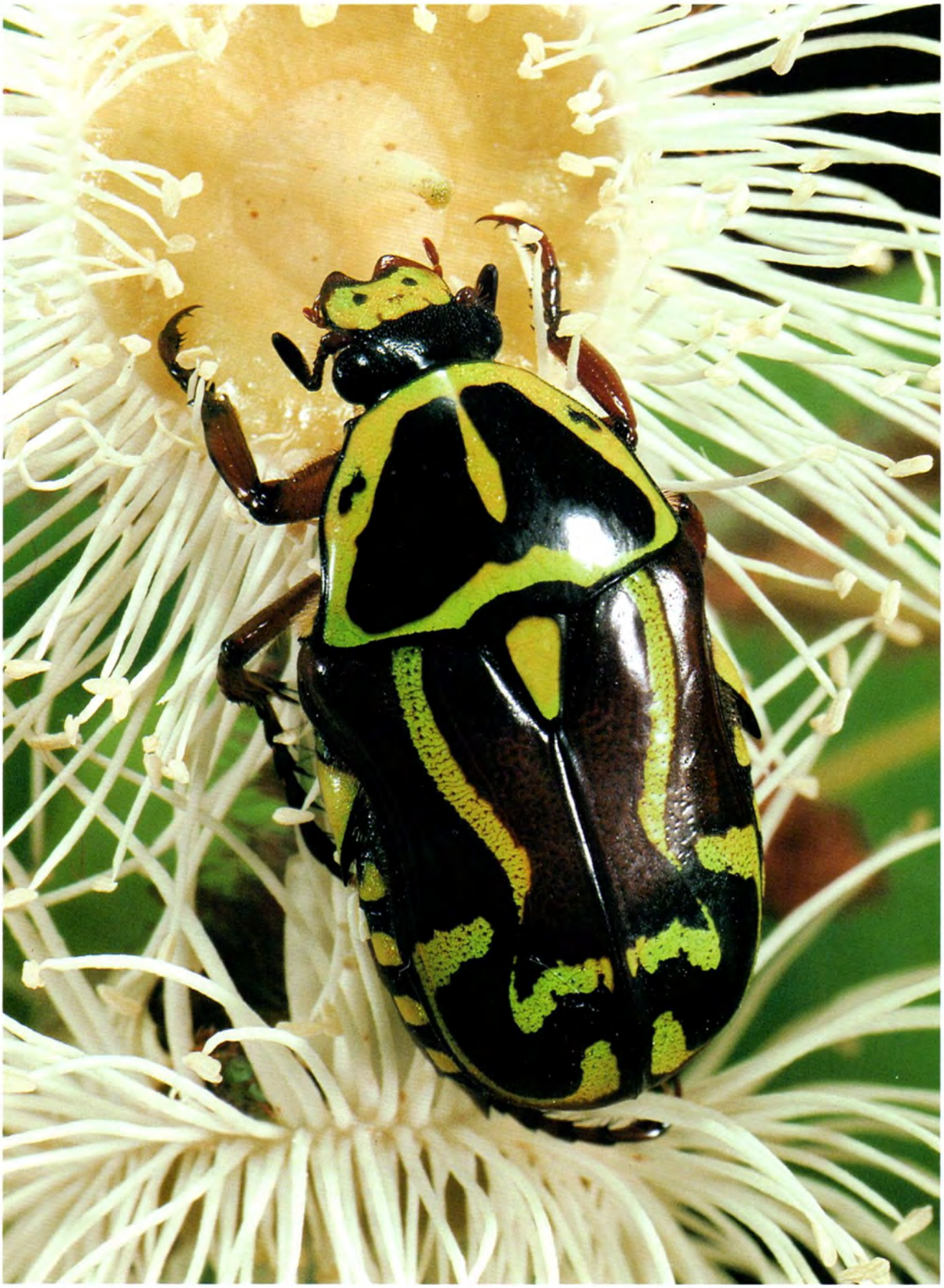
Diamond Beetle *(Chrysolopus spectabilis)*, eastern Australia.

The jewel beetle *Stigmodera variabilis*, Australia.

'BUG' ART

BY PAVEL GERMAN

In the past, Pavel German has spent much of his time photographing mammals throughout the South Pacific for the Australian Museum. Recently, however, he has found himself becoming interested in the insects of the region. By mastering the constraints of macro-photography, Pavel is able to capture on film many rare and unusual insects.



Fiddler Beetle *(Eupoecila australasiae)*, eastern Australia.

Orange Lacewing Butterfly *(Cethosia penthesilea)*, northern Australia.

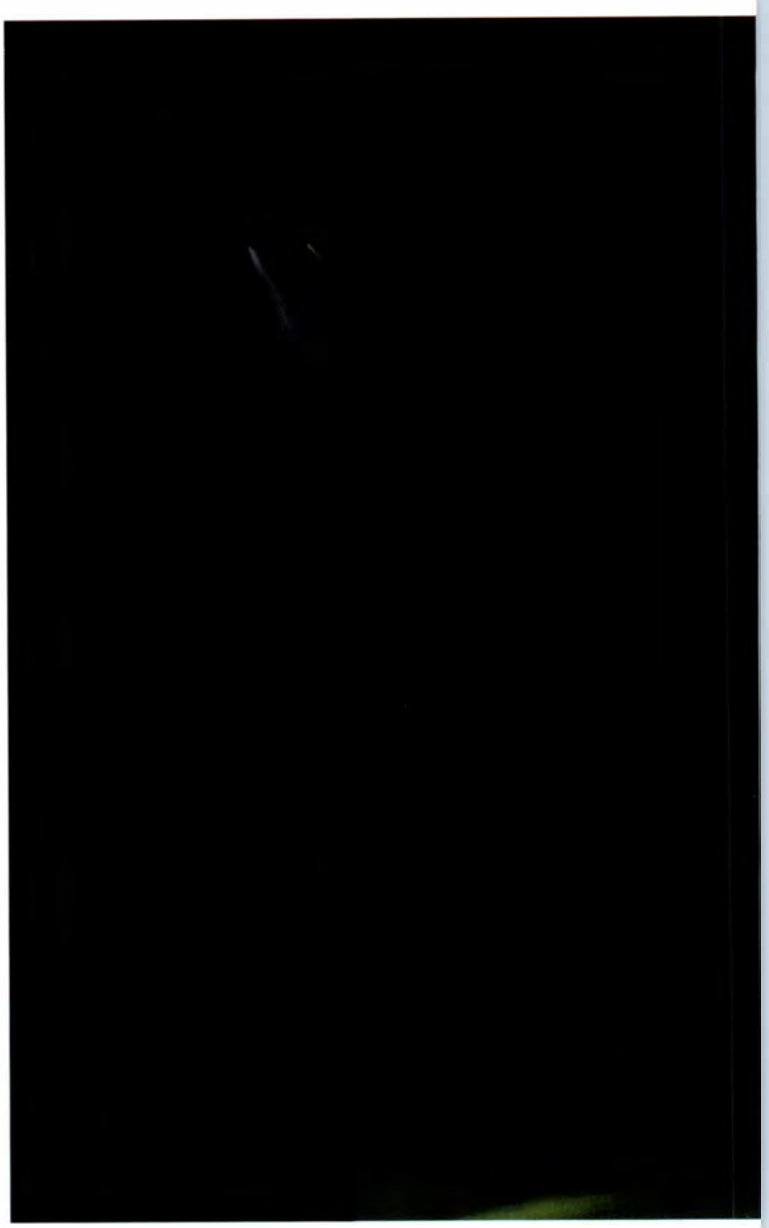
'BUG' ART

The longicorn beetle *Euryphagus lundi*, Malay Peninsula.

PHOTOART

'BUG' ART

Grass Blue Butterfly *(Zizina labradus)*, Australia.



The stag beetle *Odontolablis femoralis*, Mt Kinabalu, Borneo.

Blue Triangle Butterfly *(Graphium sarpedon)*, eastern Australia.

Australia could become the environmental Riviera for an overpopulated and devastated world.

ECOTOURISM IN A BRAVE NEW LAND

BY MICHAEL ARCHER

BRETT GREGORY / AUSCAPE INTERNATIONAL

Could ecotourism be the answer to Australia's environmental and economic problems?

THE LOGARITHMICALLY EXPANDing phenomenon called humanity has preened itself in the sun for less than one of Earth's 4,500 million years. Yet in that short time it has managed to suck more life out of the Earth than any previous natural disaster. Dangerously late, we begin to measure the wobbles of our weakening world and our skin prickles with unease. Atmospheric composition is changing (as it did once before in Earth's history with gruesome consequences), the protective ozone layer is disintegrating (has this ever happened before?), world temperatures are rising, polar ice caps are melting, complex ecosystems are being torn apart to make room for monocultures of wheat and cattle, and at least 50 per cent of the world's biological diversity is racing pell-mell for the garbage can. Left unchecked, there's a tiny possibility that the outcome will suit corals and cockroaches but for us it can only become awesome.

But rather than join many other biologists gloomily measuring the growth of this disaster, I want to focus on a survival path that may be open to Australians alone, a strategy that could return a future to Australia's environments and flood the financial coffers of this 'clever' country.

This survival path starts with consideration of the effectiveness of environmental conservation—the setting aside of enough chunks of natural habitat to ensure that the organic world will continue to bumble along as it has for the last 3.5 billion years, business as usual. What is this business as usual? Basically a threefold, endlessly repeating process that has, until now, enabled life to adapt to changes in the environment: speciation, evolutionary adaptation, extinction. All three must be able to operate, forever, if conservation efforts are to be successful.

The problem is that we have a very poor idea about how big reserves need to be to conserve, on a long-term basis, all the biological diversity they originally contained. As a springboard for this concern, consider the Pacific Island of New Caledonia. Although covering an area of 18,650 square kilometres with many old endemic plant and invertebrate species, it hasn't a single old endemic mammal lineage. Its current furry occupants are closely related to contemporary species in nearby lands. In short, although New Caledonia has undoubtedly had many opportunities to be a *long-term* host for ancient lineages of mammalian invaders, it does not appear to have done so. Why?

One explanation (there may be others, such as low soil fertility) is that this island is too small to provide a robust sanctuary for mammal populations threatened by natural disasters, or too small to allow speciation processes to offset extinctions. A severe contraction of the rainforests of Queensland's wet tropics about 17,000 years ago diminished mammal diversity in these otherwise floristically rich forests. And the lack of monotremes and other archaic mammal groups in New Zealand may similarly be accounted for by the severe 'squeeze' these islands had around 30 million years ago. For furries, at least, all of these areas appear to be death traps—unable to support mammal populations for long periods of time.

Now consider Australia's terrestrial reserves. Few are anything like the size of New Caledonia. Key reserves such as the wet tropics and Kakadu are significantly smaller. It seems probable that each generation of humans will watch lineage after lineage of mammals in these reserves grey with age and vanish without replacement. Lacking sufficient genetic resilience because of reduced and/or fragmented populations, extinction may be their only future. Although small reserves can sustain plants and many kinds of other animals, for mammal lineages to survive on a *long-term* basis, speciation processes must be able to replace extinctions—and our reserves are almost certainly too small to allow this key step in the conservation of mammals.

The solution to this problem may be the same that unlocks the vast potential of our tourist industry, which is already the fastest growing industry in Australia. Our unique environments and beasts are recognised around the world as prime tourist attractions. No other continent has a remotely comparable arkful of weird and beautiful things. Other continents have worked hard and often successfully to wipe out their natural tourist attractions for short-term economic gain. As this vandalism continues, the expanding human populations are rapidly outstripping the capacity of the world to provide tourist destinations for people who have forgotten what the word 'forest' means.

If clever, we will anticipate this crisis—and its financial opportunities—with a continent-wide banquet of wild, beautiful and underpopulated places. Basically, we could become the environmental Riviera for an overpopulated and environmentally devastated world.

For most of Australia's natural environments, beasts and places that the rest of the world will soon pay dearly to share, there is time to reverse destructive processes that otherwise doom them to the dump. If we accept that our current reserves are too small to be fully effective long-term conservation areas maximally attractive to tourists, we should immediately begin to resume as much as possible of Australia's leasehold land. These areas should then be added to the nearest reserves to make vastly bigger reserves. Resident lessees and staff, those most

familiar with the leases, could be re-educated and employed as permanent custodians of the healing land, aiding and taking pride in its return to natural, completely viable bushland.

There would be additional economic benefits beyond those generated by ecotourism. With the expansion of natural habitats, free-ranging *native* herbivores such as kangaroos and wombats could be culled on a sustainable basis as an alternative to using destructive non-Australian herbivores like cattle and sheep. The native herbivores have had millions of years to develop efficient, environmentally friendly ways to convert Australia's sunshine and plants to healthy, fat-free, yummier-than-sheep meat. Professor Gordon Grigg of Queensland University has long promoted this notion, which is, at long last, being taken very seriously.

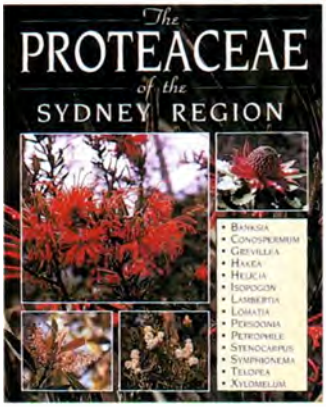
We should also face the fact that the mining industry does not pose a serious threat to the restoration and expansion of Australia's natural environments—it has always been the marginal and frequently subsidised agricultural and grazing industries, particularly in the dry lands of Australia, that destroy these environments on a wholesale basis. Mining alienates a minuscule fraction of this continent's land and yet returns an enormous profit. In principle, with care, there is no reason why a viable mining industry couldn't coexist within a continent of vast environmental parks.

But for this strategic economic overhaul to work, we must not mimic the mistakes of other continents. In particular, we cannot allow Australia to become overpopulated—or the game is up. At present, principally because of immigration, we have one of the world's highest rates of population increase. If this increase is not stopped, more private land will be needed for more people, and environmental reconstruction and its economic spin-offs will be impossible.

If we do meet the challenge, and environmental reserves and their economic opportunities expand, we will also need to take a hard look at our society's attitude to wild places. As a legacy of ancestors who stared numbly at the teeth of tigers, we are quick to build fences around environmental reserves—humans outside, beasts inside. A measure of this alienation is the backpacks we take into the bush, swags filled with things to survive the experience. The size of these alienation sacks has almost certainly increased with each more urbanised generation. As our reserves grow and strengthen, it would be nice to think that we will discover how to tear down the fences and how to reintegrate or at least intertwine the daily lives of humans and their born-again furry friends. ■

Professor Michael Archer lectures in biology and geology at the University of New South Wales. Most of his non-teaching hours are devoted to the study of the fossil faunas of Riversleigh.

REVIEWS



The Proteaceae of the Sydney Region

By Alec M. Blombery and Betty Maloney. Kangaroo Press, NSW, 1992, 216pp. $49.95.

The Proteaceae of the Sydney region is a wonderful book. The introduction is succinct and informative. The subfamily morphology and accompanying key are well laid out, and the line drawings enable swift differentiation between the subfamilies and genera.

The general descriptions are very detailed and appear accurate. These descriptions may be laboured through by the botanically fluent pedant, or scanned for historical and more general information on genera by the amateur botanist.

The strength of this book is its presentation of each species–one double page is dedicated to each plant. The history of its description is given and the morphological differences between similar varieties are made clear.

The botanical outline for each plant includes: form, height, bark type and distinctive growth features. Leaf, inflorescence and fruit descriptions are extensive and accurate. The cultural notes are also helpful.

All of this information is accompanied by between one and three colour photographs of each plant. The photographs are clear and provide wonderful detail. They have obviously been taken in order to minimise confusion caused by poor resolution and to highlight the features described on the facing page.

The life-size paintings of fruits and seeds are beautiful and I am sure they will be a decisive element for people using the book to identify Sydney's Proteaceae.

This is the best book I have seen of its type, and it covers all of the Proteaceae known to grow in the Sydney area. Its nomenclature is up to date and it is as equally informative to the professional as to the amateur. Anybody could identify any Proteaceae with this book within minutes of picking it up.

The only misgiving I have is that the geological map of the Sydney region found in the Introduction is not in colour and is confusing because of this. Nevertheless, this book is a must for any Sydney-based flora enthusiast.

—Andrew McGahey
The Total Earth Care Company, NSW

Parrots: Hand Feeding and Nursery Management

By Howard Voren and Rick Jordan. Osborne Editions International, Qld, 1992, 202pp. $70.00.

Whether breeding parrots for the pet trade or for conservation purposes, hand-rearing techniques have appeared to be, until recently, something of an art with a modicum of hard fact thrown in. Individual aviculturalists have established their own theories and procedures through personal experience and experimentation. In some instances ideas conflict and, with no sound factual explanations to call upon, we are left none the wiser. Many breeders have done remarkably well considering the lack of direct research on the natural formulas fed by adult parrots to their chicks. Considerably more attention has been given to understanding the structure of milk formulas fed to a variety of mammal young and to the development of suitable artificial substances.

As aviculturalists, one of their goals is to breed birds for conservation.

The authors have drawn upon their wealth of experience from working with a multitude of species including Australian cockatoos and smaller parrots. The large volume of birds that has passed through their hands has enabled them to establish protocols with a degree of statistical fact.

The chapters cover a comprehensive list of topics beginning with the initial setting up of a nursery followed by brooding, diets, feeding and digestion, monitoring of chicks, and health and disease. The chapters on brooder environment, digestion and health of the chick are highly informative. Frequently, lack of attention and care in these three key areas results in problems for the breeders. The text is aided by useful photographs of how to handle chicks and birds in various conditions of health and disease.

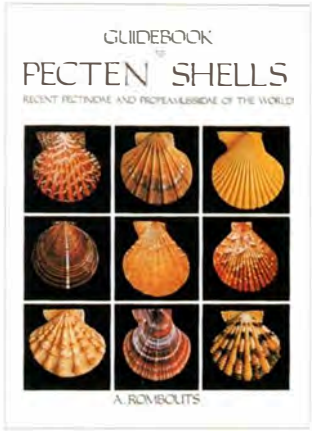
A significant omission, however, is an ingredient breakdown of the Primate Chow Biscuits, the major constituent of their hand-feeding formula. In countries where this product is unavailable, such as Australia, the lack of this data makes finding a substitute difficult. On the same note, an appendix listing products mentioned and their manufacturers or distributors would have been useful.

Sadly, it appears that a significant number of the birds acquired for hand-raising have been taken as chicks from the wild, with no apparent remorse or concern for the ramifications this is having on wild populations. Paradoxically, the authors begin by stating that as aviculturalists one of their goals is to breed birds for conservation and assist in relieving the pressure on wild populations.

On the credit side, the authors continually emphasise the importance of detailed observation and individual assessment as the best guarantees for successful hand-rearing, and not to those methods that rely upon strict adherence to charts and tables of weights and similar parameters.

This book is a natural progression from the authors' volume on parrot incubation procedures and is essential for all parrot breeders. In fact all aviculturalists will find it a valuable reference.

—Judith Gillespie
Taronga Zoo, Sydney



Guidebook to Pecten Shells. Recent Pectinidae and Propeamussiidae of the World

By A. Rombouts. Crawford House Press, NSW, 1991, 157pp. $39.95.

There have been very few books devoted to bivalve molluscs and yet they include some of the tastiest and hence some of the most commerc-

ially important and best-known invertebrates. Everyone knows all about oysters and scallops—or do they? How many people realise there are about 400 living species of scallops, or pectens as they are otherwise known? Rombouts' *Guidebook to pecten shells* illustrates most of these species.

This group has long been a popular one with shell collectors because of the extravagant colour and delicate sculpture of many species, and yet the last comprehensive coverage of the group was published just over 100 years ago, in 1888! This latest book, as its title indicates, is not a scientific revision involving new work, but rather an illustrated compilation of the species as they are presently understood—

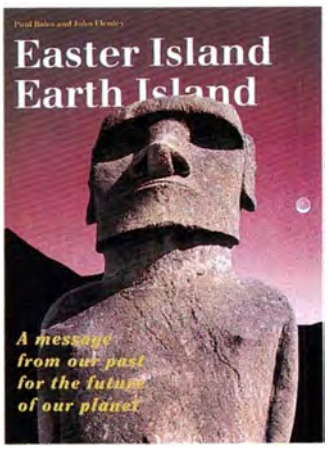
which is not very well in many cases. Each species is illustrated in colour and is accompanied by a brief description and a summary of its distribution.

Rombouts' untimely death in 1985, just as the manuscript was completed, could have spelled disaster for the project but some colleagues at the Zoological Museum, Amsterdam, took up the challenge and through their efforts the work was completed.

In all such works faults can be found, but perhaps the most disappointing aspect of this book is that it is totally lacking any information on the biology, anatomy, behaviour, harvesting, farming, or other commercial aspects, of scallops. The commercially important species are not even identified in the text. I was also a little disappointed that the opportunity was not taken to illustrate more living scallops, there being only one such photograph in the book. Nor is there a key, or even a brief diagnosis of the two families (Pectinidae and Propeamussiidae) included, although genera are briefly diagnosed. It is simply a guide to species, no more, no less.

This book will be welcomed by shell collectors with an interest in pectens, as they will now be able to identify their specimens. However, readers fascinated by the diversity of nature will also find the book of interest, as it is one of the all-too-rare published examples of invertebrate diversity at the species level with a worldwide coverage.

—Winston Ponder
Australian Museum



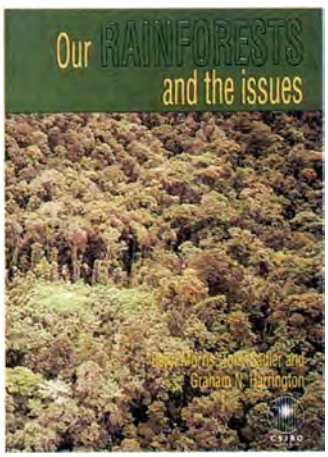
Earth Island, Easter Island: A Message from our Past for the Future of our Planet

By Paul Bahn and John Flenley. Thames and Hudson, Vic., 1992, 240pp. $49.95.

This is a very timely work. It is also fascinating and well written. Within its 240 pages it manages to tell in fine detail the story of the most isolated inhabited speck of land on the planet. Settled, probably from the Marquesas, some 1,400 years ago, Easter Island was a temperate paradise for the first settlers. Forests provided seemingly endless timber, fertile soils produced abundant crops, and rivers watered the countryside. This Arcadia nourished an extraordinary culture. Warfare was uncommon, and groups competed by raising mighty statues to their ancestors. They also developed what appears to be a written language—the only one known from the Pacific.

There were sufficient resources to support this culture for around 1,000 years but, by the time the first Europeans sighted Easter Island, the people were in trouble. By 1722 there were no or few trees, the rivers had dried up, and most sources of protein had vanished. Within a century the mighty statues would be pushed over, warfare endemic and people forced to live in caves. Starvation was almost universal and wood had become a synonym for wealth. The cause of this decline was obvious—too many people had asked too much from a limited land. Sounds familiar? The sad thing is that Easter Island is not unique in running that course, for history is littered with the remains of civilisations that have wanted to grow forever. Perhaps if they had this book there would have been a few less.

—Tim Flannery
Australian Museum



Our Rainforests and the Issues

By Beryl Morris, Tony Sadler and Graham N. Harrington. CSIRO Publications, Vic., 1992, 60pp. $14.95.

This is another title from the expanding list of publications produced by the CSIRO. Although the book covers most of the rainforest types in Australia, the emphasis is on northern tropical rainforest.

Our rainforests and the issues is essentially a source and activities book for higher primary and early secondary school grades. Some of the activities require classroom equipment and teacher or parental guidance, but many of the exercises need little more than enthusiasm and access to rainforest—or something approaching it. In the event, the lack of access to native vegetation may be the book's only shortfall. This could partly be remedied by the establishment of small rainforest planting projects on school grounds, an activity that many New South Wales north coast schools have undertaken. A chapter on rainforest plant establishment might be a useful addition to later editions.

The layout of exercises and background to the dynamics and function of rainforest ecosystems is concise and visually stimulating. The figures and illustrations exceed the coverage given in many rainforest publications of much larger size. The activities are extensive and field orientated, covering an introduction to pollen types, humidity and temperature, seasonal changes in the nature of soils, effects of light gaps and density on plant growth, nutrient cycling and disturbance impacts on populations and community structure, uses of rainforest material, and conservation and political issues.

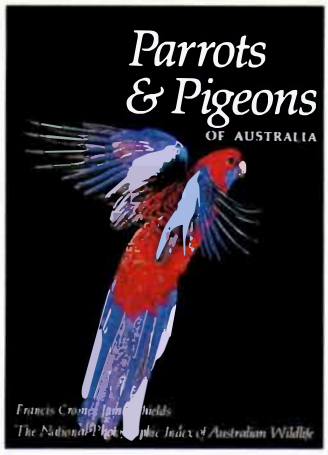
However, several minor modifications could be made. Rainforest is not necessarily confined to regions of high rainfall and some rainforests (for example 'dry' rainforest) are subject to pronounced seasonal variation in rainfall. For a book with an Australian emphasis, I was surprised to see a photograph of a south-eastern Asian *Troides* butterfly and a neotropical bromeliad. The flowering bromeliad was also used to illustrate that "bright colours attract pollinators"—most rainforest flowers are not brightly coloured but still manage to attract polli-

Most rainforest flowers are not brightly coloured but still manage to attract pollinators.

nators. The function of invertebrates in rainforests receives good coverage but, of the eight soil animals photographed on page 27, five are mites and the remainder are thrips. The comment that bats pollinate rainforest flowers is generally true of blossom bats and tropical rainforest, but is doubtful for the majority of subtropical plants and southern flying-foxes (*Pteropus* spp.).

These last comments aside, the authors have produced a stimulating book that deserves extensive placement on library shelves.

—Geoff Williams
Australian Museum



Review of Parrots and Pigeons of Australia

By Francis Crome, James Shields and The National Photographic Index of Australian Wildlife. Collins Angus & Robertson, NSW, 1992, 318pp. $95.00.

Apart from sharing the honour of having the ugliest young of any animal yet described, what do parrots and pigeons have in common? Peruse this book and you may be surprised. Perhaps you weren't aware that, like the parrots, pigeons dress flamboyantly. Both groups have fleshy ceres around the nostrils, both feed primarily on fruits and seeds and, phylogenetically, they are probably more closely related to each other than to any other group.

This is the seventh book in a series by the National Photographic Index of Australian Wildlife documenting the biology of Australian birds with comprehensive photographs and user-friendly text. And what groups could be better suited to colour photography than parrots and pigeons?

Every species of parrot (which include cockatoos, lorikeets and true parrots) and pigeon (which include doves) is represented by, on average, three colour photographs and one-and-a-half pages of text. With 54 species of parrots and 27 species of pigeons, the result is a spectacular publication.

Photographs by 56 photographers are included, many of which are outstanding artistically. A few of the species photos are, however, inferior to those in some other compilations of bird photographs and the cropping of some photos is poor. I would have preferred more comprehensive captions as some of the photos show birds of different plumage or engaged in interesting activities. In spite of these blemishes, it is the illustrative material that would make me buy the book.

The styles of the two authors are easily distinguished. The parrot text is chatty with numerous direct quotes from early Australian ornithologists, while the pigeon text is more synthesised. I found the text long-winded but, if you enjoy a narrative style, the approach will be to your liking.

Embedded in this eloquent matrix of text is much of the available information on the biology of pigeons and parrots, as well as interesting snippets about early ornithologists, nomenclature and changing attitudes towards wildlife. Habitat destruction and fragmentation have been, and still are, the major threats to the persistence of these birds, but the book also documents some alarming accounts of the attraction these groups have to shooters and poachers. Even in the late 1960s a single shoot resulted in the death of 100 Torres Strait Pigeons.

If you want to get straight to the specifics, there is a half-

page synopsis of each species including names, descriptions, voice, habitat, food, habits, breeding and distribution. The book is a useful reference but its value in this respect is limited in that the sources of information are mostly not referenced in the text.

Overall, if beauty and knowledge enrich your life, then this book should be on your coffee table. Finally, for lovers of Monty Python, the Night Parrot scene is a must: "the Night Parrot may not be on the verge of extinction – simply very hard to find"! Let's hope it's true.

—Richard Major
Australian Museum

Densey Clyne's Small Worlds: Cicada Sing-Song; Catch Me if You Can!; Plants of Prey

By Densey Clyne. Allen and Unwin, Sydney, 1992, 33pp. and $8.95 each.

Eyewitness Explorers: Flowers by David Burnie; Insects by Steve Parker; Weather by John Farndon; Birds by Jill Bailey and David Burnie.

Collins Angus & Robertson, NSW, 1992, 61pp. and $12.95 each.

The Miracle Planet: Planet Earth; Life on Earth

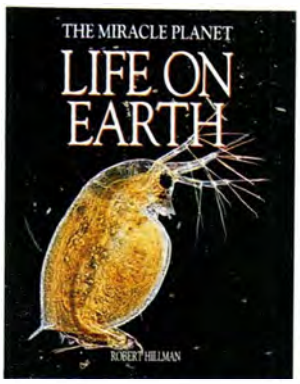
By Robert Hillman. Collins Angus & Robertson, NSW, 1991, 68pp. and $19.95 each.

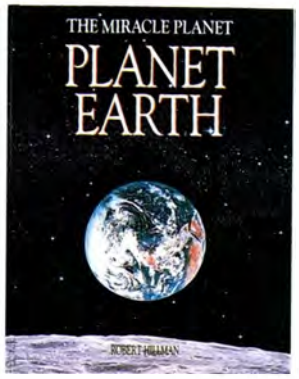
I think that children's books should be reviewed by children. Adults tend to look down from lofty heights and make pronouncements about what is 'good' in books—layout, graphics, text accessibility and accuracy. So, I thought I would get a couple of children to comment on these books.

Densey Clyne's Small Worlds *(Cicada sing-song, Plants of prey* and *Catch me if you can!)* series received the thumbs up (excellent was the ranking for this set of books). The photographs were great and the information was easy to understand. The content was really interesting and the kids felt they would read these books just for fun. From an adult's point of view, they are attractive, with a good combination of text and some stunning photographs.

Collins has produced some wonderful material recently in the field of natural history for children. The Eyewitness Explorers *(Birds, Insects, Weather* and *Flowers)* series follows the same format as the Eyewitness Guides—large, impressive photographs interspersed with text and diagrams. My young

reviewers gave this a ranking of OK. They felt that it looked like the kind of book you would use when you were doing a project. However, they felt that, although there were quite a lot of words, there wasn't enough information for researching a project. Unlike Densey Clyne's Small World series, they didn't think they would borrow these books just to read. To me though, the Eyewitness books take a topic and seem to open up a world with a magnifying glass. Maybe you need to be 'into' the subject, or a little older than my helpers were. These books give ideas of things to do, branch off into related fields, and take the reader into different levels of the worlds they explore.





The third group of books we looked at was The Miracle Planet series *(Life on Earth* and *Planet Earth)*. These books also received an OK rating (lots of information and suitable for children over ten years old). The scope of these two books is phenomenal: from the origins of life, through the ages of Earth history and life on Earth, to the issues of global warming, extinctions and endangered species. This series would be a useful reference to own. Although the information is quite detailed, it is amply illustrated with maps, diagrams and photographs. I feel children could use these at a number of different levels.

I could quibble over the text in some places and wonder why the Cherry Nose Cicada, for example, "looks as though it was drinking alcoholic sap"—why not something within the experience of a child? The difficulties adults have in writing non-fictional text is often perplexing. We try to use words kids might understand and find entertaining ('gobbled up') on the one hand and then use words like 'forage', 'strident' and 'opaque' on the other. But then maybe these are really meant to be fun books for adults. Why should kids have all the fun anyway?

—Anne Skates
Australian Museum

Just Published

September

Reptiles and Amphibians of the South Pacific
By Harold Cogger and Ross Sadlier. Reed Books, NSW. $24.95.

Curious Creatures
By Carson Creagh. Angus & Robertson, NSW. $24.95.

Quarry: Closing in on the Missing Link
By Noel T. Boaz. Maxwell Macmillan Publishing, NSW. $36.95.

The Reverse Garbage Garden
By Sandra Clayton. Hyland House, Vic. $24.95.

October

Australian Beetles
By John Lawrence and E.B. Britton. Melbourne University Press, Vic. $39.95.

Systematic and Applied Entomology
Ed. by Ian Naumann. Melbourne University Press, Vic. $44.94.

Cousteau's Australia
By Jean-Michel Cousteau. Reader's Digest, NSW. $45.00.

Bottlebrushes, Paperbarks and Tea Trees
By John Wrigley and Murray Fagg. Angus & Robertson, NSW. $89.95.

Ferns
By Gillean Dunk. Angus & Robertson, NSW. $39.95.

Palms and Cycads of the World
By Lyn Stewart. Angus & Robertson, NSW. $45.00.

November

Field Guide to Crustaceans
By D. Jones and G. Morgan. Reed Books, NSW. $24.95.

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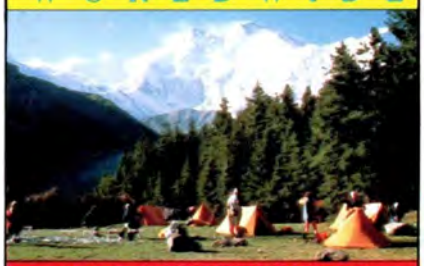

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ANH SOCIETY PAGE

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ANIMAL WELFARE

ANZFAS, Aust & New Zealand Federation of Animal Societies
37 O'Connell St, N Melbourne, Vic 3051. Phone: (03) 329 6333

Contact: Glenys Oogjes, Director

An umbrella organisation for over 40 animal welfare/rights societies. Lobbies State, Territory and National Governments for reforms. Detailed written submissions on most welfare issues.

BIRDS

BOCA, Bird Observers Club of Australia
PO Box 185, Nunawading, Vic 3131. Phone: (03) 877 5342

Contact: Mrs Zoe Wilson, Manager

Branches and representatives Australia wide; Information on request. Monthly magazine contains information on bird identification, behaviour, places to visit, garden plants, projects, conservation of bird habitat.

NSW Field Ornithologists Club
PO Box C436, PO Clarence St, Sydney, NSW 2000.
Phone: (02) 960 1552

Contact: Robyn Hill, Hon Secretary

Monthly meetings in the Hallstrom Theatre, Australian Museum. 2-3 Field outings per month—also pelagic trips & campouts. Newsletters & Journal.

RAOU, Royal Australian Ornithologists Union
21 Gladstone St, Moonee Ponds, Vic 3039.
Phone: (03) 370 1422

Contact: Michelle Rice, Development Manager

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Phone: (045) 78 2668

Contact: Kath Layton, Secretary

National Parks Association of NSW
PO Box A96, Sydney South NSW 2000. Phone: (02) 264 7994

Contact: Carol Davies, Office Coordinator

The NPA is a non-profit, community organisation working for a system of reserves that protect the complete range of habitat, features and cultural items.

CONSERVATION

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102 Bathurst St, Hobart, Tas 7000.
Phone: (002) 34 3552 or (002) 95 1748

Contact: Victoria Templeton, National Coordinator

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Queensland Conservation Council
PO Box 12046, Elizabeth St, Brisbane, Qld 4002.
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Contact: Ms Nicky Hungerford, Project Officer

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Ryde Hunters Hill Flora & Fauna Preservation Society Inc.
25 Ross St, Gladesville, NSW 2111.
Phone: (02) 210 2142

Contact: Frank Breen, Secretary

The society promotes & supports environmental issues, particularly conservation & restoration of urban bushland.

Tasmanian Conservation Trust
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EDUCATION

South Australian Science Teachers' Association
SASTA Office, c/o Plympton High School, Errington St, Plympton SA 5038
Phone: (08) 293 2733

Contact: Judy Morton, Office Manager

Publishes newsletter and journals.

Science Teachers' Association of the Northern Territory
PO Box 41809, Casuarina, Darwin NT 0811.
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Contact: Ken Squires, Treasurer

Science Teachers' Association of Queensland
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ENVIRONMENTAL

Deloraine Field Naturalists Group Inc.
PO Box 28, Deloraine, Tas. 7304
Phone: (003) 68 1313

Contact: Jim Nelson, Secretary

The DFNG is involved in gathering and sharing knowledge of local natural history. We participate in research, education and conservation projects. Visitors welcome.

Geelong Field Naturalists Club Inc.
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GEOGRAPHIC

The Royal Geographical Society of Queensland
112 Brookes St, Fortitude Valley, Qld 4006. Phone: (07) 252 3856

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INSECTS

The Australian Entomological Society Inc.
c/o Dept of Crop Protection, Waite Campus, University of Adelaide, PO Glen Osmond, SA 5064.
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Contact: Dr P. Madge, Secretary

MUSEUMS

TAMS, The Australian Museum Society
Australian Museum, PO Box A285, Sydney South, NSW 2000.
Phone: (02) 339 8225

Contact: Susan Bridie

Society members enjoy free admission to the Museum, their own magazine, lectures, seminars, field trips, films, excursions and expeditions.

Queensland Museum Association
PO Box 3309, South Brisbane, Qld 4101.

Contact: Virginia Enright

NATURAL HISTORY

Royal Society of SA Inc.
c/o SA Museum, North Terrace, Adelaide SA 5000.
Phone: (08) 223 5360

Contact: R.H. Fisher, Hon Secretary

The Society promotes knowledge in the various fields of the Natural Sciences by means of regular meetings and a broad range of publications.

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QUESTIONS & ANSWERS

Fish Circles

Q. ***Where do all the fish go when Lake Eyre dries up?***

—R. Doig
East Roseville, NSW

A. Different species of fish have different salt tolerances and as the lake dries up it gets saltier, resulting in distinctive rings of fish bodies moving concentrically in towards the centre of the lake. Eventually, only the most salt-tolerant species survive. If the lake dries completely, all the fish will die. In either case, when the rains finally return, the lake will be recolonised by fish swimming with the floodwaters from other areas and by eggs that have been capable of surviving the dry period.

—Martyn Robinson
Australian Museum

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Southern end of Lake Eyre.

PAVEL GERMAN

PIC TEASER

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, ANH Magazine. Please don't forget to include your name and address. The first correct entry will win a $20 gift voucher from the Museum catalogue. Winter's Pic Teaser was a preying mantis from Malaysia.

PETER VAUGHAN

The larvae of the Old Lady Moth have never been discovered.

Moths in the Cellar

Q. ***I have noticed a species of moth becoming very numerous in my wine cellar. Initially there were only a few, but now there are almost 100! Could you please tell me what the moths (or their larvae) feed on and why they congregate in such large numbers? Even when I go to my cellar late at night they are still there. Shouldn't they be outside flying around? Is my wine at risk? Should I drink it all now?***

—Peter Vaughan
Newcastle, NSW

A. The moth is *Speiredonia spectans*, sometimes known as the Old Lady Moth. Adults are often found sheltering in dark corners of houses and caves but the reason for this is unknown. Although the adults have a fully developed proboscis and are therefore capable of drinking and feeding, exactly what they feed on is unknown. And, yes, they should be outside at night, as it is unlikely that there would be a food supply for them in your cellar. So, either they are leaving at some stage to feed, or the next generation will not survive for lack of food. This is a common moth occurring from northern Australia south to Wollongong. The larvae have never been discovered, although that of a closely related species feeds on wattle. Should you be fortunate enough to find the larvae, your cellar could become quite famous within entomo-

logical circles. While there is no danger from the moths attacking your wine, visiting entomologists could be a worry.

—Max Moulds
Australian Museum

Caterpillars Unmasked

Q: ***While pruning my grapevine I found three caterpillars that were not familiar to me and certainly, in my opinion, not usually found on the vines. They were semi-confined and fed on grape leaves until the leaves dried up. At this stage, the caterpillars disappeared—probably into the ground as I could not locate a cocoon. Could you please identify the caterpillars for me?***

—Norm Scott
Jeparit, Vic.

A: This beautiful caterpillar is that of the Grapevine Hawk Moth *(Hippotion celerio)*. It is often found on grapevines in warmer climates but rarely is it a serious pest. The caterpillars come in several colour forms from bright green to dark chocolate brown; the different colour forms are often mistaken for different species. They only feed on the leaves and, when mature, descend to ground level to pupate in the leaf litter. The moth that emerges some weeks or months later is light brown in colour with silver stripes on the forewings and bright pink at the base of the hind wings. By the way, there are several other hawk moth species whose caterpillars feed on grapevines, plus those of some day-flying or agaristid moths.

—Max Moulds
Australian Museum

A caterpillar of the Grapevine Hawk Moth.

Fish Facts

Q: ***I often find myself using the expression 'drinks like a fish' but wondered—do fish actually drink? How do marine creatures filter out the salt if they do drink the water?***

—Colin Jones
Mosman, NSW

A: The body fluids of fish have a salt content of about one per cent. Therefore, marine fish have a lower salt content than the surrounding sea water and, by the process of osmosis, water tends to diffuse outwards, especially across surfaces such as the gills. To replace the water they're losing, fish drink sea water almost continuously. Specialised cells in the gills actively excrete the salts they unavoidably take in with the water. Most of the fish's nitrogenous waste is excreted as ammonia through the gills, therefore only a small quantity of urine is produced by the kidneys and so little water is lost in this way.

—Vicky Tzioumis
Sydney University

Answers to Quiz in Quips, Quotes & Curios (page 13)

1. Indian Ocean
2. Ken Myer
3. A stone swallowed to aid digestion of food
4. Tasmania
5. 65
6. An egg-laying mammal
7. 100 million
8. An ancient landmass
9. Environmental Impact Statement
10. Bee faeces

DENSEY CLYNE

Rarity is a varied phenomenon, and by no means necessarily the prelude to extinction.

FILLING THE LIFEBOATS: ENDANGERED SPECIES FIRST

BY JOHN C.Z. WOINARSKI

WITH NEAR RELIGIOUS fervour, David Bowman and Peter Whitehead look to the words of Charles Darwin to provide the priorities for conservation biology (ANH Winter 1993). This is inappropriate. Darwin was not especially keen on conservation. He found extinctions interesting. Indeed the evidence of loss of species was a major plank in the demonstration of his grand argument, and the process of decline and extinction was the operating force he posited to be behind natural selection. Since Darwin, society's values and perceived responsibilities are much changed, we have a far greater understanding of ecological relationships and the ability to manage habitats, but most especially we are degrading natural values at a rate that would probably have greatly surprised and horrified Darwin. In the space of a few years, we can witness far more extinctions than Darwin could have studied in a lifetime.

Bowman and Whitehead erect a straw man, in presenting a dichotomy in research (and funding) focus between the study (and conservation) of rare species and that of reasonably healthy landscapes in general. Their argument is not served well by Darwin's coupling of rarity and extinction. Rarity is a varied phenomenon, and by no means necessarily the prelude to extinction. Very common species may disappear extraordinarily rapidly, with the most celebrated example being the North American Passenger Pigeon presumed to be the most common bird in the world in the 19th century but extinct within the first few decades of this century. Conversely, rare species may be naturally at low numbers (such as top-order carnivores) but happily sustain this low population density over many millenia. Admittedly rarity may sometimes be a predisposing factor to endangerment, but it is *endangerment per se* that we should be worried about.

Conservation biology is neither the study of endangered species nor the study of ecological processes in healthy landscapes. It is, and indeed must be, both. There are clear functional (biological) links between these extremes. There is also financial support for the study (and conservation) of both extremes, and also for midway points on this gradient. In pursuing their argument, Bowman and Whitehead criticise the $4 million allotted to endangered species programs. They don't mention that substantially more funding has been allocated to whole-area conservation (protection of biological diversity and maintenance of ecological processes and systems) through sources such as National Rainforest Conservation Program, Save the Bush Program, One Billion Trees Program and National Soil Conservation Program, to mention only some of the more specific federal initiatives. But even endangered species funding need not be as insular as Bowman and Whitehead suggest, for much of its budget has been allocated to research on feral predators, especially foxes, and how these disturb ecosystems functioning.

Perhaps they are trying to say that money spent on endangered species is misdirected because these focus on the losers and goners. This is too simplistic and wrong. There are many reasons for focusing, at least partly, on endangered species. Species heading towards extinction may be readily identifiable examples, symptomatic of a malaise pervading the environment they inhabit. Study directed at such species may be the most effective way of identifying factors that are disturbing, or which may soon disturb, whole suites of species and broad environments. Examples would include the Peregrine Falcon and DDT, global decline in frogs, and research on the endangered Mala, which has demonstrated the devastating impact of introduced predators on Australian wildlife and the management importance of an Aboriginal burning regime for arid Australia.

There is also more urgency to the study of endangered species. We aim to hold the line with what we've got now, and not watch unconcerned as species vanish forever. More than 40 per cent of the central Australian mammal fauna has disappeared since European occupation, some species as recently as 20 or 30 years ago. Their loss is a terrible one to our heritage, and especially to the Aboriginal people linked to them. It could possibly have been averted if a few scientists had monitored and studied them. We don't now have the chance.

In some cases, there is hope that species endangered or declining in a now flawed environment can be re-introduced successfully when that environment is healed. Such recovery demands the protection of breeding colonies (*in situ* or *ex situ*) of endangered species. Also individual endangered species may provide critical resources for an unexpectedly wide array of other, dependent species. There are many celebrated examples of the inevitable extinction of invertebrate species following the demise of their host plant species, or of parasites gone with the extinction of their hosts.

Finally much of the philosophy, and means to financial health, of conservation organisations such as World Wide Fund for Nature is based on the marketing of the plight of individual endangered species. Endangered species can be readily appreciated by a public anxious to support conservation in some form.

Bowman and Whitehead seem concerned that funding for endangered species is a waste, with an inevitability of the depressing outcome that the beasts don't cooperate anyway and more or less go extinct out of spite. There are some failures, and have been some misdirected monies. But neither should discredit the general aim of studying, and trying to conserve, endangered species. The failures tend to have been when the research effort was made too late. Financial investments in research and conservation of endangered species are now reasonably tightly targeted and prioritised: there is a carefully considered listing of Australian endangered vertebrates, and applications for funding are competitive and tightly assessed. Research into, and protection of, endangered species and habitats should continue to be an important component of our national and State conservation efforts. ■

Dr John Woinarski is a Research Scientist with the Conservation Commission of the Northern Territory.

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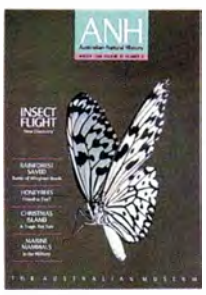

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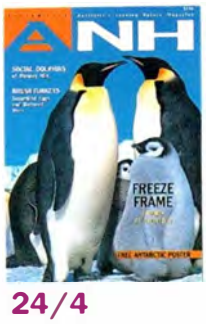

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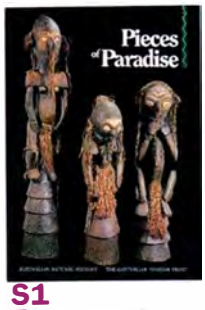

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You're probably asking who is Stephen Keir. We'll come to that in a minute.

Benjamin Dunkerley, his wife Harriet and daughter Ada ran a hat making business in Sydney. Benjamin was a technician who had an eye for a good product and Stephen Keir had an eye for his daughter. Following his marriage to Ada, Stephen was promoted to General Manager. In 1918 when Benjamin died Stephen steered the Company on to greater things; moving the factory to larger premises, increasing the production and branding the hats 'Akubra'.

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