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WINTER 1994

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BIG BEAKY AND BEAUTIFUL PELICANS

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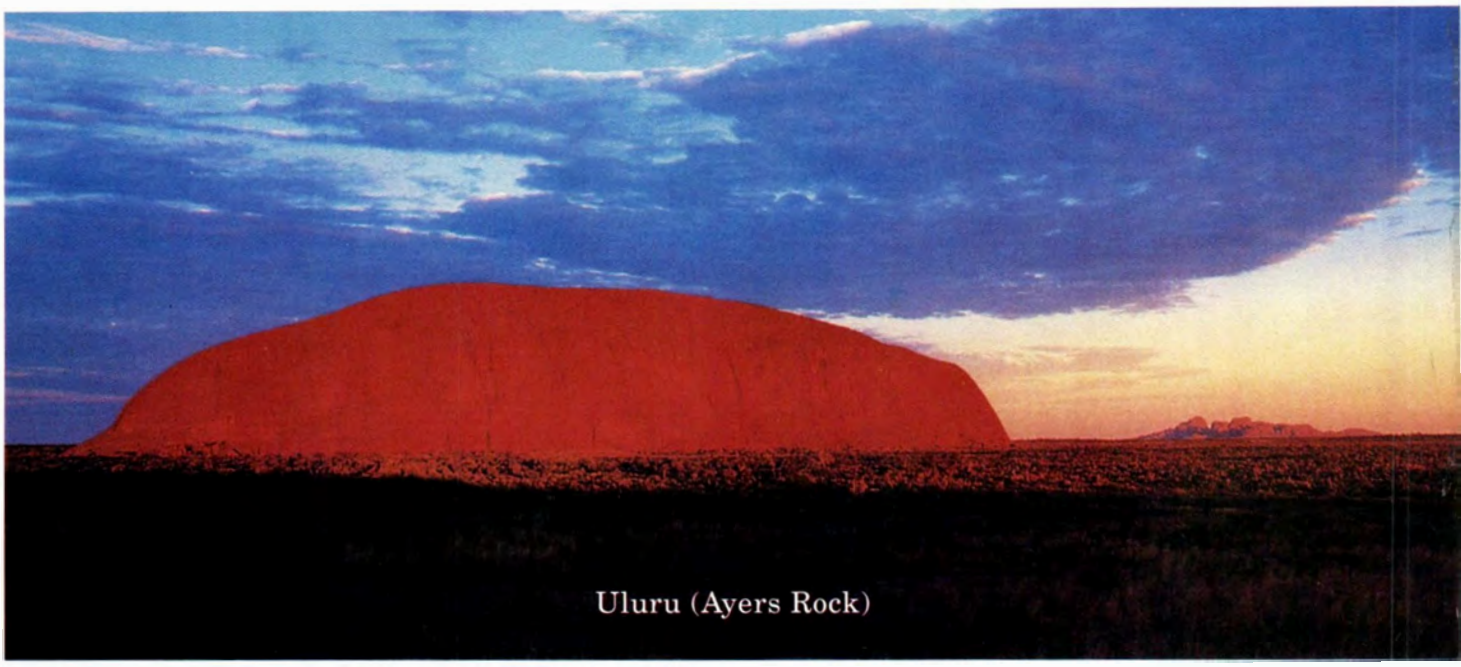
Kakadu



Uluru (Ayers Rock)

Uluru (Ayers Rock) and Kakadu National Park are both on the "must-see" list for overseas visitors.

Sadly, many tourists fly the 1,500kms that separate Uluru (Ayers Rock) and Kakadu, missing out on the wealth of experiences that lie hidden 10,000 metres below them.

Never mind, their loss is your gain.

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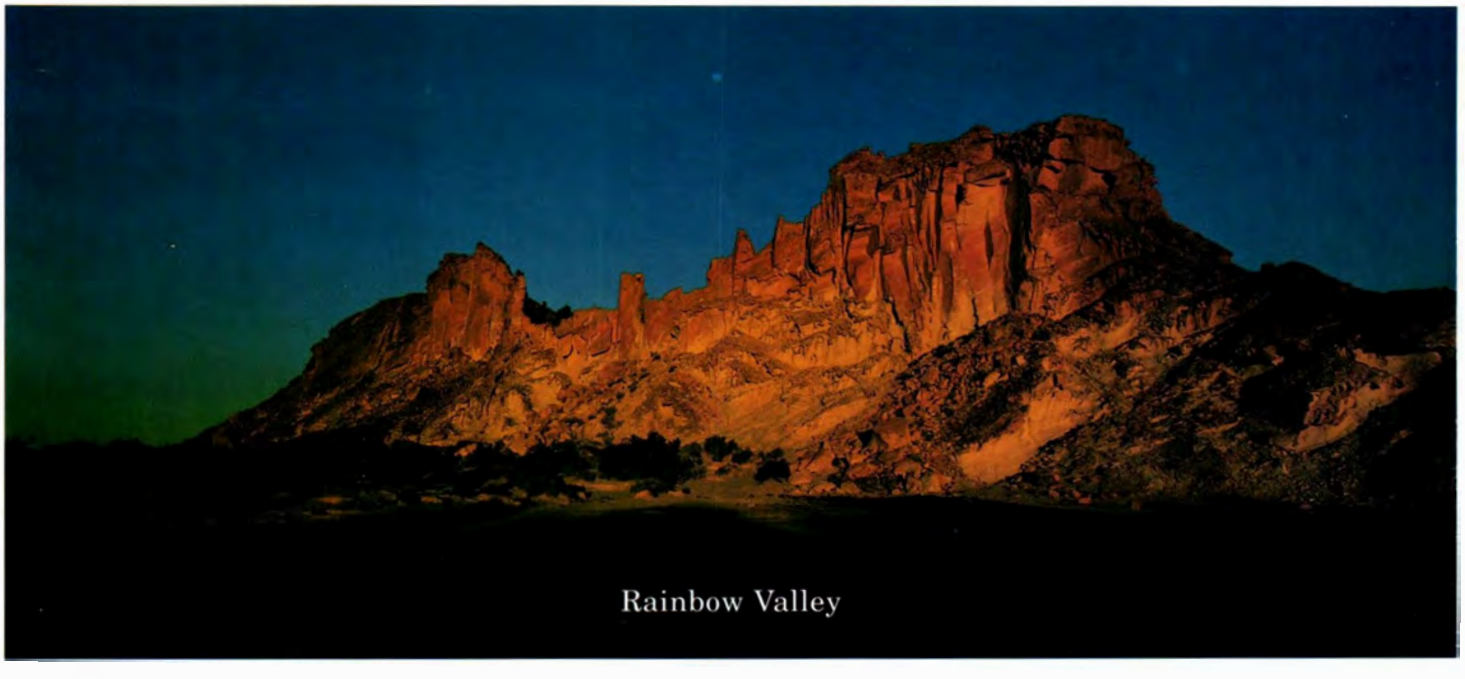
Nitmiluk (Katherine Gorge)



Rainbow Valley

huge thermal pool at Mataranka; of the Devil's Marbles, known in Aboriginal culture as the Eggs of the Rainbow Serpent; of the spectacular gaps and gorges in the majestic MacDonnell Ranges.

These are just a sample of the Territory's other treasures. Discover them at your leisure, before the rest of the world does.

For details and bookings contact Qantas Australian on 13 14 15, Ansett Australia on 13 13 44 or your travel agent.

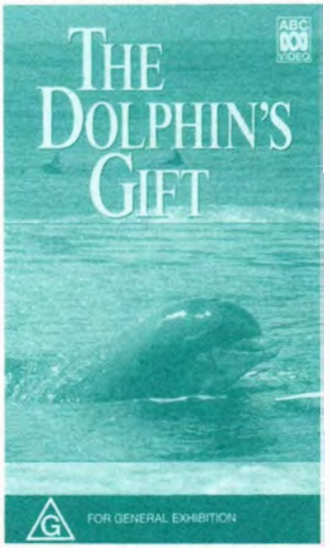
"You'll never never know, if you never never go."

ANH NEWS

FREE DOLPHIN'S GIFT

The Winter issue's offer is a special one for all dolphin lovers! The new ABC video "The dolphin's gift" tells the story of Fungi, a friendly Bottlenose Dolphin that lives at the mouth of Dingle Harbour, County Kerry in south-west Ireland. Fungi has been charming local people and visitors to County Kerry for six years, and the film documents his relationship with a variety of people. "The dolphin's gift" is available from ABC shops, ABC Centres and leading department stores and video retailers for $29.95 rrp.

We have ten copies of "The dolphin's gift" to give away, courtesy of Roadshow Entertainment. To win a copy all you have to do is send a postcard or letter with your name and address to The Dolphins Gift Giveaway, ANH, Australian Museum, PO Box A285, Sydney South 2000 by Friday 10 July. The first ten names drawn on that date will receive a free copy of the video.



Save the Koala Day

is a special day organised every year by the Australian Koala Foundation to focus attention on the plight of the Koala. This year it will be Friday 29 July 1994. It provides an opportunity for people to take some positive action towards saving the Koala, either by protecting habitat, fund- raising, planting a tree or increasing understanding of the Koala's plight and what can be done to help.

This year you can also buy Save the Koala Sun Visors at outlets, including pharmacies, throughout Australia to help the cause.

Described as bright and fun, coming in three shades, and sporting a cheeky Koala face, they will cost only $2.00 each.

For more information about Save the Koala Day please contact Ann Sharp on (07) 229 7233.

WINNERS

The winner of the Discovery Ecotours Holiday in our Autumn '94 subscribers competition is Stuart Gairns of Perth, WA. The Autumn Pic Teaser winner was K. Wynn-Moylan of Billinudgel, NSW.

An Apology

In the Autumn 1994 issue of ANH we published a box on "Eastern Whale- watching Hotspots". Unfortunately some of the information and contact numbers provided were incorrect. We apologise for any inconvenience caused and suggest that, for any information regarding the best vantage points from which to view whales and the availability of tours, you contact the local tourist and visitor information centre for that area. These and other correct contact numbers are listed below:

Airlie Beach, Whitsundays: Whitsunday Visitors Bureau (079) 466 673.

Hervey Bay: Hervey Bay Information Centre (071) 242 448.

Bundaberg: Lady Musgrave Barrier Reef Cruises (071) 529 011.

Moreton Island: Tangalooma Resort (07) 268 6333.

Stradbroke Island: Queensland Government Travel Centre (07) 221 6111.

Byron Bay: Australian Whale Conservation Society (07) 398 2928.

Korogoro Point, Hat Head National Park: NSW National Parks & Wildlife Service in Port Macquarie: (065) 842 203.

Wollongong: Wollongong Visitors Centre (042) 280 300.

Eden: Eden Tourist Information Centre (064) 961 953.

There are no longer any tours operating out of Sydney and Heron Island as sightings are too unreliable.

TAMS EVENTS

Just some of the events in the TAMS (The Australian Museum Society) calendar:

"Putting Cats in their Place" An all day Seminar on Sunday July 31 at The Australian Museum, 10am-5pm.
Cost: Members $38.00, Non Members $50.00 (includes Lunch).

"The Expanding Universe - Measuring Hubble's Constant" A lecture by Professor Jeremy Mould, Professor of Astronomy at ANU will be held on Thursday 28 July - 6.30pm at The Art Gallery of NSW.
Cost: Members $10.00, Non Members $12.00

Go Fossil Fishing for the Weekend - A field trip led by Dr Alex Ritchie at the Devonian Fossil Fish Sites, in Canowindra NSW, Friday 9 - Sunday 11 September 1994
Cost: Members $235.00, Non Members $260.00

As an ANH subscriber, you can enjoy all the benefits of being a TAMS member (including free admission, magazines, discounts and events) for only a small additional fee. For further information phone the Society's office on (02) 339-8225.

Another one bites the dust

Sorry to say that we have run out of stock of another back issue - this time Volume 22 No.7.

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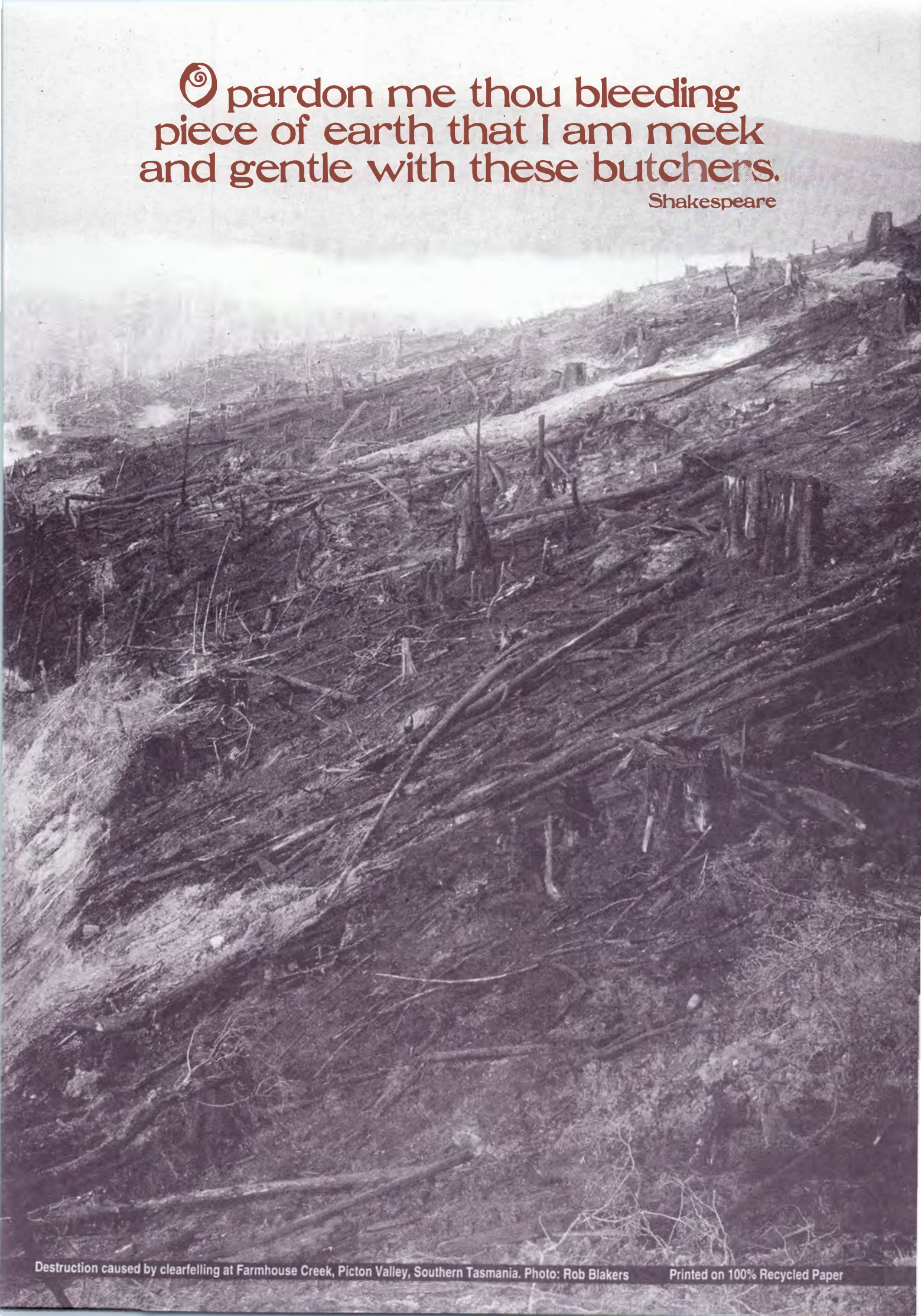

Destruction caused by clearfelling at Farmhouse Creek, Picton Valley, Southern Tasmania. Photo: Rob Blakers

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If Shakespeare's Mark Antony were alive today, he would not have to be pardoned. He would join The Wilderness Society.

Our forests have never before been under such attack. Only urgent action will prevent the destruction of what precious little remains of our forest wilderness.

Across the country The Wilderness Society is working hard to save our native forests — we have the solutions, but we need YOUR help to implement them.

It's hard to believe but the Federal Government has just approved another five-and-a-half million tonnes of export woodchips from our forests — that's a death warrant for two million trees.

What are now the living, breathing homes of some of the world's most remarkable animals will soon become paper bags for Japan.

Whether the government and woodchipping industry like it or not, these forests still have a voice — The Wilderness Society!

Your donation will keep us lobbying in the parliaments and boardrooms; visiting schools and community groups; running street stalls; producing award-winning education kits, videos and posters; and working in the forests and outside the chipmills.

Help us to stop the senseless butchering of our native forests. Please give generously and post your pardon for the forests today.

Yes, I want to help save our native forests!

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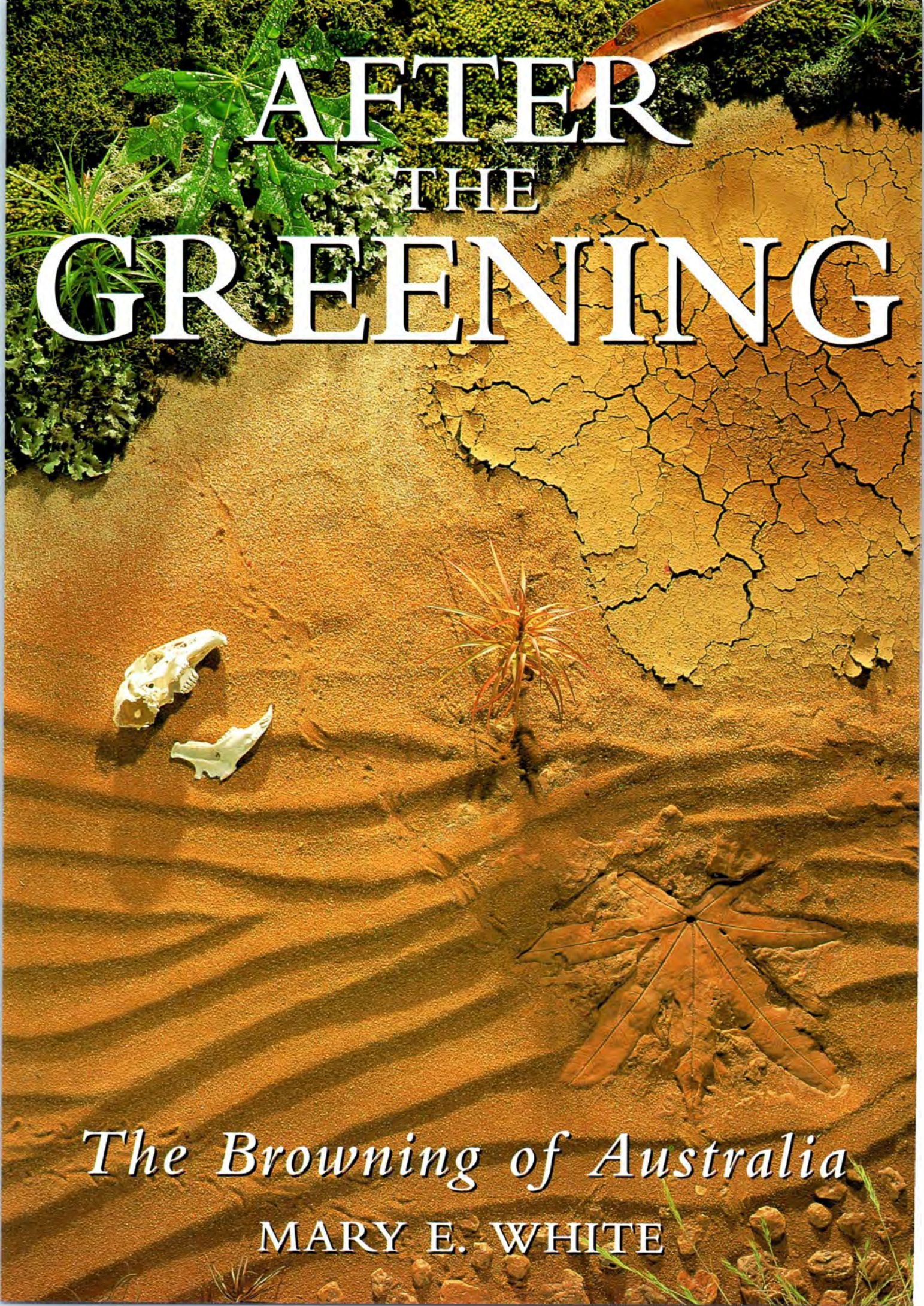
AFTER THE GREENING



The Browning of Australia

MARY E. WHITE

MARY E. WHITE
AFTER THE GREENING

AUSTRALIA and Antarctica today are island continents. In the modern world they share the honour of being the most arid lands — Antarctica by virtue of having its water frozen, and Australia the driest vegetated continent with more desert within its boundaries than exists within the borders of any other country.

In the prehistoric past Australia was part of the southern supercontinent Gondwana and was attached to Antarctica. The two lands shared a Gondwanan flora and fauna, and when the final separation between them occurred (only 45 million years ago), both lands were well-watered and supported forests of conifers and flowering plants with a mixture of kinds which are today sorted and sifted into cool temperate and subtropical, mesophyll and sclerophyll.

This book traces the evolution of the driest vegetated continent from the green and forested, well-watered piece of Gondwana. Like the birth, maturing and aging of an organism, the evolutionary stages *RIFTING, DRIFTING* and *DRYING* have produced the modern land we know today — a wide brown land, time-worn and unique.

How Australia broke free from Gondwana, and the geological processes which were involved, forms the *RIFTING* section of this book. *DRIFTING* documents the changing vegetation, climate and landscapes as the Island Continent moved northwards away from Antarctica. The progressive cooling of Antarctica which resulted from its increasing isolation affected world climates and Australia began to dry out. Its forests contracted and were replaced by arid-adapted vegetation, with a consequent increase in the impact of fire on the biota. When the South Polar ice cap formed fifteen million years ago, the world was on track towards an ice age and climatic fluctuations from warm and wet to cool and dry became marked.

The *DRYING* of the Australian continent that resulted in its blown-sand and stony deserts, its vast arid and semi-arid zones and its present-day vegetation patterns began with the formation of the North Polar ice cap about 2.4 million years ago. Very dry, cool and windy glacial stages alternated with warmer and wetter interglacials. The last glacial maximum, between 18,000 and 14,000 years ago, saw most of the continent covered by wind-blown dunes, acute aridity, and enormous stress for flora and fauna. We live today in the interglacial that follows the recovery from that last glacial stage of the continuing ice age.

The arrival of the Aboriginal people in the continent, possibly as long ago as 140,000 years, and the impact of their "fire-stick farming" on an ice age-affected land was profound, altering the nature of vegetation over much of the continent. The impact of European settlement on this unique land in the last 200 years has been devastating. The reasons why are clearly seen in the *DRIFTING* and *DRYING* story. *UNBALANCING THE BIOTA*, looks at current problems from the prehistoric perspective gained from the study of the development of the driest vegetated continent from a green and forested piece of Gondwana.

Mary White is a Palaeobotanist whose fascination with prehistoric Australia, its changing environments and flora and fauna, resulted in her books *The Greening of Gondwana, The Nature of Hidden Worlds* and *Time in Our Hands*. She believes that the degradation of Australia's soils, its grazing lands and forests, can only be understood and hopefully remedied when the history of the land and the nature of its finely balanced ecosystems are understood. With *After the Greening* she has shared with her readers the story of the birth, maturing and emergence of modern Australia — hoping that respect, reverence and understanding of this amazing and wonderful land will ensure that humans do not continue to misuse it in a way that threatens to turn it into a lifeless desert.

ISBN 0 86417 585 X, 288pp, 300 colour plates, 290 × 210 mm (8¼'' × 11⅜''), rrp $59.95 May

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Up Front

On the first Sunday in March, Australians gather to take part in one of the most worthwhile events of the yearly calender—Clean Up Australia Day. This year saw over 500,000 Australians collect more than 20,000 tonnes of garbage from all over this beautiful continent—a continent that far too many of us use as our own private rubbish tip. In recognition of the importance of this event, which has now expanded into a Clean Up the World campaign, its organiser, Ian Kiernan, was made 1994's Australian of the Year. In this issue of ANH, we would like to introduce you to another Australian who, like Ian, is passionate about rubbish.

PATRICK HONE

Nigel Wace is passionate about rubbish.

Dr Nigel Wace was amazed to discover that televisions and refrigerators are found washed up on the beaches of uninhabited coral atolls that lie in the middle of the Pacific, far from the madding crowd. As a result, he decided that it was time someone tried to find out just how much litter is floating around out at sea, what it consists of and who is using the oceans as a garbage tip anyway. In order to answer some of these questions, he has spent quite a bit of time on an isolated beach in South Australia collecting, recording and analysing rubbish. In his article "Beachcombing for Ocean Litter", Nigel explains that, as good as it is to clean up the garbage, it is far better to identify where it is coming from and hopefully prevent it from becoming litter at all.

KATHIE ATKINSON

An Australian scorpion fluoresces under ultraviolet light.

We also look at one of our great opportunists—the Australian Pelican, and profile a mysterious dolphin that inhabits northern Australian waters. We investigate whether we're living in a universe full of WIMPs or MACHOs, and discover that Australian scorpions are not as fearsome as their overseas relatives.

—Jennifer Saunders

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Front Cover
The Australian Pelican is a skilled opportunist and this, combined with little direct human predation, has allowed the birds to exist in healthy numbers while overseas pelican populations have declined. Photo by Kevin Deacon/Dive 2000.

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Articles

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LETTERS

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

Trees on the Beach

In north-western Tasmania, the Arthur River and its tributaries flow through the wet, heavily timbered Campbell Range in the Tarkhine Wilderness, and straight into the Southern Ocean. The river has no sand-barred lagoon typical of many river outfalls on the mainland, so the trash that floats down the Arthur goes straight into the sea. The catchment of the Arthur includes large areas of old-growth forest that have been logged for many years. Striking evidence of this logging can be seen on the beaches near the river outfall.

While looking for beaches fronting the Southern Ocean that could be suitable for monitoring stranded ocean litter (see article in this issue), I walked over the dunes to Arthur Beach—an open strand to the south of the river mouth. The whole coast for several kilometres is choked with tree trunks up to a metre or more in diameter, jumbled up on the rocks and in the sand. Strolling along the tidelines in the dusk, while the surf pounded the beach, I could only feel dismayed and angry at the carelessness and waste displayed by all these trees lying on the sand. Trees are not only valuable as timber, but they are also valuable as sinks for carbon dioxide to redress the imbalance in the atmosphere brought about by human burning of fossil fuels. Trees are not things to be thrown away. What right have we to question the destruction of tropical forests in poor countries, when we throw away our own trees like this?

The timber on Arthur Beach is not just rubbish wood. There is plenty of myrtle and blackwood there. And it's not very old, either. On most of the timber there were the unmistakable marks of chainsaws, with clean cuts through the massive trunks, showing how they had been felled and dismembered. Why were they felled if they were just going to be thrown away?

Today people come to this beach to collect firewood, and also to scavenge high-quality pieces for craft work. I was told that such scavengers pay $25 a year for a licence to take wood from the beach—hardly the sort of sustainable use one would expect for such a valuable resource as this.

I wonder how much more of this wasted old-growth timber in the Arthur catchment never got into the river? How many more trees have been felled and left to burn or rot on the hillsides, while the prime timber is taken away to feed the mills? The trees on Arthur Beach are the result of a 'driftnet mentality': catch everything, then throw away what you don't want for immediate profit.

Our forest industries are demanding they have guaranteed access to many of the remaining old-growth forests on crown land. Proponents of this concept of 'resource security' should visit the outfall of the Arthur River to see for themselves how the Tasmanian forest industries are using what they already have, before they are given access to any more. I cannot understand how any industry can throw so much away, and still insist that it needs more.

In southern Australia, many of the rivers that drain forested catchments end in coastal lagoons and lakes, so that forestry waste floating downstream doesn't actually reach the sea. It would be interesting to look at the bottom of, say, Macquarie Harbour in Tasmania or Lake Macquarie in New South Wales. Do these sediments contain a lot of waterlogged timber; a hidden signature of the past use of our forests?

I live in Canberra—a beautiful planned city. When overseas visitors want to see the city, I take them round the tourist sights. But for those people who really want to understand Canberra, I make sure we go to the tip. If you look at what is being thrown away by a city or an industry, you gain an insight into how it works as a physical and biological system. In this way, Arthur Beach in north-western Tasmania is like the Mugga Tip in Canberra.

—Nigel Wace
Australian National University, ACT

COURTESY NIGEL WACE

These trees are the result of a 'driftnet mentality': catch everything then throw away what you don't want.

More on Mounds

Despite Geoff Bailey's claim to the contrary (Letters, ANH Summer 1993–94), the Weipa shell mounds are no longer a subject of controversy. Had he read my Master of Science thesis entitled *Origins of the Weipa shell mounds* (ANU 1992) he would have found that there is a significant body of field evidence to support the claim that the mounds are natural—not cultural—in origin. This evidence consists of detailed maps and stratigraphic sections backed by a comprehensive series of radiocarbon dates. For the first time ever it has been possible to interpret the mounds in a sensible geomorphological context.

The results of field work I conducted in 1991 clearly demonstrate that the shell mounds began as wave-built chenier ridges or related shoreline deposits. The

anthropologist W.E.H. Stanner was of a similar opinion in 1958. The fact that many of these deposits appear as tall, steep-sided, conical mounds can only be explained in terms of reworking by the Orange-footed Scrubfowl (*Megapodius reinwardt*). This process is observable and also explains the many similar mounds composed of sand and gravel. Although Bailey interprets mounds of different composition in terms of fundamentally different processes, it is not the dictate of Occam's razor to have two theories for the one phenomenon.

Bailey also believes that composition can distinguish middens from cheniers. However, like middens, cheniers may also be composed of large whole shells and geomorphologists attribute this phenomenon to sorting by wave action. The location of the Weipa shell mounds on sand ridges or silt substrates is also characteristic of shell chenier deposits. The presence of other faunal remains, ash lenses and the occasional artefact can also be explained by natural processes. Bailey would do better to consider that the criteria archaeologists traditionally use to distinguish middens from natural shell deposits are flawed.

The radiocarbon evidence is as powerful as that drawn from geomorphology. Dating of the shells in the Kwamter mound was undertaken not to distinguish scrubfowl mounds from middens, but to test Bailey's very specific hypothesis of how the shell mound formed. He claimed that the shells accumulated from the activities of generations of human occupants and envisaged a period of at least 1,000 years for this to happen. This hypothesis is false because most of the shells I had dated from the Kwamter mound are all of the same age.

It is reasonable to assume that human shell-gatherers have made some contribution to the shell deposits at Weipa. It is unreasonable, however, to claim that human predation caused the death of almost every cockle in the landscape. Shellfish mortality on the scale evident at Weipa is normally attributed to natural processes and, if archaeologists wish to believe otherwise, they must have good reason.

—Tim Stone
Mawson, ACT

Zebra Stripes and Swatting Tails

I am writing in regard to the QQC article about Zebras and tsetse flies (ANH Spring 1993), which suggested that the Zebra's stripes might help prevent it being bitten by the fly, since it has been shown that the flies avoid horizontally striped forms. This seems an unlikely explanation of the situation to me. Surely the phenomenon to be explained is why tsetse flies avoid horizontal stripes, rather than why Zebras have them, and surely this is simply because it helps them avoid being swatted by the Zebra's tail. The rump of the animal is the most obvious horizontally striped area and, if a fly was able to select some part of the animal other than its rump, perhaps it would have a better chance of both finishing its meal and surviving to have another.

—Timothy Millar
Elsternwick, Vic.

To Kiss or to Sniff?

The insert box "Give me a sniff" accompanying Michael Stoddart's article "Picking up the human scent" (ANH Winter 1993) intrigued me greatly. The reported examples of humans sniffing as a substitute for kissing dated back to 1831, the implication being that such behaviour died out some time ago or is only practised by obscure societies untouched by the modern world.

In fact Lin Roth's 1890s description of the greeting habits of the Khyoungtha people is an accurate description of greetings still practised in modern-day Thailand.

There couples still prefer the traditional 'sniff' to the modern 'kiss', and almost every time a woman picks up a baby or toddler it is accompanied by a long, deep sniff and often preceded by the expression "please give me a smell of your cheek".

Possibly there are many more examples of such behaviour around the world and, as in Thailand where the word for kiss is the same as 'to smell', it's probably not an unusual practice at all.

—Terry Coldham
Sydney, NSW

STEVE THOMAS

Why do tsetse flies avoid horizontal stripes?

Condor Update

An update on the Californian Condor situation (QQC Autumn 1993). The juvenile Condor Xewe actually died of poisoning due to drinking antifreeze, not lead poisoning as reported. The source of the antifreeze is still debated, but it is thought to have originated either from rain gauges being dumped or spillage left by a motorist.

Of the six additional juveniles that were released, unfortunately two were electrocuted in power lines near the town of Fillmore. The power company (Edison) has since installed raptor guards to make the poles and towers unsuitable for perching. Closer to the Sespe Condor Sanctuary, Edison had buried power lines and installed raptor guards on high-voltage towers but they hadn't expected the condors to come so close to town. (What you essentially have with these young condors are unsupervised 'teenagers' exploring their surroundings with no experienced adults to keep them out of trouble!)

These large birds also make tempting targets. A couple of men hiking in the back-country took several shots at a condor. Fortunately, their aim was poor and a wildlife officer was nearby and observed the incident. One man has since been brought to court and fined $US1,500 for shooting at an endangered species.

The next condor release is planned for a remote area of Santa Barbara County, in an effort to avoid some of the problems encountered in Ventura County.

—Susan Williams
Ventura, California

JOHN CANLALOSI/AUSCAPE

A disease transmitted by feral cats is partly responsible for the decline of the last wild population of Eastern Barred Bandicoots on the Australian mainland.

Writing in Mysterious Ways

I read with interest the QQC item "Writing in Reverse" (ANH Winter 1993). I'm not convinced, however, that the thesis of Smetacek as presented gives the whole answer to the phenomenon.

[The following two paragraphs were hand-written in mirrorscript.] The reason I say this is that now, according to Smetacek, I should be writing with my left hand, as the above paragraph was written with my right hand. However, I am continuing to write with my right hand. The scrawly nature of this reverse writing compared to my usual forward writing above is primarily a consequence of a lack of practice. Some years ago, however, I used to write the occasional letter or postcard in reverse. This practice ceased when, for some inexplicable reason, responses to my letters failed to arrive!

Anyway, be that as it may, I wonder just where a person who writes both forwards and backwards with the same hand (and who is incapable of creating a recognisable scrawl with the other hand, in my case the left) fits into Smetacek's scheme of things.

My curiosity is genuine, as the phenomenon conjures up some weird brain function permutations!

Finally, I just wish to add that ANH never fails to fascinate me and I also wish to pass on my congratulations (and thanks) for the persistent high-quality production of high-interest articles over the past several years.

—Phil Plummer
Seychelles

Infectious Cats

I wish to comment on the diseases transmitted by cats to our native wildlife (as briefly discussed in ANH Winter 1993). Quite apart from the efficient predatory activities of cats, their disease toxoplasmosis has a significant impact on wildlife. This protozoan parasite has an infectious stage that is passed in the cat's faeces, contaminating soil and herbage. Grazing marsupials (kangaroos, wallabies and wombats) can become infected by inadvertently ingesting these oocyst stages while feeding. Bandicoots seem to acquire the disease from insects and earthworms that have had contact with the infected cat faeces or contaminated soil. Even carnivorous marsupials can become infected by consuming animal tissues that contain the resting cyst stage of the parasite. Several eutherian mammals can harbour these cyst forms without exhibiting any illness. Examples include introduced rodents and sheep.

The impact of toxoplasmosis in wild populations of marsupials is only beginning to be investigated. In Tasmania, the mild climate favours the survival of the parasite and Bennett's Wallaby, the Tasmanian Pademelon, Common Wombat and Eastern Barred Bandicoot have all succumbed to fatal infections in the wild. In addition many species of marsupial now classified as endangered or threatened have died of toxoplasmosis in captivity, including the Parma Wallaby, Kowari, Yellow-footed Rock-wallaby, Numbat and Bilby. Toxoplasmosis has also been partly responsible for the decline of the last wild population of Eastern Barred Bandicoots on the Australian mainland. 'Disease' *per se* has also been proposed as an explanation for the decline of dasyurids (Western and Eastern Quolls) on the Australian mainland, however there is no firm evidence that toxoplasmosis was responsible.

Feral cats are also contributing to disease on farms. Toxoplasmosis in young ewes can cause abortions, stillbirths and a reduced lamb survival. Another protozoan disease spread by cats, sarcosporidiosis, produces large white cysts in beef and mutton and, although they don't generally lead to livestock deaths, it can cause carcasses to be condemned in abattoirs.

—David Obendorf-Reid
Launceston, Tas.

All Aboard

Echidna is a secretive
Australian,
Encounters with echidnas
are quite rare,
But come the winter weather,
They get their act together,
Yet not as you'd suspect—
a single pair.

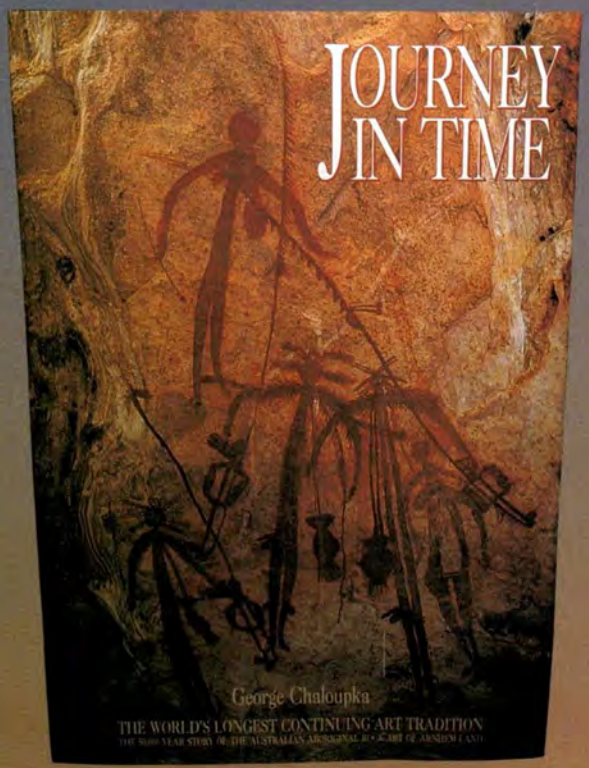
They form a conga line
of expectation,
With nose to tail, that's
an echidna train.
But only one's a breeder,
All male except the leader,
A solitary female chatelaine.

Voyeurs are active
on Kangaroo Island,
We hope their observations
aren't in vain.
It should be fascinating,
To watch echidnas mating,
So hurry folks or else
you'll miss the train.

—Len Green
Vaucluse, NSW

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 $20.00 gift voucher from the Museum Shop catalogue. The winner this issue is Timothy Millar.

...the 50 000 year story of the Australian Aboriginal rock art of Arnhem Land



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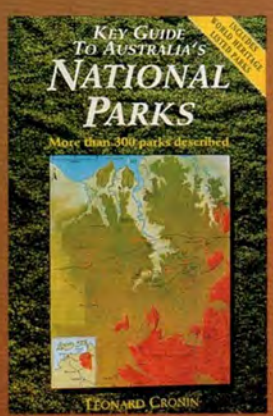

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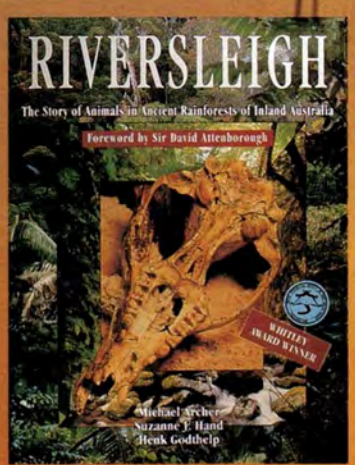

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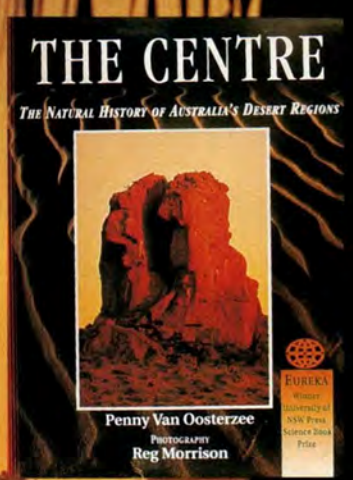

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QUOTES & CURIOS

QUIPS

COMPILED BY GEORGINA HICKEY

Live Gut Flora from Extinct Mastodon

Golfers at Burning Tree Golf Club in Ohio have an unusual obstacle to contend with. It's not a bunker or a pond, but the resting place of a large mastodon (*Mammut americanum*)—an extinct elephant-like mammal.

The mastodon skeleton was discovered by a construction worker as he excavated a small pond on the golf course. For almost 12,000 years the animal had lain there, refrigerated in a cold peat bog.

The mastodon was killed by human hunters who stashed the carcass in the bog for later. Slowly it sank into the mud until the hunters could no longer retrieve it. The bog's cold, constant temperature, its lack of oxygen, and protein-rich environment were ideal for the mastodon's preservation. In fact, part of it was still alive when it was dug up.

A cylindrical mass, thought to be preserved gut contents, was isolated from the remains. Gerald Goldstein, a microbiologist from Ohio Wesleyan University, wanted to see what would happen when he inoculated flasks of sterile broth with samples of the material. Nobody else had tried to culture bacteria from the remains of extinct animals before.

Goldstein found, to his amazement, that bacteria from the material grew in the broth. They were identified as *Enterobacter cloacae*, a species found in the intestinal tract of present-day mammals.

Tests on the surrounding peat samples proved negative to *E. cloacae*; and the bog had been effectively sealed from any outside water (and thus bacteria) by an impermeable layer of heavy inorganic clay. These facts suggest that the bacteria are not the result of any contamination. They are the original gut flora (or their descendants) used to break down the food in the mastodon's intestinal tract. As such, they may well be the oldest living organisms ever discovered.

—C.B.

Moulting and Fasting in the Cold

The two largest species of penguins, the Emperor Penguin (*Aptenodytes forsteri*) of the Antarctic and King Penguin (*A. patagonicus*) of the sub-Antarctic, live in harsh cold surroundings. They are subjected to unusual environmental stresses and cope with these in unusual ways. One aspect of these processes was studied by French CNRS researchers R. Groscolas and Y. Cherel, who looked at how these penguins survived periods of enforced fasting during the non-breeding season.

Each year during summer these penguins go through a moult in which all their feathers are simultaneously renewed. This moult period is particularly demanding on the penguins. Without the insulative and waterproofing properties of their feathers, they cannot enter the water to catch fish and so must fast for a period of two to five weeks. Although fasting also occurs for a longer period (up to four months) during the breeding season, when penguins must stay ashore to incubate the eggs, the energetic demands are nowhere near as great. During moult, additional energy demands come from the synthesis of new feathers and the greater production of heat to compensate for the reduction of thermal insulation.

STEVE KIRK/©1992 DISCOVER MAGAZINE

Reconstruction of an extinct mastodon, *Mammut americanum*, whose well-preserved remains were discovered after being refrigerated in a cold peat bog for nearly 12,000 years.

In the absence of food, the energy supply comes from the penguins' fat and body protein. During breeding, when moulting does not occur, a male Emperor Penguin loses about 16 per cent of his body protein. In contrast, a moulting Emperor Penguin loses about 50 per cent of its body protein in one month and can survive a 60–70 per cent loss. This is a remarkable feat: in most birds and mammals a 30–50 per cent loss of body protein is considered lethal.

It is little surprise that penguins starting moult with a low body mass often do not survive the period. It is probably also not surprising that moult occurs at a separate time of the year from reproduction. This temporal separation, the researchers suggest, occurs because the two energy-demanding processes are under the control of different hormonal systems—reproductive hormones for breeding and thyroid hormones for moulting—that operate on near mutually exclusive time schedules.

—Walter E. Boles
Australian Museum

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

Moulting in King Penguins is an energy-demanding process made all the more difficult because they can't enter the cold water to feed.

Bacteria Blamed for Ulcers

For decades, popular therapy for peptic ulcers has meant out with cigarettes, coffee, alcohol and the key to the executive bathroom, and in with baby food, antacids and the pursuit of a stress-free life. Yet, as many sufferers will attest, the sacrifices don't really work long term. The reason, according to a growing body of research, is that ulcers are not caused by stomach-acid secretions but by bacteria.

In 1982, while based at Western Australia's Royal Perth Hospital, Barry Marshall, a medical doctor, and pathologist Robin Warren discovered and managed to culture a new bacterium from the stomach wall of ulcer patients. Named *Helicobacter pylori*, the researchers proposed it caused peptic ulcers and that antibiotics could be useful in treating the painful gastric complaints. They tested the treatment in Perth in 1985 and published the results in 1988.

However, change in the medical world comes slowly. Only recently have other studies been published to confirm Marshall and Warren's work, that is that antibiotics are more effective in treating ulcers than antacids. One Austrian study found that duodenal ulcers treated with antibiotics recurred in only eight per cent of patients. This is in marked contrast to a US study that reported up to 95 per cent of ulcers subjected to conventional treatment recurred within two years.

While many researchers are convinced that *H. pyloric* causes ulcers, it may be some time before antibiotics become a routine part of ulcer treatment. The message appears to be only trickling down from researchers to clinical practitioners. And, even when it does get through, there are still many sceptics—50 years of medical dogma, it seems, are difficult to shake!

—K.McG.

WARDENE WEISSER/ARDEA

Individual paloverde trees have a characteristic DNA profile that has been used to link a murder suspect to the scene of the crime.

Seed Pods Take the Witness Stand

In May 1992, the trees at an abandoned Arizona factory were silent witnesses to a woman's murder. The main suspect says he wasn't there. But, if two paloverde seed pods found in the back of his truck could talk, they may well have another story.

Paloverdes are thorny, often leafless, desert trees of the pea family that can photosynthesise through their branches. One of the trees growing near the factory driveway—a Blue Paloverde (*Cercidium floridum*)—had recently been scraped. If the seed pods in the truck came from that tree and had fallen in as the suspect drove into the factory site, DNA from the pods and the scraped tree should match.

To make the pods 'talk', plant geneticist Tim Helentjaris of the University of Arizona had to match their DNA to the tree, just as human DNA fingerprinting is used to link blood or semen to a particular human suspect. But when human DNA profiles are used as evidence, a probability is given, based on thousands of samples, that the blood or semen could have come from someone else. Unfortunately, no such bank of DNA profiles exists for paloverde trees.

Helentjaris found wide genetic variation among the trees he tested. He could easily identify individual trees and, in one test, picked the correct tree from 11 others at the factory. Based on this, DNA profiles from the pods were admitted as evidence—the first time plant DNA has been used in court.

Matching the pods in the truck with a tree at the murder scene doesn't convict the suspect, but it does suggest his truck was there. However, because Helentjaris could only test a relatively small sample of trees, it's possible that there are trees elsewhere with the same genetic profile as the scraped tree. Without more data, the suggestion remains just that.

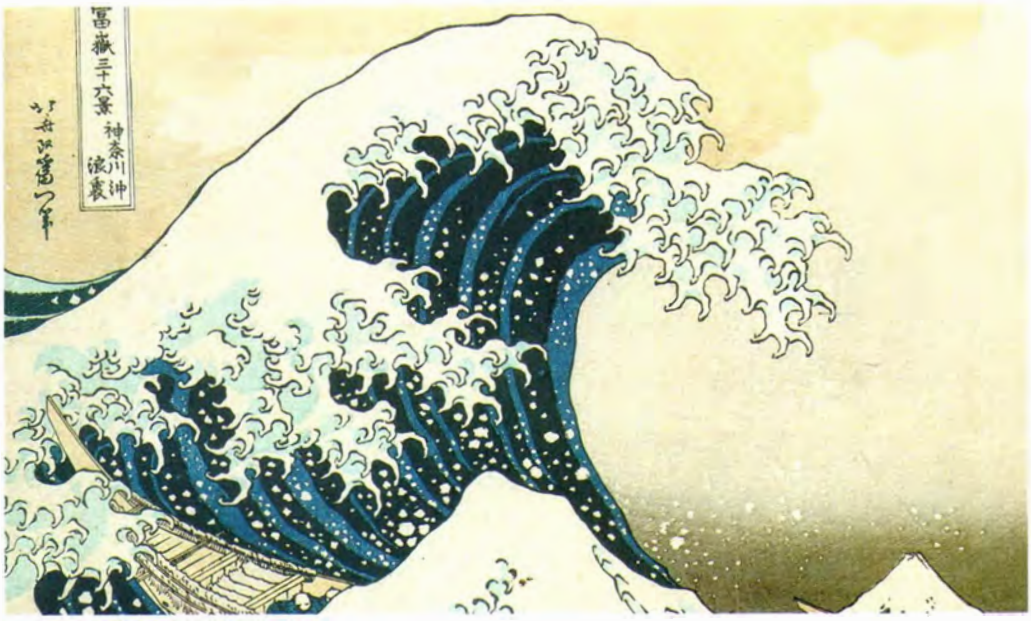
—C.B.

Not the Last Wave?

Tsunami, or tidal waves as they are often incorrectly called, are feared along many shorelines around the world. These great waves have nothing to do with the tides; rather, they are generated by severe earthquakes, landslips or volcanic explosions, like that of Krakatoa which, in 1883, generated tsunami 25 metres high, killing over 30,000 people. The word tsunami is Japanese for 'harbour wave', so called because their effects are most noticeable in shallow waters, such as harbours and bays, within which they often oscillate back and forth. Although the south-eastern coast of Australia seems relatively secure from tsunami, research at the University of Wollongong indicates it to have been repeatedly struck by them in the past.

Fellow geographer Ted Bryant and I first recognised traces of tsunami impact at Tura Head on the far south coast of New South Wales. There undoubted evidence of severe wave action lies well above the erosional limits of even major storm waves. On the north side of this headland, 15 metres above sea-level, the top of a sandstone ramp has been carved by wave action into parallel ribs up to a metre deep. Further down the ramp, large angular blocks of sandstone, some weighing an estimated 20 tonnes, were quarried or plucked out by waves and swept right off the ramp. There is little doubt that Tura Head was struck by a catastrophic train of waves up to 20 metres high, and we have recently argued that these were part of an enormous (about 325 metres high) tsunami that started from a submarine landslide at the Hawaiian Island of Lanai about 105,000 years ago. Such a great train of waves would have had a severe long-distance impact along much of the Australian coast. We have found similar evidence of catastrophic erosion on rock platforms and ramps as far north as Wollongong.

Although the Tura event is the largest for which we have evidence, there appears to be evidence for at least four more tsunami reaching



METROPOLITAN MUSEUM OF ART

"The Great Wave at Kanagawa." Painting of Japanese tsunami by Katfuskika Hokusai, held in the Metropolitan Museum of Art, New York.

the south coast of New South Wales between 10,000 and 200 years ago. One inundated Batemans Bay about 3,000 years ago and would probably have drowned much of the present town site. The key to this argument is a deposit of sand, containing a curious mix of shells from sandy beaches, rock platforms, tidal mudflats and from even the inner continental shelf, that was swept into an extremely sheltered site near the tidal limit of Cullendulla Creek on the northern side of the bay. Even the most severe storm wave known would not have reached this point.

Some people have been quick to write this claim off as just more Doomsday stuff. However, the evidence is there and, if our interpretation is correct, it could have severe implications for the planning of future coastal development.

—Bob Young
University of Wollongong

Cross-dressing in Hyenas?

Occasionally girls are born with male-like genitals: their clitoris is enlarged into the shape of a penis (pseudopenis) and their labia majora have grown, folded down and joined into a false scrotum. They have no testes but do have ovaries and develop breasts at puberty. These girls have all been found to have an abnormally high level of androgens (male hormones that are normally present in only small amounts in females). In humans this occurs very rarely—as a result of certain disease or drugs taken by the mother while pregnant—but in Spotted Hyenas (*Crocuta crocuta*) it is the norm.

The condition in Spotted Hyenas led to the erroneous belief that they were hermaphrodites (that is, had both male and female sex parts). But this is not so. The sexes are separate and reproduction carries on as per usual for placental mammals, albeit with more difficulty. In a very awkward mating procedure to which the female must obviously consent, the male inserts his penis into the female's

FERRERO/LABAT/AUSCAPE INTERNATIONAL

Male or female? It's difficult to tell. The genitals of female Spotted Hyenas mimic those of males.

pseudopenis. The cubs are also born through the pseudopenis, the opening of which is so narrow that the first-born cub often dies in the process.

Evolutionary biologists have struggled to provide an explanation as to why the female genitals of Spotted Hyenas should mimic those of males, given the obvious restrictions of such a system. One suggestion has been so that hyenas can recognise each other in the ritualised 'meeting ceremony' in which individuals sniff and lick each others' genitals (male-like genitals provide a more conspicuous structure for recognition). But recent studies on Spotted Hyenas both in captivity and in the wild indicate this line of reasoning may not be strictly correct.

Spotted Hyenas live in clans that vigorously defend territories and engage in communal hunting. They have an extremely complex social structure, with the females being larger and dominant over males. Their cubs are born with fully erupted teeth and come out fighting—literally—to the extent that they routinely opt for same-sex siblicide (where one of the cubs attacks and kills the other if it's the same sex; also the only known case of siblicide in mammals). By the time the cubs are 7–12 months old they assume the social rank of their mother, and may gang up with other cubs to attack adults of lower rank. However, when the males reach sexual maturity (at about two years of age) they leave their home clan to join another. Here they assume the lowest rank until another male joins the clan. In this way female dominance in the home clan is maintained.

This complex social organisation of Spotted Hyenas, which is presumably necessary to maintain cohesion and survival of the clan, is driven by their aggression, exhibited from the moment they squeeze their way out of the birth canal. And studies so far seem to indicate that this aggression results from the high levels of maternal androgens, which also cause female foetuses to develop male-like genitals.

Although the female Spotted Hyena's pseudopenis and false scrotal sac may be used in their meeting ceremony, it does not mean those structures evolved for that purpose. They may simply have arisen as an automatic consequence of increasing the level of androgenic hormones in females (necessary for a female-dominated society), and may since have been put to good use. As we learnt from Mike Archer's essay on "Palaeontological Poltergeists" (ANH Autumn 1992) and the QQC item on why kiwis' eggs are so large (ANH Autumn 1993), use of a structure need not imply it was built for the purpose it now serves. —G.H.

Getting the Gossip

"Brooke Shields Tells: My Love for Michael Jackson" and "Fergie AIDS Terror!". Magazines with shout lines like these sell in their millions because people love to hear the latest gossip. Well, the latest gossip is that getting the gossip may be good for us.

Robin Dunbar, a biological anthropologist at University College London, has a theory that gossip is good for us because it binds us into social groups. Social groups of humans are much larger than groups of other primates because humans can keep in touch with more individuals. Other primates literally 'keep in touch' by grooming members of their group. But grooming takes up a lot of time because only one individual can be groomed at a time. A human conversation, on the other hand, can involve several individuals, and it doesn't stop us doing other things—we talk and drive, talk and cook, talk and sort papers.

Language allows humans to keep track of many relationships. More than a way of exchanging information about ourselves, language allows us to learn about

other people. Gossip about someone teaches us how to relate to them. It lets us teach others about people they are yet to meet. Gossip organises relationships.

Gossip dominates conversations. Dunbar found that 70 per cent of the conversations he monitored in a university refectory were about relationships and personal experiences. Interestingly he found that women tend to talk about other people, while men talk more about themselves.

Evidence suggests that humans form 'natural groupings' of about 150 individuals, and that it is only possible to keep track of this many people by getting the gossip.

—C.B.

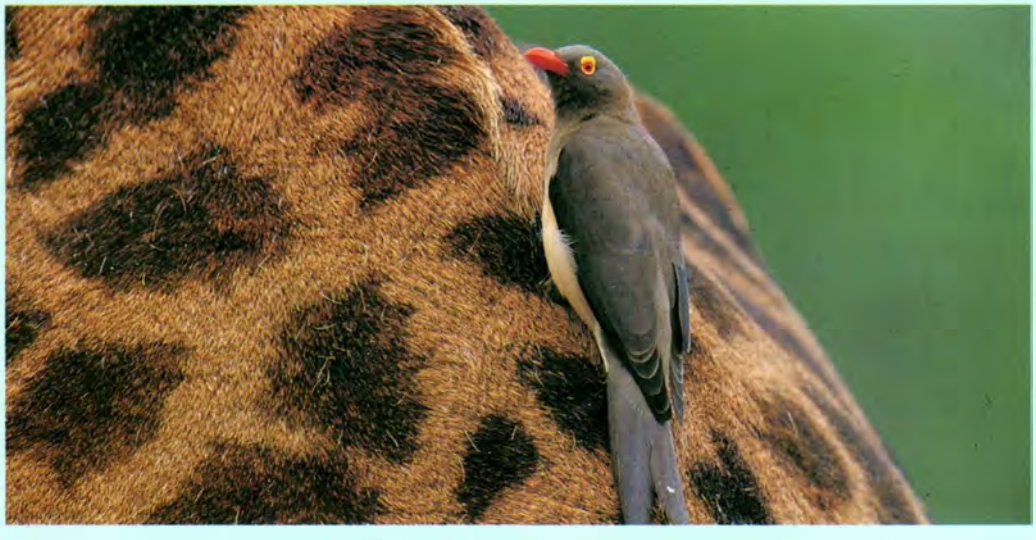
WADE HUGHES

Relocating 'problem' Saltwater Crocodiles may just be a waste of time.

Homing Crocs

Saltwater Crocodiles (*Crocodylus porosus*) are a hazard for the residents of Nhulunbuy, in north-eastern Arnhem Land. At least two people have been killed by the reptiles in the small mining township since 1979 and large, potentially dangerous adult crocodiles are common at waterways used by humans in the area.

The response by Government officials has been to implement, with the cooperation of traditional local Aboriginal landowners, a crocodile relocation program. (The Aborigines would not allow them to be sent to crocodile farms as is the practice elsewhere in the Northern Territory.) A recent assessment by Bryan Walsh and Peter Whitehead from the Conservation Commission of the Northern Territory (CCNT), however, reveals this may not be the answer.



NIGEL DENNIS/PHOTO RESEARCHERS

Red-billed Oxpeckers (*Buphagus erythrorhynchus*) prefer backs to branches. A Giraffe in Kruger National Park is this particular bird's host.

TALKING AMONG THE ANIMALS

Communication between oxpeckers and the mammals they peck their food from has recently caught naturalists' attentions. Oxpeckers are nervous, 'flighty' birds common in the savanna of sub-Saharan Africa. They eat the blood-sucking flies, maggots and ticks on mammals such as Zebras, Impalas and Giraffes and, in so doing, rid their hosts of debilitating pests. In their search for food, oxpeckers scurry over every part of the animal. When not feeding, they ride on the animals' backs and heads, preferring these to branches.

While observing oxpeckers in the Masai Mara Nature Reserve in Kenya, Randall Breitwisch (University of Dayton) noticed that most of the host mammals appeared to communicate encouragement. For example, when an oxpecker hopped down a Zebra's back, the Zebra would lift its tail as if to invite the bird to inspect its anal region. Sometimes a Zebra would repeatedly shake off an oxpecker—only to have it land on a different spot. But rather than discouragement, Breitwisch believes the Zebra may have been directing the oxpecker to a particular spot on its body, perhaps where there was an annoying tick.

Oxpeckers have a hypnotic effect on their hosts. Frequently when an oxpecker is looking for parasites, the mammal it is on stops grazing, stands still and appears mesmerised, sometimes even sinking on all fours to the ground. This, according to Breitwisch, makes the oxpecker's job less dangerous—just as predatory coral reef fish obligingly open their mouths for 'cleaner fish' to clean inside. An immobile, relaxed animal is simply easier and safer to clean than a moving, nervous animal.

The ability to 'communicate' between species has obvious benefits. Breitwisch has even suggested that the 'flightiness' of oxpeckers warns their mammalian hosts of impending danger.

—C.B.

Between mid 1986 and mid 1991, CCNT officers caught 52 'problem' Saltwater Crocodiles in the Nhulunbuy area. Small harmless notches were cut in their tails to make them readily recognisable as individuals, and 48 were released at remote sites suitable for crocodiles but uninhabited by humans. Release sites ranged between 17 and 282 kilometres from the township. Yet 23 of the crocodiles, including those released at the most distant sites, returned and were recaptured. Some individuals were caught at or near Nhulunbuy and relocated up to eight times.

Relocating the crocodiles in river systems separate to those in which they were caught did not appear to deter the animals' homing instincts. Most of the crocodiles that returned would have had to pass several rivers and travel along stretches of coastline with suitable crocodile habitat to complete their journeys. Their determination to return to Nhulunbuy may have been influenced by the recovery of crocodile populations since the animals became protected under legislation. Suitable crocodile habitats in remote eastern Arnhem Land may be nearing carrying capacity. Saltwater Crocodiles are extremely territorial and those in residence at relocation sites would be unlikely to welcome interlopers if there was no room for them.

—K.McG.

A Bird with an Ear for Fruit

The Eastern Whipbird (*Psophodes olivaceus*) appears to be a discriminating diner. One late spring morning in a northern Queenland rainforest, ornithologist Clifford Frith noticed an adult whipbird feeding on fallen ripe fruit of *Fagraea fagraeacea*. The bird would pick up the fruit in its bill then place it beneath its left foot and, while holding it to the ground, cock its head before apparently making a decision to either eat or leave it. The bird hopped from fruit to fruit repeating the same ritual.

Frith initially thought the bird had been turning its head to look at the fruit. But he changed his mind when he later discovered that ripe fruit often contained insect larvae that produced a clear ticking sound.

Frith now believes that, when the bird cocked its head, it was listening for the sound of the larvae, tearing open those fruit that ticked to feed on the grubs within, and discarding the silent fruits that presumably contained no prey. It is also possible, according to Frith, that when the bird held the fruit beneath its foot, it may have been able to feel the larval vibrations.

—K.McG.

C.B. & D.W. FRITH

The Eastern Whipbird is a discriminating diner that likes to listen to its food before eating it.

COURTESY C.G. SCHMITT

When grasped lightly about the waist, this West African tree frog feigns death by opening its mouth, sticking out its tongue, and going limp.

Frogs Fake it for Freedom

If there were Academy Awards for amphibians, the West African tree frog *Leptopelis macrotis* would surely top the list of nominees. This tropical rainforest species has extraordinary 'acting' abilities, as researchers discovered during an expedition in northern Liberia.

Zoologists Christopher Kofron and Gregory Schmitt, from Louisiana State University, have reported that at least seven adult West African tree frogs feigned death, complete with melodramatic death throes, when grasped around the stomach. They would arch their back, open their mouth wide and stick out their tongue. When the hold was maintained, the frogs would eventually go limp with their mouth open and tongue lolling out as if dead. When the collectors loosened their grips, the frogs made what seemed like miraculous recoveries and attempted to jump free. Tightening the grips again elicited more fake death throes.

'Passive' death feigning (when the animal simply plays dead) is thought to be a last-ditch attempt by prey to escape the hold of a predator, and it has been reported in a wide variety of animals, including other frogs, lizards, snakes (see ANH Autumn 1991) and mammals. However, the report by Kofron and Schmitt is the first of 'active' death feigning, that is complete with death throes, for a frog species.

—K.McG.

Carrie Bengston (a science communicator for the CSIRO) and Karen McGhee (a freelance science writer living in Newcastle, NSW) are regular contributors to QQC.

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QUICK QUIZ

1. What type of bird laid the giant fossilised egg found in late 1992 by school children near Cervantes, Western Australia?
2. What is the name of the world's largest sand island?
3. In which year was Charles Darwin's book *On the origin of species* published?
4. What type of animal was 'Alex', whose ability to talk made headline news in the 1980s?
5. What does ACF stand for?
6. Who is the new President for the Australian Museum Trust, appointed in December 1993?
7. What type of whale was Moby Dick?
8. For which island did the High Court hand down its historic Mabo decision?
9. Name the largest living organism.
10. What is a polyclad?

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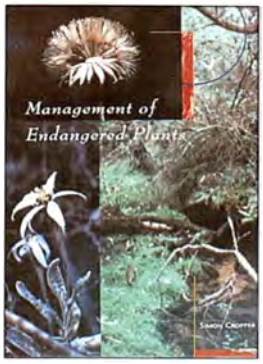

Management of Endangered Plants
Simon Cropper,
Dept of Conservation and Natural Resources, Victoria.
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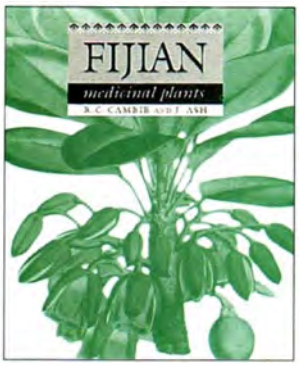

Fijian Medicinal Plants
RC Cambie and J Ash,
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A comprehensive, up-to-date compilation covering the origin and dispersal of plants; literature in the field; medicinal use of plants; Fijian diseases and medicinal chemicals from plants. 450 plant species are described.
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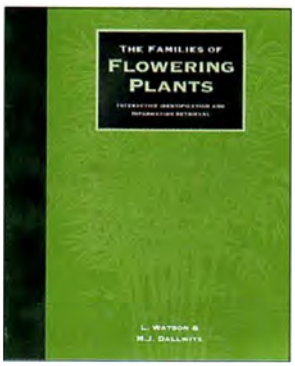

The Families of Flowering Plants
L Watson and MJ Dallwitz
Australian National University and CSIRO Division of Entomology
This CD-ROM package applies INTKEY (an interactive program for identifiying biological specimens) to 560 descriptions of the Angiosperm families. The program is designed to detect taxonomic patterns in botanical data, and to select taxonomically balanced samples for experimental work.
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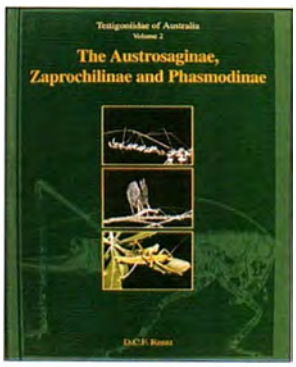

The Austrosaginae, Zaprochilinae and Phasmodinae, Vol 2 in the series Tettigoniidae of Australia.
DCF Rentz
CSIRO Division of Entomology
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ANH 24/9

Although we dismiss leeches as symbols of quackery, they really did work.

SUCKING UP TO THE HUMBLE LEECH

BY STEVE VAN DYCK

WHEN ALL MY OLD school mates were impressing the girls with really high-class sports injuries like broken legs and knocked-out teeth, the best I could come up with was a dose of ringworm that cost me all my hair and married me to a woollen beanie for most of the football season. All I ever wanted was a black eye or at least an excuse to wear a patch like the macho man on my dad's Pelaco shirt box.

In the fullness of time, an obliging goose with a nest of eggs and a lashing bullseye peck provided the long-awaited shiner. But the fantasy and the reality surrounding the black eye had nothing in common, and I was only too happy to cover it with a raw steak to try and reduce the swelling.

Thirty years earlier I might have been reaching for leeches. Four of them, dispensed by the local pharmacist or barber for between sixpence and a shilling each, would have been enough to deflate the puffed-up eye.

Although we wince at the thought of it now, and dismiss leeches as symbols of quackery from an age of misinformation, they really did work. Not so well perhaps when put to dissolve slowly on the tip of the tongue to cure the body of headaches, mental illness and syphilis. But, given the task of reducing swelling and bruising in delicate tissues, and stimulating blood circulation following reconstructive surgery, leeches still have a place in modern medicine. It's just a pity they are so revolting.

Like common garden earthworms, to which they are closely related, leeches have partitioned segments (34) spaced along their muscular macaroni-like bodies. But while both leeches and earthworms have a mouth at one end and an anus at the other, only leeches boast a sucker on both ends. Working these like alternating rubber drain pumps, leeches are able to quickly inch their way along when searching for prey. Depending on the type of leech, a potential meal may be bitten-and-sucked (jawed leeches), overpowered-and-swallowed (worm leeches) or speared-and-sucked (jawless leeches).

Land-living leeches, like the ones that tumble out of our socks after a walk through rainforest, are found only in South-East Asia and Australia. Set inside the front sucker of such leeches are two or three jaws sporting sharp microscopic teeth that tap the blood when a suitable host is found. In the medicinal aquatic leeches beloved by the Parisians, the mouth sports three jaws. In 1825 Parisians imported three million into their fair city and, in that same year, an estimated 20–30 million were imported into France alone. In time, Australia's Murray River was supplying some of the overseas demand when it was discovered that the aquatic leech that infested its shallow lagoons and billabongs was perfectly behaved when it came to doing whatever Parisians did with their leeches.

One Australian naturalist to observe professional leech-collecting along the Murray was Charles Barrett. "The flat-boards were flopped on the surface of the water, while the natives stirred up the mud with bare feet. Leeches rudely disturbed, rose in a hurry and fastened upon the undersurface of the boards, which were then turned over. Quickly the little creatures were scraped off into old stockings ringed at the top with wire. Nearly 1,000 leeches formed the catch that morning."

Some leech-gatherers preferred to coat their boards with lard, while others wrapped them in the skin of a freshly killed sheep. Others wore thick trousers tied at the ankles, or simply preferred to stand in the water and pick leeches off their bare bodies before being bitten. (In some jawless aquatic leeches, a probing, sucking proboscis up to a third of the leech's length is jabbed into the host's flesh. Bites from these leeches can be positively painful.) Regardless of the method of collection, the live captives were then packed in moist clay and grass, and sent to Melbourne for local sale and export. Barrett noted that Victorian hospitals needed 50,000–100,000 medicinal leeches every year, and that the leech-gatherers were paid 25 shillings per thousand.

The praises heaped on the Murray suckers were glowing. They bit into flesh quickly and sucked voraciously, and the scar they left was considered not as unsightly as that resulting from

Leeches, like this species from northern Queensland, are more commonly encountered around rainforest creeks than among backyard foliage.

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

FRITHFOTO/ANT PHOTO LIBRARY

This jawed leech from Queensland uses sharp microscopic teeth to tap the blood of a suitable host. During feeding, the leech may undergo a five-fold increase in body size and just one meal can keep it well fed for an entire year.

the bite of some leeches from India and China. Blood being thicker than water, this should make us Aussies swell with patriotic pride.

Leeches mostly appear dull brown to black in colour, but some are beautifully pin-striped in green or gold. Australian leeches, of which there may be well over 100 species, are generally between 20 and 85 millimetres long (unengorged), but one veritable dill pickle from Lightning Ridge can be up to 20 centimetres long on the slack. Leeches are not just pretty faces though. Their bodies are dotted with receptors that can pick up odours, light, heat, cold and vibration. Should a jawed leech detect a potential meal, it finds a suitable drilling site, rocks gently from side to side and slices a small hole with its sharp teeth. While cutting, it floods the wound with an anticoagulant to keep the blood flowing. It may also bathe the bite site with an anaesthetic to keep its host oblivious to the five-fold increase in body weight the leech may have just made at its expense.

When the feast is finished, and the leech, like a shining stuffed black olive, has fallen off replete, it sets about extracting and excreting all the water from its bloody dinner. Then, bacteria begin slowly breaking the blood extract down into digestible bits. Such a meal might well last the leech a whole year. If, however, you wanted more round-

This Sydney leech is fully outfitted with receptors that lock onto odours, light, heat and vibration—all in the name of a blood meal.

the-clock work from a fleet of medicinal leeches, then a gentle squeeze after the meal or dunking in salty water would cause the leech to regurgitate its dinner and the whole process could be repeated *ad nauseam*.

At the other end of the leech-appreciation spectrum, it is said that common laundry soap lathered and left to dry on the skin will prevent leech attack. Eucalyptus oil is also claimed as a repellent and, if these fail, a slinky pair of pantyhose worn outside the socks and long pants should make the tempting bits difficult to get at.

One evening, when preparing to go out spotlighting mammals in a northern patch of rainforest, I watched with fascination as my mate produced a jar of white powder and began tipping the stuff generously inside his long socks and boots. On asking the obvious, I was told it was leech repellent one of the Museum staff had given him to try out. It was also purported to be effective against ticks and scrub itch, to have no effects on the ozone layer, to shake out of clothing and to biodegrade in 24 hours.

If it worked I would gladly dust myself in it to escape the mess and revulsion of blood and burst leeches that fell out of our boots every night. But as this was just a test run I declined his offer to fill my socks, but promised to watch the progress of the experiment with interest. At the end of the night, true to his word, there were no leeches and no bites... but a familiar breakfast odour coming off his legs. The powder had dissolved in the rain to form a thick white paste that clung to his socks and bogged in his boots like a viscous pikelet batter.

Alas, the danger of packing look-alikes. It was powdered milk! We sat at the table and laughed until the tears ran down onto our unwashed breakfast plates and begged the question... what did we have on our muesli that morning? ■

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Steve Van Dyck is a curator in the Vertebrate Department of the Queensland Museum, where he has worked since 1975.

KATHIE ATKINSON

Bettongs are about the size of a wild rabbit, are stocky in build and pugnacious in disposition.

BURROWING BETTONG

BY JEFF SHORT

IN 1817 THE FRENCH SHIP *URANIE* anchored off Dirk Hartog Island in Shark Bay as part of its exploration of the west coast of Australia. Its crew collected, among other things, a specimen of a small kangaroo unknown to science. It was subsequently described and named after Charles Le Sueur, the artist and naturalist on a previous French expedition to the islands in 1802. It became known as Lesueur's Rat-kangaroo (*Bettongia lesueur*). Today it is more commonly known as the Burrowing Bettong.

This species is unique among the kangaroos in that it lives underground in large communal warren systems or burrows. Bettongs are about the size of a wild rabbit, are stocky in build and pugnacious in disposition. They are strictly nocturnal, sheltering during the day in burrows and foraging widely at night in search of seeds, fruits, flowers, tubers, roots and succulent forbs and grasses. They will often climb into low shrubs to feed.

Bettongs are capable of producing three young per year in captivity. They have a gestation period of 21 days and give birth to a tiny, hairless and undeveloped young weighing less than half a gram. Females mate again on the day after the birth and the resulting fertilised egg remains in arrested development in the uterus of the mother until the pouch young is weaned. Pouch life is about 115 days (approximately four months). Dominant males establish a harem of females, which they defend vigorously against other males.

At the time of the French expedition the Burrowing Bettong had one of the widest distributions of any species of kangaroo. Its range extended from the western slopes of the Great Divide in eastern Australia to the west coast, and from Broome in the tropical north to Albany and Adelaide on the southern coast. Many of the first explorers encountered and commented upon the distinctive warren systems of the bettong. These were characterised by dozens of entrances dug under breaks in surface rock with extensive high mounds of soil around. Burke and Wills encountered them in southern New South Wales on their south–north crossing of Australia in 1860 as did Giles when crossing the great unexplored deserts of central Australia in the 1870s. These warren systems, now occupied by rabbits, are still recognisable today in many parts of outback Australia.

The Burrowing Bettong now survives only as three remnant populations on offshore islands: Bernier and Dorre Islands in Shark Bay, and Barrow Island off the north-west coast of Western Australia; and a recently reintroduced population on the southern shores of Shark Bay in Western Australia. It is absent on Dirk Hartog Island, probably due to a combination of predation from feral cats and the grazing and trampling (of burrows) by sheep. It was also recently lost from Boodie Island off the north-west coast due to an over-enthusiastic attempt by the management authority to rid the island of rats.

It is likely that bettongs were eliminated from mainland Australia by a combination of factors: the alteration of the vegetation understorey by introduced grazers such as sheep and rabbits; direct competition for food and shelter from rabbits; predation from introduced species such as foxes and cats; and changes in land-use practices to either intensive agriculture in the wetter parts of their range or to grasslands in central Australia dominated by natural fire regimes rather than regimes imposed by Aborigines.

In recent years the CSIRO Division of Wildlife and Ecology have conducted surveys of Bernier, Dorre, Barrow and Boodie Islands to establish the size and stability of populations of endangered mammals. Surveys in 1988 and 1989 revealed a population of some 5,000 bettongs distributed between three islands. Barrow Island (240 square kilometres) contained the greatest number with some 3,500 animals. Subsequent surveys have revealed that these populations fluctuate strongly in size, building up steadily over several years of average to above average rainfall and then crashing in drought.

In 1992, 50 years after the last European record of the species on the mainland, bettongs were returned from these last island refuges to the mainland with the transfer of animals from Dorre Island to Heirisson Prong, a peninsula that juts into Shark Bay. The project is a cooperative venture between the local community of Useless Loop, a mining company (Shark Bay Salt Joint Venture Pty Ltd), the CSIRO, and the Agricultural Protection Board of Western Australia. This group is attempting to create a fox- and cat-free area of some 1,200 hectares on Heirisson Prong. This is maintained by a fox-proof fence that runs across the peninsula, a 20-kilometre-wide buffer zone of reduced fox density to the south of the fence maintained by poisoning, and the geography of the peninsula (long and narrow) which limits recolonisation. Within five months after reintroduction, numbers of bettongs in the fledgling colony had increased by over 50 per cent.

This reintroduction may be the first of many. Reintroductions to the Gibson Desert in Western Australia and a sanctuary in South Australia are either planned or under way. If such reintroductions succeed, then perhaps tomorrow the Burrowing Bettong will be as familiar to every Australian as the alien bunny is today. ■

BURROWING BETTONG
Bettongia lesueur

Classification
Family Potoroidae (potoroos, bettongs, rat-kangaroos).

Distribution
In WA, currently on only three offshore islands (Bernier, Dorre and Barrow) and a reintroduced mainland population at Shark Bay.

Behaviour
Nocturnal; live in large communal burrows; harems of females defended by dominant males; feed on grasses and herbs, seeds, fruits, flowers, tubers, roots and fungi.

Threats and Causes of Demise
Predation by cats and foxes; competition for food and shelter by rabbits; grazing and trampling of burrows by sheep; change of land-use practices.

Status
Endangered; occupies less than 1 per cent of its former range.

Jeff Short is a Senior Research Scientist with the CSIRO Division of Wildlife and Ecology based in Perth.

E. BEATON

Queensland school children long ago used Red Ash or 'Soap Tree' to scrub ink stains from their fingers.

BUSH SOAP

BY TIM LOW

After cutting up kangaroo meat or performing other messy tasks, Kakadu Aborigines sometimes pluck the green pods of the silver-leaved 'Strap Wattle' (*Acacia holosericea*) and rub them with water to make a cleansing lather, called andjana, or bush soap. At the end of a long day they may also reach for a cold refreshing can of "andjana", for this is a name they also give to beer, because it too froths up.

In eastern and northern Australia there are various leaves and pods that can be crushed in water to produce soapy lather. The Foam-bark (*Jagera pseudorhus*), a small tree of eastern rainforests, is said to ooze froth from its trunk after rain. During World War I a Foam-bark extract was added to beer and cordials to make them froth; about nine tonnes of bark were gathered for this purpose.

The most famous Australian lather-maker is the Red Ash or 'Soap Tree' (*Alphitonia excelsa*), a common tree of open forests and rainforest margins in eastern Australia. Queensland school children long ago used Red Ash to scrub ink stains from their fingers, and rubbed the leaves on their hands before being given the 'cuts', with the idea of dulling the pain. Aborigines at Weipa call the tree the 'Shampoo Tree', and use the leaves for washing. They can even be used in place of dishwashing liquid.

Soap-making plants contain abundant saponins, natural detergents that probably serve some defensive role in the plant. If the leaves, and in some cases seeds, pods or bark, are finely crushed in water, they increase the water's surface tension, creating a cleansing effect just like that of conventional soaps. Soap plants featured prominently in Aboriginal medicine. In northern Queensland, Red Ash leaves were frothed into a bath for headache sufferers, or the leaves lain on sore eyes for relief. A more effective treatment was probably the green wash made from Strap Wattle leaves or Earpod Wattle (*Acacia auriculiformes*). Said to be cleansing, deodorant and mildly antiseptic, it was a popular treatment for sores in the Top End. A lather from the ripening pods of these wattles, and also from *Acacia pellita* (called 'Soap Bush' on Groote Eylandt), relieved the allergy rashes caused by itchy caterpillars.

Aborigines also used soap plants to poison and catch fish (see ANH Spring 1991). The saponins released by the crushed leaves or bark hurled into pools asphyxiated the fish, which could then be gathered, cooked and eaten. Strap Wattle, Earpod Wattle, Red Ash and Cocky Apple (*Planchonia careya*) were used in this way.

PHOTOS: TIM LOW

Crushed Foam-bark leaves moistened with water produce a lather equal to that of most soaps.

Coastal Saltbush berries have been crushed to make ink, and the leaves burnt to make soap or boiled as a vegetable.

Conventional cakes of soap are made by combining fat or oil with an alkali, in a very simple chemical process. Nowadays chemical alkalis are used, but until the mid 19th century, lye made from the burnt ash of soda-rich plants was used. Tallow from beef or mutton supplied the fat. Colonial households often made their own soap. The Hobart Town Almanac of 1819 suggested making liquid soap "perfectly fit to communicate sufficient whiteness to linen" from the well-burnt ashes of Black Wattle (*Acacia mearnsii*) or she-oaks mixed with "greengum", lime, water and "any rancid grease or fat".

Home hints author Mina Rawson, writing in 1894, gave four soap recipes, concluding that "in the bush every one should make their own soap". By that time chemical alkalis had replaced plant lye, and the main problem was obtaining the fat. Rawson recommended using an old kerosene tin as a fat tin, and filling it with kitchen fat scraps. Rawson even made soap from Dugong oil.

But even in earlier times most soap was made in factories. Native plants

The Earpod Wattle has leaves and pods that Top End Aborigines crushed as 'bush soap'.

were burnt to make the lye, and tallow was supplied by the booming sheep industry. Energetic local soap-makers supplied all the eastern Australian colonies, even exporting soap to England, New Zealand, California and South America.

The best plants for soap are the soda-rich plants of seashores. European soap-makers used kelps and the fleshy-leaved Barilla plant (*Salsola soda*), which in Spain was even cultivated on the southern salt marshes. Australian soap-makers burned a variety of salt-marsh plants for soap (and a few inland species), and some of these also came to be called barilla.

On mainland Australia it was found that burnt wood of the Grey Mangrove (*Avicennia marina*) produced superior soap, and this formed the mainstay of the local industry. Grey Mangrove is the common mangrove with opposite leaves and spike-like aerial roots (pneumatophores) sprouting in mud around the tree.

In the first half of the 19th century, soap factories using Grey Mangrove sprang up in Sydney, Port Phillip Bay and at Moreton Bay, where hapless convicts were forced to fell the trees. Barilla cutters waded barefoot into mosquito-infested swamps, dragging the barnacle-encrusted logs to camps to be burnt.

Geographer Juliet Bird believes the mangroves were grossly overexploited. In Westernport Bay near Melbourne, the trees have disappeared from mud-flats where they were surveyed in 1842.

Mangroves do not grow in Tasmania, and the industry there relied on fleshy seashore shrubs, mainly Grey Saltbush (*Atriplex cinerea*), Coastal Saltbush (*Rhagodia candolleana*) and the samphire *Sclerostegia arbuscula*. Coastal Saltbush and Grey Saltbush were also used by colonists as vegetables, and the latter was a staple food during the Tasmanian famine of 1806–1807.

Tasmania's main soap-maker, Robert Roberts of Bruny Island, ordered in huge shipments of barilla plants from as far away as the Bass Strait islands. A correspondent to the *Hobart Town Gazette* in 1824 suggested the local barilla plants be cultivated and exported. They would bring a better return than wheat, he claimed. Another writer proposed importing European barilla plants for settlers to grow on the sea coasts. Nothing came of this.

In the late 19th century, botanists and chemists hoped eucalypts would find a place in soap-making. At the London International Exhibition of 1862, aromatic oils of peppermints (*Eucalyptus* species) were used to scent soap, although the perfume was considered by some to be "more peculiar than agreeable". Therapeutic eucalyptus soaps were displayed before the Royal Society of Queensland in 1896. The soaps, for diseased skin, were made from fat, soda, "vegetable slime", and water in which young eucalypt branches and twigs had been boiled.

The history of soap plants in Australia shows that, in the quest for cleanliness, Australians were extremely inventive, using a remarkable variety of plants in a range of different ways. ■

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Tim Low is a Brisbane-based environmental consultant and the author of four books about edible and medicinal plants.

FISH CAPERS AT CAPE CUVIER

BY BARRY HUTCHINS

Spectacular film footage showed sharks and whales swimming through the two-kilometre-long school engulfing large mouthfuls of fish.

IN FRONT OF ME, A SOLID WALL OF fish had appeared, anchovies stretching as far as I could see. The barrier parted as I pushed into the myriads of tiny fish, only to reform behind me like a silvery amoeba engulfing its victim. I swam on, the wall of fish rolling slowly away on either side. A break suddenly appeared to reveal another interloper coming towards me, a whaler shark with a mouthful of fish. For a brief instant, we stared at each other and then it was gone.

I surfaced to check my position. The dark green of the school was contrasted against the clear turquoise colour of the surrounding water. I could see that the school stretched at least 50 metres on either side of me, and was about 25 metres at the widest point. It seemed to be trapped against the shoreline, although few predators were visible. I dived back through the school to the sandy bottom; little light was getting through the thick layer of fish above, making it quite dark. A school of Tailor (*Pomatomus saltator*) swam around me, followed by another whaler shark; I was now convinced I had seen enough.

My thoughts once again returned to the present, the memory of this dive fading just as the TV news commentator was concluding his report. It was June 1993, and an exciting new phenomenon had been discovered in Western Australia: a huge school of baitfish was trapped against the shoreline at Cape Cuvier, just below the Tropic of Capricorn, and was being devoured by numerous large predators. Spectacular film footage showed sharks and whales swimming through the two-kilometre-long school engulfing large mouthfuls of fish. These images had reminded me of my earlier encounter with the school of anchovies. The latter had taken place in Turtle Bay, a rather remote location at the northern end of Dirk Hartog Island, which forms the western border of Shark Bay. Cape Cuvier is only about 150 kilometres to the north, so surely both sightings involved the same phenomenon? However, judging by the television report, the Cape Cuvier event involved many more predators feeding on a much larger school than I had seen at Turtle Bay.

Other viewers of this television program rang the Western Australian Museum to say they had witnessed similar occurrences. The sightings ranged from as far south as Cervantes (just to the north of Perth) to Exmouth Gulf at the north-western corner of the State. The earliest reliable report concerned an observation in 1945, although a lady in her eighties remembered seeing something similar when she was a young girl. Most mentioned schools of baitfish being rounded up and forced against the shoreline by predators such as sharks, trevallies and tunas, during late autumn and winter.

Subsequently I received some specimens from the Cape Cuvier school; these proved to be the same species I had seen at Turtle Bay, namely the Australian Anchovy (*Engraulis australis*). This species normally inhabits inlets, embayments and estuaries of Australia's southern half. Adults are known to move out to sea in winter, where they form compact schools close to the coast. Here they are constantly preyed upon by larger predators,

PHOTO INDEX

Surrounded by a sea of plenty, these sharks will gorge themselves on anchovies until the weather changes and the school disperses.

including sharks, tunas, trevallies, mackerels, Tailor, dolphins, turtles and seabirds. The depleted schools of anchovies eventually return to the inlets in spring, where spawning probably commences with the approach of summer.

It seems likely that the Cape Cuvier school of anchovies originated from Shark Bay, a large embayment to the south of the Cape. Furthermore, because of the favourable winds that occur in this area during May and June (winds are generally lighter and tend to blow offshore), schools of baitfish can be easily pushed by predators into the shallow waters along the coastline. This makes them easier to feed upon than in more offshore waters where the schools have a better chance of escape. However, the passing of the next cold front with its accompanying south-westerly swells makes these inshore waters a dangerous place for both predator and prey, and the schools of anchovies then scatter to reform further offshore.

Held by predators against the Cape Cuvier shoreline, this massive school of anchovies turns the water black.

Last year (1993) an offshore easterly wind blew for much of June, thus enabling the predators to hold the anchovy school against the Cape Cuvier shoreline for the whole month. But why was the school so large?

Research conducted by the Fisheries Department of Western Australia on the snapper that inhabit Shark Bay suggested that the previous (1992–1993) season was particularly productive. The fish were noticeably fatter than in other years, indicating they had had more to eat. Obviously this was reflected by the larger number of anchovies heading out to sea, which tended to form much larger schools than before. These in turn attracted a larger array of predators. Combined with the favourable weather conditions and the ready accessibility of the Cape Cuvier area, this had made the event a public spectacle.

Will this phenomenon occur again this year? There seems little doubt that the schools of anchovies must make an annual migration out of the bay. However, unless the schools are very large, and are subsequently pushed by the predators into an easily accessible location, then, as in past years, it will probably not attract much attention. ■

Dr Barry Hutchins is a curator in the Department of Aquatic Vertebrates at the Western Australian Museum.

PATRICK BAKER/LOCHMAN TRANSPARENCIES

DAVID MALIN/COURTESY ANGLO-AUSTRALIAN OBSERVATORY

28

FOUR

Somewhere between 90 and 99 per cent of the matter in the universe is completely invisible.

WHERE IS THE REST OF THE UNIVERSE?

BY GEOFF McNAMARA

"THE DARK MATTER PROBLEM IS really one of the most pressing problems in physics and astronomy at the moment", remarked one of the astronomers. We were standing under the 1.2-metre Great Melbourne Telescope at Mt Stromlo Observatory near Canberra. The Great Melbourne Telescope was built in Dublin in 1868 for the Victorian Government, and was the first of Australia's 'big' telescopes. But the telescope was plagued with mechanical and optical failures, and eventually sold to Mt Stromlo Observatory for scrap value in 1947. Now the Great Melbourne Telescope has been lovingly refurbished and outfitted with state-of-the-art equipment for one of the most important searches of all time—the search for dark matter.

CARL BENTO/AUSTRALIAN MUSEUM

Despite the fact that our skies appear to be full to overflowing, most of the universe is completely invisible. Above: Two of the scientists involved in trying to discover exactly what the rest of the universe is made of.

Dark matter is the name given to the as yet undiscovered matter that makes up most of the universe. The issue is not so much about finding the dark matter: astronomers know the location of the dark matter from its influence on visible objects like stars and galaxies. It's more about discovering what it's made of. The astronomer went on: "...this could be the beginning of the ultimate Copernican revolution in that we're not at the centre of the solar system; we're not at the centre of the universe; in fact we may not be made of the same stuff as the rest of the universe".

Originally intended for scrap, the Great Melbourne Telescope is now an integral player in one of the most important astrological searches of our time—the search for dark matter.

COURTESY MOUNT STROMLO OBSERVATORY

OUR AWARENESS OF THE NATURE OF the universe has come a long way since the invention of the telescope. The world view that people held well into the 17th century was based on Aristotle's idea* that the Earth was at the centre of the universe. This geocentric model was based on the only observations available at the time: to the early astronomers, Earth stayed still while everything in the night (and daytime) sky moved around it. Aristotle's idea was that the Sun, the Moon and the stars were all attached to transparent crystal spheres that were centred on Earth.

The crystal spheres were shattered in 1609 when the Italian physicist Galileo Galilei first turned his telescope on the heavens. There he saw things that just couldn't be explained by the old ideas of Aristotle and Ptolemy. Galileo saw moons revolving around the planet Jupiter, and craters and mountains on our own Moon, proving that the Moon was just like Earth, and not some divine celestial entity. Observations like these convinced Galileo that the Sun, not the Earth, was the centre of the universe.

Since then, our ideas about the universe have been continually adjusted to fit newer, better observations. The picture we now have is something like this. Earth is one of nine planets that orbit a fairly common star we call the Sun. Together with comets, asteroids and other objects, the planets and the Sun are called the solar system.

** The idea of an Earth-centred universe was suggested by Parmenides (born about 514 BC), developed by Eudoxus (408–355 BC), and matured into the crystal spheres by Aristotle (384–322 BC). Aristotle's model was further developed by Ptolemy (2nd century AD), whose ideas reigned for centuries.*

The stars you see in the night sky are simply other suns, and are part of a disc-shaped collection of stars and gas called the Milky Way galaxy. The Milky Way contains some 100 billion stars, and stretches for 100,000 light years from side to side. (A light year is the distance light travels in one year, about a billion kilometres.)

The Milky Way can best be seen from the country, where the night skies haven't yet been polluted by the bright lights of cities and towns. From places like national parks, the Milky Way can be seen as a bright band that stretches from horizon to horizon. We see the Milky Way as a band because we're inside it. Like an ant in a dinner plate, we don't see the circular shape of the Milky Way, just a band of stars completely encircling us. By the turn of the century, astronomers had seen other galaxies, or 'nebulae', but they were thought to be part of our own Milky Way. Then, in the 1920s, the American astronomer Edwin Hubble showed that these 'nebulae' were, in fact, galaxies just like the Milky Way.

This single discovery magnified the size of the universe in the minds of astronomers. Now the universe was more than just the Milky Way. Our galaxy had become one among thousands of others. Instead of a universe measured in thousands of light years, now it was measured in millions. And, with the development of larger telescopes and more sensitive detectors, it was soon measured in billions of light years.

Large bubbles of relatively few galaxies are surrounded by giant sheets of thousands of galaxies. As one of my astronomy students once remarked, "the universe is an aerobar".

Just as stars form groups called galaxies, so the galaxies are in clusters of galaxies. The Milky Way is part of a cluster called the Local Group. The Local Group consists of two large galaxies—the Milky Way and the Andromeda Galaxy—and two dozen or so smaller galaxies. In addition, there are two 'irregular' galaxies that orbit the Milky Way, the Large and Small Magellanic Clouds.

Clusters of galaxies tend to gather together into larger groups called superclusters containing millions of galaxies. Beyond the scale of superclusters, the universe takes on a foamy appearance. Large bubbles of relatively few galaxies are surrounded by giant sheets of thousands of galaxies. As one of my astronomy students once remarked, "the universe is an aerobar".

While Hubble was revealing the scale of the universe, another American astronomer, Fritz Zwicky, was looking at its motion. Astronomers had known since the time of Newton that gravity was the dominant force in the universe. The Earth orbits the Sun, for example, because the Sun's gravity attracts the Earth, balancing the centrifugal force of

DAVID MALIN/COURTESY ANGLO-AUSTRALIAN OBSERVATORY

Because we are in it, we see the Milky Way galaxy as a band rather than its true shape, which is similar to this spiral galaxy.

DAVID MALIN/COURTESY ROE/ANGLO-AUSTRALIAN OBSERVATORY

Just as stars form groups known as galaxies, galaxies form groups known as clusters. We are part of a cluster known as the Local Group and shown here is our nearest large cluster neighbour, the Virgo cluster, which is moving away from us at a speed of 1,000 kilometres per second.

the Earth's motion around the Sun. This prevents Earth from flying off into space.

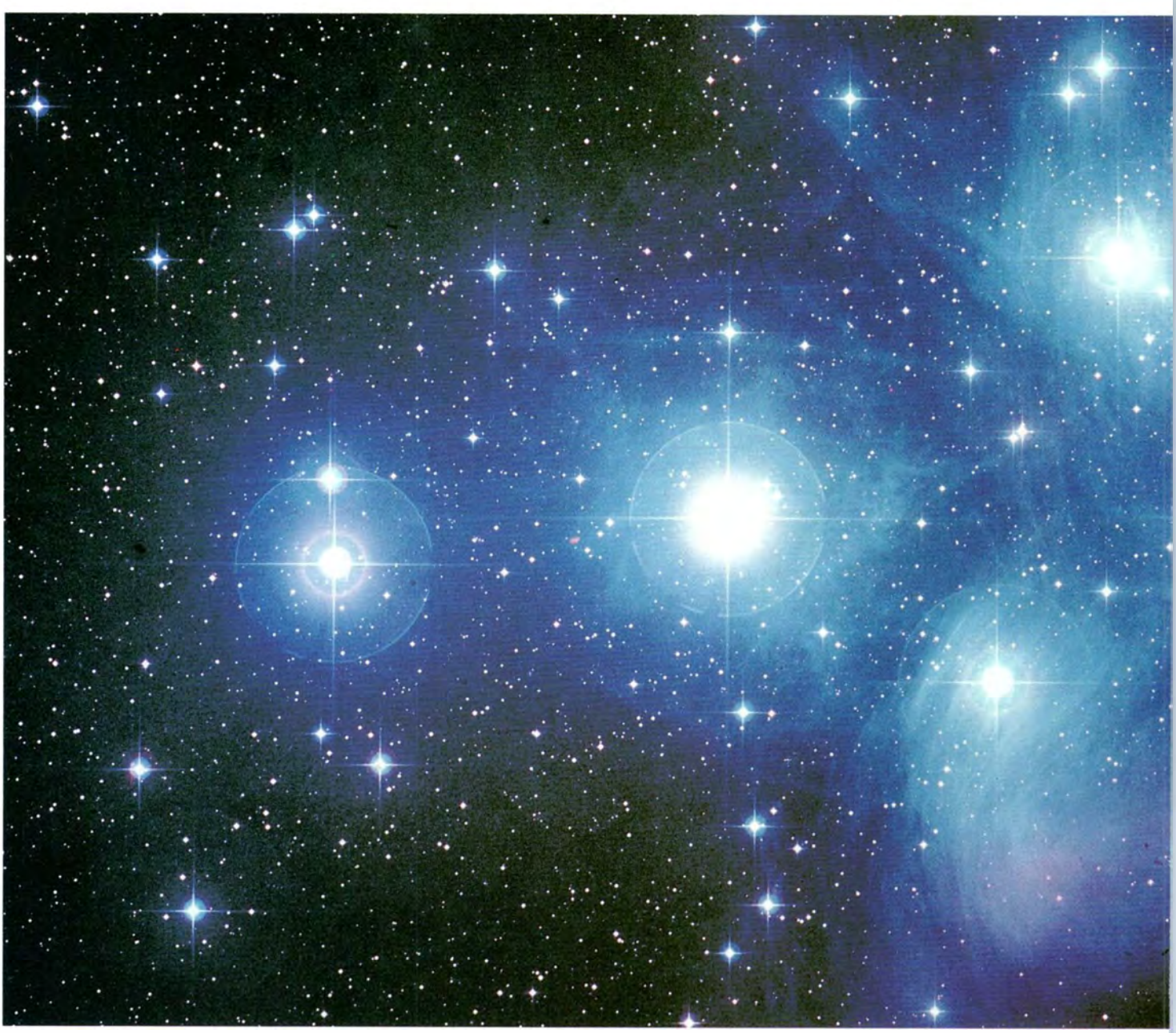
Galaxies stay in clusters for the same reason: their mutual gravitational attraction counteracts the motion of the individual galaxies. But when Zwicky observed the motions of galaxies he found them moving too fast. At the speed the galaxies were travelling, the clusters should have dispersed long ago. What was keeping them together?

There was only one solution to the puzzle: in order to keep the galaxies together, there had to be more gravity, and that meant more matter...'dark matter' that neither Zwicky nor anyone else could see.

Astronomers began to encounter dark matter almost everywhere they looked. One of the most convincing pieces of evidence came from the study of spiral galaxies like the Milky Way. You can demonstrate the motion of a spiral galaxy next time you have a cup of coffee. When you stir in the milk, a spiral pattern often forms on the surface. As the coffee rotates in the mug, the inner parts of the spiral will rotate faster than the outer edges.

The same was expected of spiral galaxies: the stars in the outer regions of the galaxies should be moving more slowly than those closer in. But astronomers found the outer stars keeping up with the motion of the inner stars. The only way to explain this motion is to have large amounts of mass in a halo surrounding the galaxy.

As astronomers looked at larger and larger structures in the universe, the conclusion was inescapable: somewhere between 90 and 99 per cent of the matter in the universe is completely invisible.



DAVID MALIN/COURTESY ROE/ANGLO-AUSTRALIAN OBSERVATORY

The Pleiades star cluster is a spectacular example of the luminous matter that makes up the visible universe. The important question is, however, what makes up the invisible universe?

SO WHAT CAN THIS MATTER BE? DARK matter candidates fall into two classes. One is baryonic matter, the same type of matter that makes up the magazine you're holding, and indeed you. All baryonic matter contains the elementary particles known as nucleons and hyperons. The other is non-baryonic, which is made of particles that haven't been discovered yet. One of the favourite types of non-baryonic matter is called a WIMP, which is short for Weakly Interacting Massive Particle. WIMPs are subatomic particles left over from the Big Bang, the explosion in which the universe began some 10 to 20 billion years ago. Because WIMPs interact only feebly with matter, instruments designed to detect them need to be very sensitive. To protect the detectors from interference, scientists conduct their experiments deep below the surface of the Earth. Experiments to detect WIMPs are currently being conducted down kilometre-deep mine shafts around the world.

Of the baryonic matter candidates, the most promising are MACHOs—Massive Astrophysical Compact Halo Objects. The exact nature of these objects is unknown. They could be planet-like objects about the size of Jupiter (about a hundredth of the mass of the Sun), or they could be 'dead' stars, stars that have long ago used up their nuclear fuel and stopped shining. MACHOs might even be black holes, objects so dense that not even light can escape from them.

How do you look for something that can't be seen? You look for its effects on things you can see. Although the evidence for dark matter initially came from dynamical studies, gravity affects more than just the movement of stars and galaxies; gravity also distorts their *light*.

The bending of light by gravity was one of the major triumphs of the General Theory of Relativity put for-

Experiments to detect WIMPs are currently being conducted down kilometre-deep mine shafts around the world.

ward by Albert Einstein in 1916. This theory predicted that the gravity of a massive body would deviate light from a background source.

When the British astronomer Arthur Eddington heard of the General Theory of Relativity, he immediately started making plans to test its predictions. Eddington decided to use the most massive object at hand—the Sun. According to Einstein, the light from the stars near the Sun would be bent, shifting their apparent position like a celestial image.

Because of sunlight reflecting off our atmosphere, the stars are normally invisible in the daytime sky. But during a total solar eclipse, the Moon covers the Sun, and the stars become visible in the darkened sky. This allows astronomers to photograph the stars near the Sun, and then to compare these 'apparent' positions with their known fixed positions.

Eddington organised two expeditions to observe the total solar eclipse of 1919, himself leading one of the teams to the island of Principe, off the west coast of Africa. The other expedition was sent to northern Brazil. Two expeditions were mounted to improve the chances of seeing the eclipse: should one team experience cloud during the eclipse, it was hoped that the other would have clear skies. As it turned out, both teams experienced clear weather. When the eclipse photographs from the two teams were measured, the displacement of the star images near the Sun was almost exactly the same as predicted by Einstein.

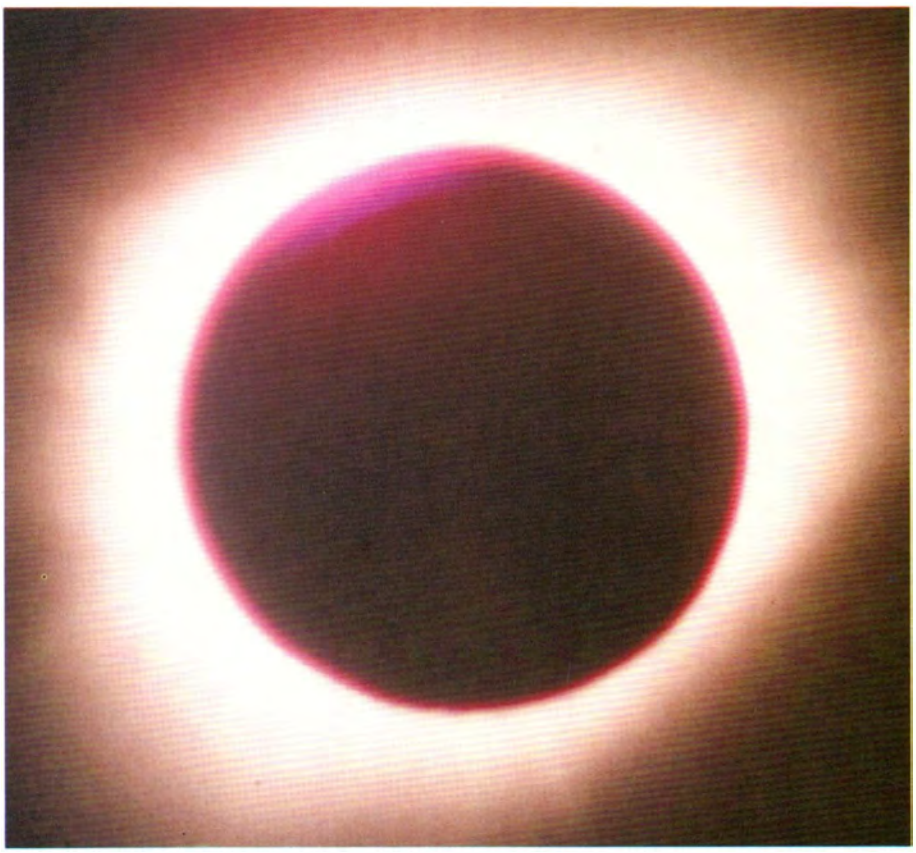
And so it was shown that the gravity of a massive object would distort the image of a background light source...whether the foreground object is visible or not. This is the key to searching for dark matter. Like the silhouette of a dark object against a bright background, dark matter by its very nature must influence the light of background objects.

Astronomers know dark matter exists in halos around galaxies, including the Milky Way. In the form of MACHOs, dark matter should influence the light of background objects. What was needed was a background light source against which to search for MACHOs. Astronomers found such a background source in the southern skies, a nearby galaxy called the Large Magellanic Cloud.

This is where the team of MACHO astronomers comes in. The team is made up of 15 astronomers from Mt Stromlo Observatory near Canberra, and the Centre for Particle Astrophysics and the Lawrence Livermore National Laboratory, both in the United States. The MACHO astronomers are searching for MACHOs between Earth and the Large Magellanic Cloud using the Great Melbourne Telescope at Mt Stromlo.

So what does the MACHO team hope to see? When a MACHO passes between us and a star in the Large

Gravity of a massive object, whether visible like the Sun or invisible like dark matter, can bend the light of nearby stars. The effect of the Sun's gravity on the apparent position of stars can be measured during a solar eclipse.



L.F. & O.G. SCHICK

CARL BENTO/AUSTRALIAN MUSEUM

Mount Stromlo Observatory near Canberra has already sighted at least one probable MACHO event.

Magellanic Cloud, the star's light will be distorted for a short time. This 'gravitational lensing' makes the star appear temporarily brighter. By watching the stars in the Large Magellanic Cloud, the MACHO team hopes to catch a MACHO in the act of passing in front of a star.

There are millions of stars in the Large Magellanic Cloud, so the chances of a MACHO lining up between us and one of those stars should be, well, astronomical. So the MACHO team had to develop an enormous detector (indeed the largest ever built) that was capable of looking at as many stars as possible during any one night. Attached to the 1.2-metre telescope, it receives the star images on what is essentially electronic film. The images are then recorded on video tape and a computer measures them for brightness. The recorded data is then searched for any changes in the brightness of the individual stars.

The detector is capable of watching up to 500,000 stars at once, and a series of ten million stars is being observed every clear night. It's important to observe each star at least once a night since some MACHO 'events' can last for less than a day.

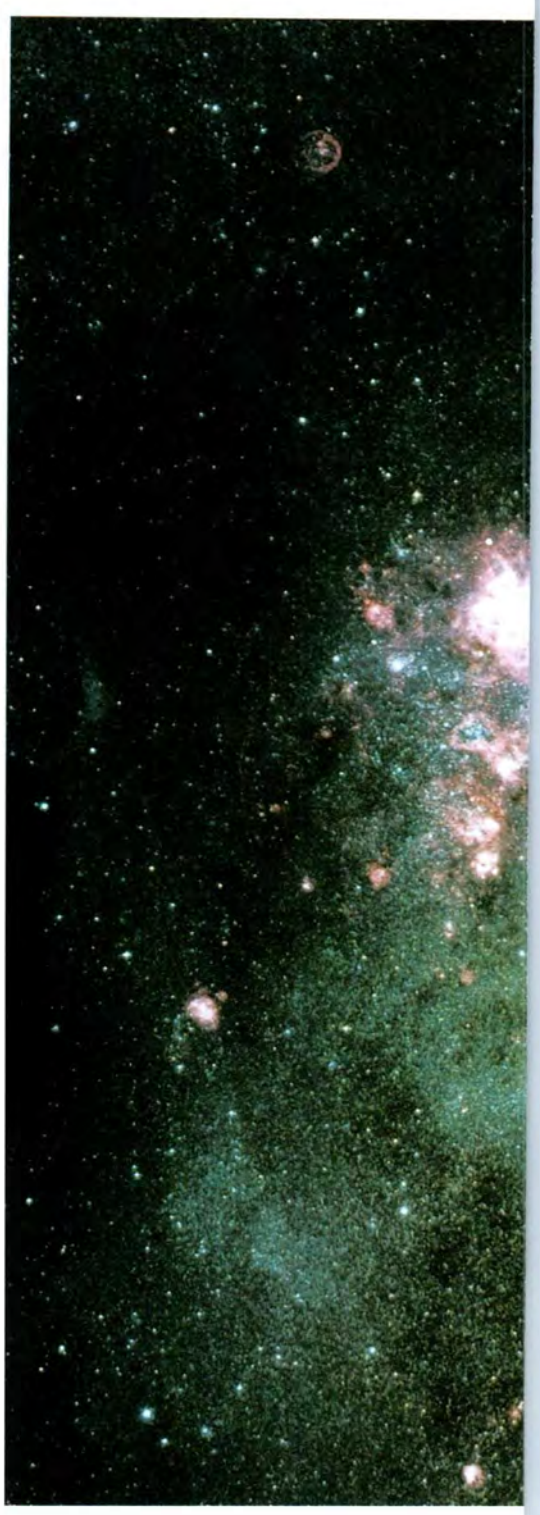
The MACHO program has been running since mid 1992 and will run for four years. In the first year of the project, there was at least one probable MACHO event, demonstrating that the experiment is working. "There is no question that this remarkable event occurred", comments Charles Alcock, leader of the MACHO team, "but now we have to keep working to find more of them". At this stage, there's no way of telling how many MACHOs are out there or how much they account for the galaxy's dark matter.

In a thousand years, our descendants may look back at our time and wonder how it must have felt not knowing what 90 per cent of the universe is made of.

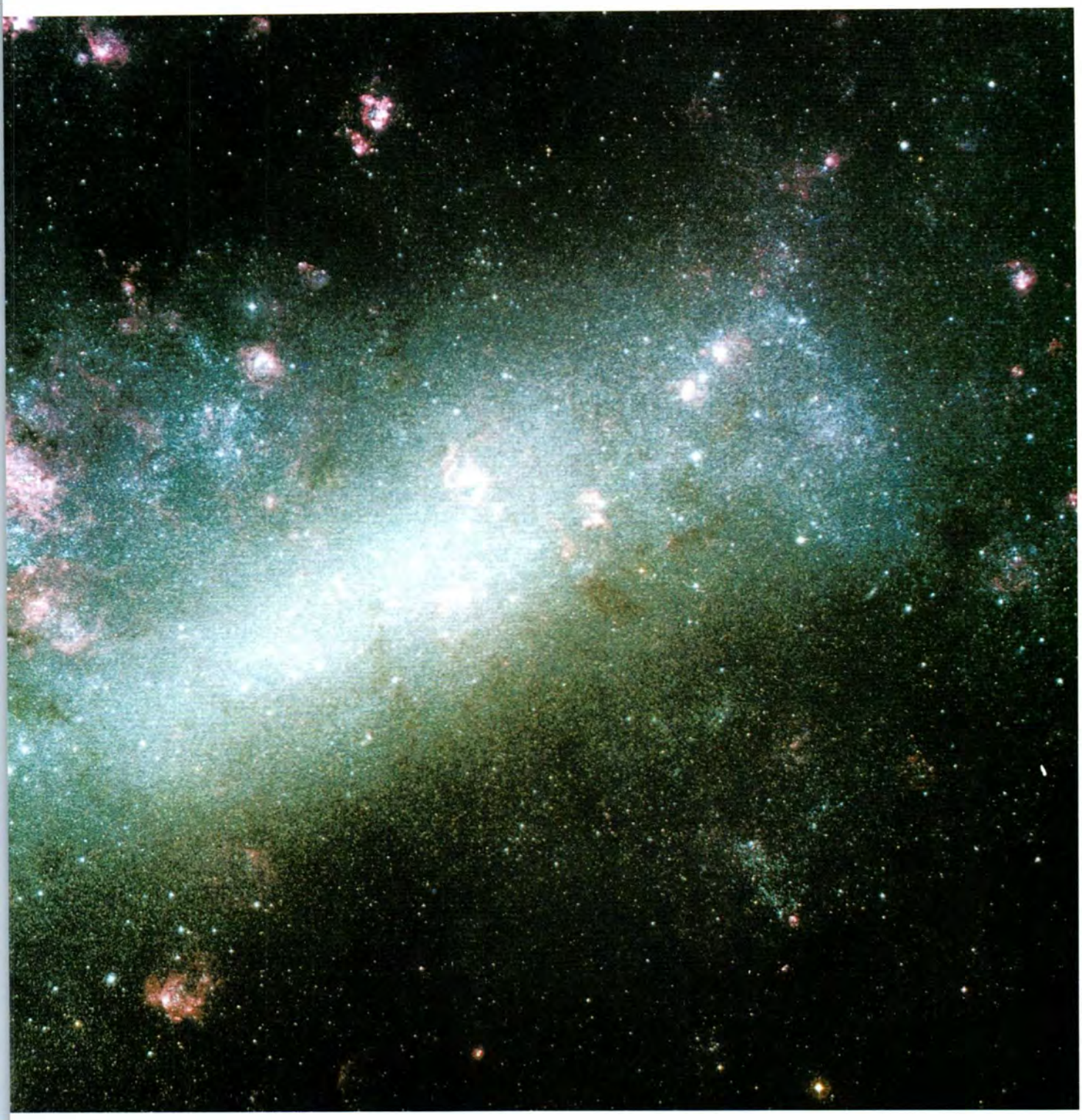
THE DISCOVERY OF DARK MATTER WILL tell us more than just the nature of the universe. The amount of dark matter will determine its fate. The universe has been expanding since the Big Bang, and so the question arises: will it keep on expanding? Like a stretching rubber band, the gravity of the matter in the universe is resisting its expansion.

The density of matter needed to stop the universe from expanding forever is called the critical density. So far, the visible matter only adds up to a few per cent of the critical density, but the addition of dark matter could tip the cosmic scale.

By themselves, MACHOs can't halt the expansion of the universe, but astronomers expect the total mass of the universe will eventually add up to the critical density. This expectation is



Along with large galaxies such as the Milky Way and the Andromeda Galaxy there are 'irregular' galaxies. These are galaxies that have no ordered structure and this one, known as the Large Magellanic Cloud, lies only 160,000 light years away.



DAVID MALIN/COURTESY ROE/ANGLO-AUSTRALIAN OBSERVATORY

based not only on the best theories currently available, but also an aesthetic desire to see nature display simple symmetry: a delicate balance between the expansion of the universe, and the gravity needed to one day halt that expansion.

Back in the days of Aristotle, astronomers wondered what held the stars and planets up in the sky. The solution Aristotle came up with was a set of crystal spheres. We look back on this explanation with a much clearer understanding of the real nature of the universe. In a thousand years, our descendants may look back at our time and wonder how it must have felt not knowing what 90 per cent of the universe is made of. ■

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Geoff McNamara has been involved in public education in astronomy for about ten years. He is a Contributing Editor to Sky & Space *magazine, and writes and produces a weekly radio segment called "The Sky This Week". He would like to extend special thanks to MACHO astronomers Prof. Ken Freeman, Dr Peter Quinn and Dr Chris Stubbs for an opportunity to see history being made.*

A newly hatched pelican must vie for the title of the ugliest young of any bird.

PELICANS

BY WALTER BOLES

PELICANS ARE AMONG THE most familiar of birds. In coastal areas pelicans are a common sight, loafing, swimming or standing expectantly for a handout. They feature in the mythology and folklore of many countries, and appear frequently as collectables, cartoon characters and trademarks. This ease of recognition is directly related to what is undoubtedly the most characteristic feature of pelicans: the elongated bill with its massive gular (throat) pouch. More than any other character, it is this unique bill that makes pelicans among the most distinctive birds in the world and permits instant recognition. While obviously related to feeding, the bill and pouch are integral parts of many facets of a pelican's life.

CHERIE VASAS/ NATURE, TRAVEL & MARINE IMAGES

Making use of its characteristic pouch, this pelican collects drinking water from a park sprinkler.

Approaching half a metre in length in the larger species, the bill is equipped with a formidable hook at the end of the upper mandible. The pelican's bill is also sensitive and this helps to locate fish in murky water. The pouch does not function as a place to hold food for any length of time; instead it serves as a short-term collecting organ. When a food item is caught, the pelican manipulates it in the bill until the prey is properly oriented, usually with the head pointing down the throat, and then swallows it with a jerk of the head. The pouch can also serve as a net to catch tossed handouts, and there are observations of pelicans drinking by opening the bill and using it as a rainwater collector. When fully extended, it can hold up to 13 litres! Despite this capacity, the bill is a delicate construction with the lower jaw, from which the pouch hangs, consisting of two thin and weakly articulated bones. Maintaining the flexibility of the pouch requires a series of bizarre contortions that stretch it in different directions. In one, a bird opens its mouth wide and literally turns itself inside out by bringing the pouch down over the upper chest. In another manoeuvre, the bird straightens its neck and pulls its head backwards, thus stretching the pouch in the lengthwise direction.

HORIZON

AUSTRALIAN PELICAN

Pelecanus conspicillatus

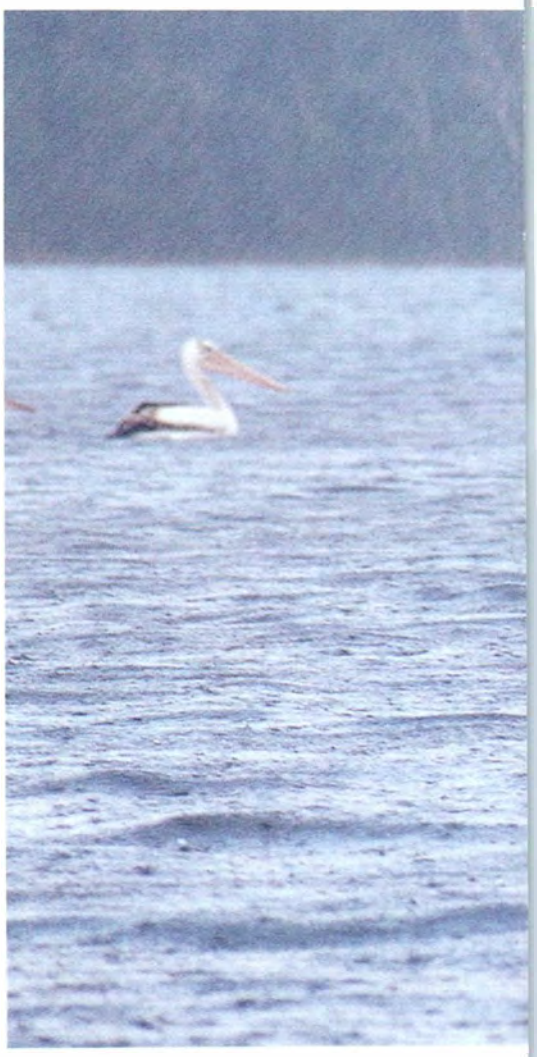
Distribution
Australia, Papua New Guinea and western Indonesia, accidentally reaching New Zealand and various western Pacific islands. In Australia it is widespread on both coastal and inland waters, avoiding the western deserts, and breeds at scattered localities on inland lakes, swamps and rivers, and coastal islands and shores.

Habitat
Wetlands and waterways; freshwater, estuarine and marine.

Identification
Large gular pouch; mainly white with black on wings and tail; steel grey legs; body length 1.6–1.8 metres; wingspan 2.3–2.5 metres; bill length 40–50 centimetres; mass 4.0–6.8 kilograms; males larger than females, particularly in bill length; immature birds brown where the adult is black and with straw-coloured legs.

Food
Mainly fish, but other aquatic vertebrates taken, as well as a variety of handouts.

Breeding
Nesting recorded at all months, depending on conditions; bill, pouch and skin of face become more brightly coloured; colonies formed on islands or secluded shores; nests consist of scrape on ground, often lined with vegetation or other debris; clutch size usually 1–2, rarely 3; eggs white when laid but soon become discoloured; incubation alternately by both sexes for 32–35 days; eggs held on feet of parent; chicks naked on hatching, soon covered in white down; young leave nests to form creches at about 25 days and stay until able to fly; adult size reached at about 2 months; first attempts to fly at about 3 months.



In order to quench its thirst, this pelican uses its bill to collect rainwater.

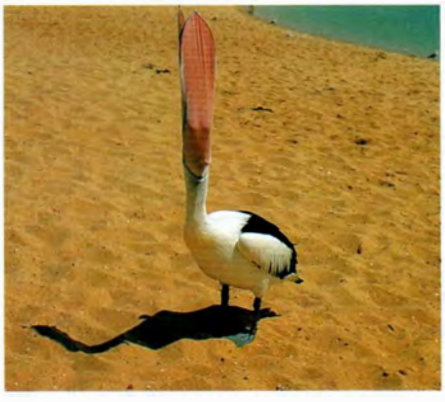
The bill certainly contributes to the comical appearance of pelicans, yet this is contrasted by their grace on the water or in flight. The control and precision that pelicans possess are well illustrated when a bird lands on the surface of calm water. Using its huge wings and broad webbed feet as air brakes, it skis to a gentle rest. And it is this juxtaposition of grace and mild ludicrousness, together with their large size and confiding nature (when not harassed), that have made pelicans popular cultural figures.

LIKE MOST LARGE BIRDS, PELICANS HAVE undergone a worldwide decline, although most species are not globally threatened. The causes for these population reductions are related to human activity. Several species have figured heavily as local sources for food, fat or feathers, or have been destroyed by fishermen who regard them as competitors to their livelihood. Australia is fortunate that its native species, the Australian Pelican (*Pelecanus conspicillatus*), still exists in healthy numbers. Today, direct human predation is

DAVID TURNER

almost nonexistent and culling is rare. Although the absence of human persecution is an obvious benefit to this species, the Australian Pelican has been very much a contributor to its own success. Foremost among the traits working for this species is its ability to react quickly to changing conditions and to exploit some of these to its benefit. Australia, with its arid environment and often unpredictable climate, has placed a premium on the evolution of such opportunism. Conditions suitable to provide the birds' needs can be irregular, thus demanding a capacity to move rapidly from an area of insufficiency to one of plenty.

The large wings that bestow pelicans with both power and grace in flight are absolutely crucial for such rapid and often large-scale movements. So too is their extremely light skeleton. In a 13-kilogram bird, the skeleton may weigh less than one kilogram. Although not capable of sustained flapping flight, pelicans can nonetheless remain aloft for 24 hours, covering hundreds of kilometres. They are excellent soarers and can use thermals to rise to considerable altitudes. Flight at 1,000 metres is common, and heights of 3,000 metres have been recorded. By moving from one thermal to the next, pelicans can travel long distances with a minimum of effort, reaching air speeds of up to 56 kilometres per hour.



They may look bizarre, but these exercises are serious business and enable the pelican to keep its pouch flexible.

This mobility permits pelicans to search out suitable areas of water and, as a consequence, an adequate supply of food. Fish are the primary prey actively caught, but other aquatic animals, such as crustaceans, tadpoles and turtles, may be eaten. The Australian Pelican may feed alone, but more commonly feeds as a cooperative group. Sometimes these groups may be quite large, with one recorded feeding assemblage comprising over 1,900 birds! A flock of pelicans works in unison, herding schools of fish into shallow water or surrounding them in an ever-decreasing circle, driving them into a concentrated mass with their bills and sometimes beating wings. Once the fish are concentrated, the pelicans plunge their bills into the water, using the pouches as nets. Once something is caught, a pelican draws its pouch to its breast. This evacuates the water and allows the bird to manoeuvre

CHERIE VASAS/NATURE, TRAVEL & MARINE IMAGES

KEVIN DEACON

the prey into a swallowing position.

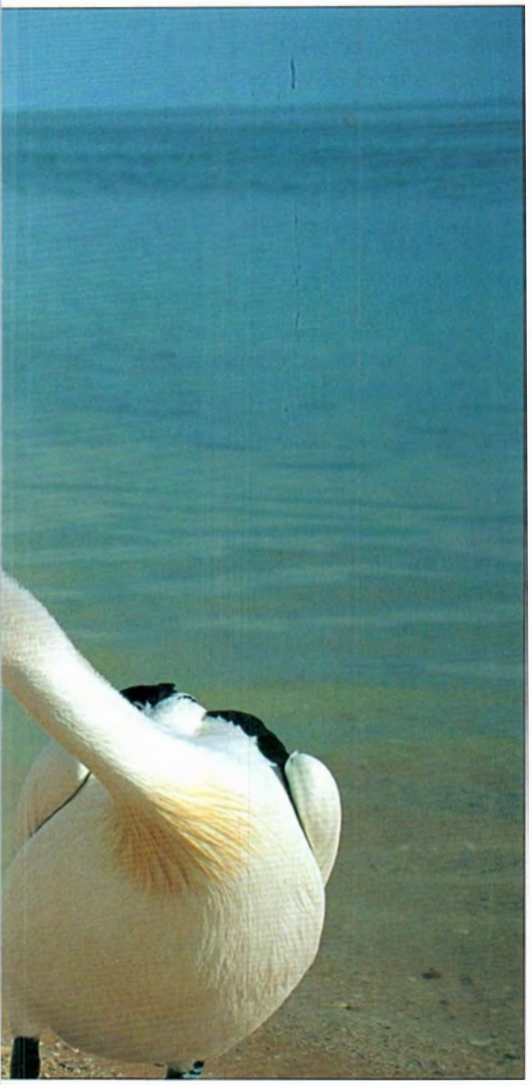
It is in the acquisition of food that pelicans demonstrate one way in which they can turn a situation to their advantage. They are nothing if not opportunistic in their feeding habits (see Pelican Lunch Box). In some areas, pelicans are able to exploit handouts from humans, deliberate or otherwise, as an important component of their diet. Unfortunately, this practice has also led to claims of competition with fishermen. Pelicans have been accused of having significant detrimental effects on the fish available to commercial operations, which has stimulated the occasional call for official control (see Cull of the Wild box).

COURTSHIP IN THE AUSTRALIAN PELICAN IS an impressive sight. The sequence begins with the female leading potential suitors (two to eight or more) around the colony. As they follow her in these walks, the males threaten each other while also attempting to attract her attention by swinging their open bills from side to side. They may also pick up a small object, like a stick or dry fish, toss it in the air and catch it again, repeating the sequence several times. Both sexes perform pouch-rippling in which they clap their bills shut several times a second and the pouch ripples like a flag in a strong breeze. As the courtship parade progresses, the males drop out one by one. Finally, after pursuits on land, water or in the air, only a single male is left. The female leads him to a potential nest site. The couple strut slowly, with bodies held upright, heads raised and bills lowered, deliberately lifting their feet high with each stride.

Both sexes perform pouch-rippling in which they clap their bills shut several times a second and the pouch ripples like a flag in a strong breeze.

During the courtship period, which can take place in any month of the year provided conditions are favourable, the bill and pouch of the birds change colour dramatically. The forward half of the pouch becomes bright salmon pink, while the skin of the pouch in the throat region turns chrome yellow. Parts of the top and base of the bill change to cobalt blue, and a black diagonal strip appears from the base to the tip. This colour change is of short duration, the intensity usually subsiding by the time incubation starts.

The pelicans waste little time once they have chosen a nest site. The female makes a scrape in the ground with her bill and feet, and collects any suitable material (vegetation scraps, feathers etc.) within reach of the nest. Often this includes some or all of a neighbour's nest! Such attempts at thievery can lead to fights between nesting pairs. Within three days egg-laying begins, with both parents taking turns in the incubation. Between one and three eggs are laid two to three



The bill is an important focus of aggressive encounters between adults. Displays include gaping and pointing.

days apart. The first-hatched chick is substantially larger than its siblings. It receives most of the food and may even attack and kill its nest mates.

The striking appearance of the adult bird is not foreshadowed by the chicks. A newly hatched pelican must vie for the title of the ugliest young of any bird: the bill is a grotesque protuberance, the eyes bulge, and the skin has the appearance of small-grained bubble plastic. No two pelican chicks are exactly alike, the skin around the face is mottled with black to varying degrees and the colour of the eyes varies from white to dark brown. This individual variation helps the parents to recognise their chick from hundreds of others.

When being fed, a chick literally sticks its head down the parent's throat to get the food. This transfer can take several minutes, ending with the parent drawing away with a toss of the head. Then something peculiar happens. The chick goes into convulsions, during which it will bite anything within reach, including its own appendages. With a leg or wing still in its mouth, the bird collapses to the ground. These attacks are not fatal and usually within a few minutes the young pelican recovers, seemingly unaffected by the ordeal. The function of this bizarre action is not understood. Some scientists have suggested it occurs because the chicks are unable to breathe properly while eating; it may also be a means of retaining the adult's attention.

After about a month the chicks leave the nest to form creches of up to 100 birds. There they remain for about two months, by which time they have learnt to fly and are fairly independent. The purpose of these creches is not understood. It is probably not for warmth, as pelican colonies always occur in exposed, often hot situations, and many of the chicks must pant to keep cool. Perhaps it is a safety device, granting protection against predators and keeping the stray chicks from wandering near incubating adults, which may attack and even kill them.

For pelicans, the greatest mortality occurs in the first year of life but, if a bird survives, the chances of a long life are good. Captive birds, in the absence of predators and environmental stresses, have been known to achieve an age of over 50 years, while wild birds may live between ten and possibly 25 years or more.

THERE ARE MANY REASONS WHY THE normal sequence of breeding events may fail. Predation and other forms of interference (human and otherwise), destruction of eggs by displaying adult pelicans, and rises or falls in water level can all result in breeding failure.

The uncertainty of these various perils makes the 1990 breeding success at an inland Australian colony remarkable. In early 1990, South Australian ornithologists Max Waterman and John Read began banding chicks at an exceptionally large colony on three islands in Lake Eyre South. The breed-

FORD KRISTO

PELICAN LUNCH BOX

Although fish comprise the primary food of the Australian Pelican, these birds have been recorded eating a range of unusual items. During periods of starvation, they have been reported capturing and eating Silver Gulls and ducklings. The gulls are held under water and drowned before being consumed head first. Other tales of unusual prey items occasionally verge on being 'urban myths', with chihuahuas being among the most frequent victims of marauding birds. Nonetheless, some of these reports appear genuine and must be taken seriously.

The Australian Pelican is also known to rob other birds of their prey. Among the many unusual food items recorded being taken are pies, vegetable scraps, bird carcasses and mushrooms, and in one case a pelican visited a house daily for its reward, which consisted of a loaf of bread and a pint of milk.

In one very peculiar incident, a Brown Pelican is known to have entered the water where a small girl (age 3 or 4) was bathing, grabbed her on the arm and apparently tried to manipulate her into a swallowing position. The bird was quickly driven off by the girl's mother "who clouted the bird's head with a book". This tale would be easy to dismiss if it had not come from the girl's father, the prominent ornithologist Stephen Marchant.

STEPHEN DAVID MILLER

Like many seabirds, pelicans can drink salt water. A special gland situated above and behind the eyes removes the excess salt from the body by discharging it through the nasal passages as a highly concentrated saline solution.

Substantially bigger than its sibling, the first-hatched pelican chick will receive most of the food and may even attack and kill the other chick.

ing population was estimated at 100,000 to 104,000 birds. By counting carcasses of young birds, Waterman and Read estimated that a maximum of 90,000 chicks had fledged, a success rate of up to 90 per cent!

Most colonies, however, do not approach this level of success. The greatest mortality occurs when the water source that initially stimulated the breeding dries up before the last bout of nesting has been completed. With the major food source dying rapidly, the adults have little choice but to abandon any offspring that are still dependent. They, and any young from previous broods, vacate the natal area and disperse in search of more optimal conditions. This was very marked in 1974, when Lake Eyre filled for the first time in many years. Pelicans quickly took advantage of this sudden new resource, establishing a nesting colony and breeding prolifically. The conditions were such that the colony thrived for several years before the inevitable drying up of the lake in 1978. At that time, vacating pelicans, many in advanced states of starvation, appeared throughout the country and beyond, turning up in parts of Indonesia, east to Fiji and north across the equator to Palau. Within Australia, they arrived on the east coast in far greater numbers

NICK GLEITZMAN/OMNIVISION

Pelicans soon come to learn the habits of people, especially if it involves a free feed—intentional or otherwise. This has sometimes caused problems, particularly with fishermen who may see the birds as competition.

CULL OF THE WILD

A call to cull pelicans in the Forster–Tuncurry area of coastal New South Wales, and even suggestions that this was happening illegally, led David Turner, Senior Ranger for the district, to investigate the evidence of competition.

Turner found that many of the pelicans in the local area received their food through human agency, either unintentionally or intentionally. Displaying their ability to take advantage of available opportunities, the pelicans learnt to recognise the timing and appearance of potentially profitable human activities. Netting of fish in shallow water was one such activity. The pelicans approached from the side away from the humans and attempted to pull the accumulating fish through the net. This resulted in damaged fish, which were unsaleable. On occasions, up to ten per cent of the fish were damaged in this manner. The fishermen threw back undersized fish, but the pelicans made only half-hearted attempts to catch them. They apparently had expectations that fish would soon become available with less effort.

Another unintentional food source was provided by crab boats. As the traps were checked and rebaited, the old bait was thrown overboard. It was not unusual to see six or more birds following each crab boat.

Anywhere that fish are cleaned is a prime locality for scavenging pelicans. They will loaf around cleaning tables, often becoming so bold that they steal fish from bags and other containers. Turner found that perhaps the biggest source of scraps for the Forster pelicans was the local Fishermen's Co-op. Despite the protestations of some fishermen, he noted that many others, both amateur and professional, enjoyed feeding the birds. He concluded that there was no reason to cull pelicans in the Forster-Tuncurry area. The biggest source of food for the 'competing' pelicans was actually being provided by the fishermen in the form of intentional handouts. Indeed, the birds were doing the Co-op a service by cleaning up the scraps that would otherwise have to be disposed of in a more expensive manner.

KEN GRIFFITHS

DAVID TURNER

CHERIE VASAS/NATURE, TRAVEL & MARINE IMAGES

For a successful breeding attempt, pelicans require three months of plentiful food, a water supply and no disturbance. If the water supply is permanent, then the colony can become longstanding with hundreds of nests.

PELICANS IN A NUTSHELL

There are seven species of pelicans (*Pelecanus* spp.) in the world, similar in shape and, with one exception, primarily white in colour. These fall into three groups, based on their biology.

The first group comprises four species: the Australian (*P. conspicillatus*), Great White (*P. onocrotalus*), Dalmatian (*P. crispus*) and American White Pelicans (*P. erythrorhynchos*). These are gregarious species, often forming large feeding flocks and nesting colonies, and they nest and roost on the ground. These are also the largest species, with the Dalmation Pelican reaching a mass of 13 kilograms and a wingspan of 3.5 metres.

The second group consists of two somewhat smaller species—the Pink-backed (*P. rufescens*) and Spot-billed Pelicans (*P. philippensis*)—that differ from the previous group by being less communal and often solitary, and by nesting and roosting in trees. All these species feed from the water's surface.

The last group is made up only of the Brown Pelican (*P. occidentalis*) of the Americas. It differs by being smaller (four kilograms), brown rather than white, exclusively marine, and diving for its food from a height. Nesting is mainly on the ground, but may also be in trees.

than usual.

This dispersal process no doubt has occurred each time Lake Eyre dries up. On this occasion, however, instead of eventually retreating back to colonies in the drier parts of Australia, some of the pelicans remained on the east coast and began to breed. One of the new breeding colonies was on an island in Wallis Lake, on the central coast of New South Wales. At one time over 350 nests were recorded. Unfortunately this island was subject to flooding and other disturbances. After ongoing destruction of nests, the number of birds dropped until in 1992 no birds attempted to breed. Whether or not this or a new colony will become successfully established in the area awaits to be seen.

Another breeding colony was established on the Five Islands, off Port Kembla, just south of Wollongong. This was notable because of its marine situation. Although coastal colonies are not unusual elsewhere in Australia, this was the first for the country's south-east. Two pairs nested in a large Silver Gull (*Larus novaehollandiae*) colony in 1983. The colony is now occupied year round, although the numbers of birds breeding at any time varies from a few pairs to over 200 pairs at peak times, considered to be the limit that the island can support. The Silver Gulls,

BOB WALDEN/AUSTRALIAN PICTURE LIBRARY

Although pelicans don't have a true voice box, they still manage an array of unmusical sounds including bleats, whines and hisses, which they augment with claps of the bill.

which had colonised the island some years previously at the expense of the former nesting species, were now displaced over much of their original colony. Unlike that at Wallis Lake, this area was much better protected from disturbance, and the prospects for the colony's long-term continuance seem good.

Although the Australian Pelican is sometimes persecuted by humans, provided its breeding colonies remain undisturbed, their ability to adapt to the pressures of human interference and intrusions should allow these magnificent birds to remain relatively common. Soon perhaps, pelicans will be known to most people not just from mythology, cartoons or collectable trinkets, but from close encounters of a real kind. ■

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To support their opportunistic lifestyle, pelicans are skilled long-distance travellers. Using thermals to cover hundreds of kilometres at a stretch, they search for suitable breeding sites and food.

NIGEL WACE

ANH

Ocean litter is now found on beaches all over the world—even on remote uninhabited islands.

BEACHCOMBING FOR OCEAN LITTER

BY NIGEL WACE

NEXT TIME YOU GO TO THE BEACH, look at the tidelines. Along with the natural flotsam of shells, cuttlebones and seaweed, you will probably find some plastic containers, polythene bags, old beer cans, glass bottles and thongs. Most of this beach litter is trash left behind by the slobs who can't be bothered to take their rubbish away with them. If there's a river or port nearby, the litter is likely to include some packaging or other industrial rubbish that has washed along the coast. But on any beach there are usually bits of rope and fishing gear, or other maritime debris that has floated ashore from out to sea. Such ocean litter is now found on beaches all over the world—even on remote uninhabited islands. Items as large as TV sets and refrigerators float ashore on coral atolls in the mid-Pacific, joining the more traditional human flotsam of timber and glass bottles. Along with the atmosphere into which we pour the waste gases from our industries and agriculture, and even outer space into which we have hurled our orbiting space junk, the sea is gradually becoming our biggest garbage dump.

At Anxious Bay, South Australia, volunteers soon learn that systematic beachcombing is hard work.

NIGEL WACE

Anxious Bay is a relatively isolated, well-ordered beach with regular foredunes, a narrow tidal range and minimal seagrass accumulation. All this combines to make it a perfect site on which to base an investigation into ocean litter. This view is from the cliff top at the northern end.

How much litter is floating around at sea, and coming ashore on our coasts? Just what does it consist of? Where has it all come from? And who is using the sea as a garbage tip, anyhow? One way to find some answers to these questions is to go beachcombing on remote coasts far away from industry, towns, rivers and tourists, where all the litter on the beach has come from the sea. Although Australia has huge lengths of such coastline, finding a good beach for monitoring ocean litter is not a simple matter. It must be inaccessible to vehicles and defended from litterbugs by features such as dunes, salt lakes or cliffs; it should also face the prevailing winds and currents, and have foredunes accessible from the beach itself, so that beachcombers can collect flotsam that has blown inland.

Western Eyre Peninsula in South Australia provides one such place. Facing the westerly winds and swells at the northern margin of the Antarctic Circumpolar Current, it presents a barrier to the uninterrupted fetch of the sea across the Indian and South Atlantic Oceans, as far away as the Patagonian coast of South America. Most of the coast is cliffed, but north of Elliston the spectacular rampart of limestone cliffs is broken at Anxious Bay by a 26-kilometre sandy beach. This is defended from motor vehicles (and therefore from tourist trash) by soft sand and rock bars at each end, and separated from the pastures and wheat fields inland by high sand-dunes and the sticky saline muds of Lake Newland. As such, Anxious Bay is one of the best sites for monitoring ocean litter on the south coast of Australia.

PATRICK HONE

With the aid of a 'pooper-scooper', the author collects samples of beach sand for analysis in the laboratory to determine if small plastic fragments remain in the sand.

SYSTEMATIC BEACHCOMBING INVOLVES a lot of walking and carrying. To clear a 26-kilometre beach is beyond the capacity of just a few people. So, in October 1991, I joined the South Australian Scientific Expeditions Group, and with some 25 Adelaide school children over a period of three days, collected and later cleared the beach of all its litter. The clearance was repeated the following two years, with the South Australian Research and Development Institute (SARDI) organising the surveys and help from students at Streaky Bay and Elliston schools.

While most people feel pretty good about cleaning up a beach, this feeling presents difficulties for marine litter monitoring, because enthusiastic beach-cleaners generally ignore the distribution of natural sediments and flotsam, and thus much of the evidence regarding the origin of the human litter and the time it has spent floating at sea or on the beach. There is a scientific side to beachcombing for ocean litter. It is founded in the processes of coastal geomorphology, but draws on marine and intertidal ecology, and on some understanding of the rates and processes by which plastics, glass and metals are broken down in the windy, sandy, salty environment on the beach.

In the systematic surveying of ocean litter at Anxious Bay, our first task was to stake out the beach with kilometre markers. We then collected all the litter on the beach and in the foredunes, assembling it at the five-kilometre markers, and later retrieved it for sorting, weighing and recording before taking it all off to the Elliston tip. It was hard work in the hot windy weather on both the open beach and in the dunes. We couldn't manage the heavy baulks of driftwood; and some ropes and netting jammed between rocks were impossible to shift. Altogether, about 344 kilograms of beach litter were collected in 1991,

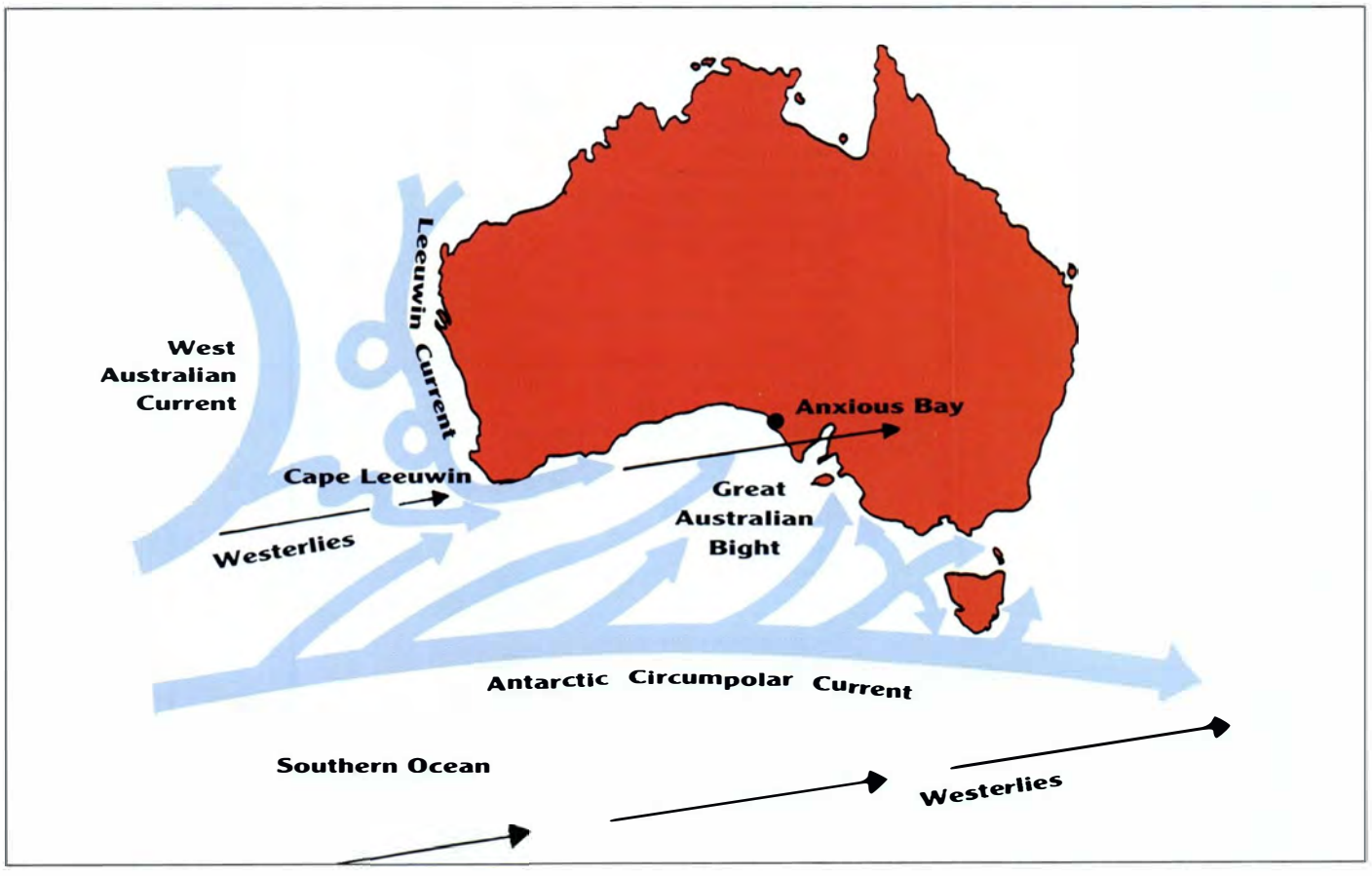
391 kilograms in 1992, and 216 kilograms in 1993. This comes to between eight and 15 kilograms per kilometre. The types of litter found at Anxious Bay were much the same each year: about 60 per cent plastic and 30 per cent glass by weight (see Litter Box).

Because the Anxious Bay clearances have all been carried out on the same beach in the same month (October), it is tempting to regard these litter yields as annual deposits. But we do not know how much litter is buried in beach and dune sands, and we know nothing about the rates at which light litter such as plastic sheeting is blown inland and thus lost from the beach–dune system, or the rates at which different plastics break down on an open beach. The lower yield for 1993 may reflect smaller deposits, or the clearance of accumulated litter in earlier years. This year's yields will be interesting. But even if only eight kilograms per kilometre was typical of the amount of litter stranding on the southern coast of Australia, the total quantity of ocean litter floating ashore must amount to some hundreds of tonnes a year.

How much litter is floating around at sea, and coming ashore on our coasts? Just what does it consist of? Where has it all come from?

As mentioned previously, plastics formed the bulk of the beach litter, with about equal weights of hard (moulded) and soft plastic. The number of litter 'items' was impossible to count because thousands of plastic fragments were strewn around in the dunes and buried in the sand. Often a plastic bucket or similar-sized item, when picked up, would just disintegrate into fragments. Hence, collecting everything we could see and then weighing it was the only way to get a reliable measure of the beach litter.

Results from the Anxious Bay surveys to date indicate that fishing debris far outnumbers all the items whose purpose can be identified (see Litter Box). Craypots, fish boxes and crates, bait baskets, buoys, ropes, strapping tape, nets and cod ends (the bases of trawl nets) formed the bulk of the Anxious Bay litter, and could often be traced to particular fisheries. The discovery of 43 uncut strapping loops on the beach in 1992 and 21 in 1993 was disturbing because these loops, which are used to secure bait boxes, are known to garrotte or strangle marine animals such as seals and sharks through entanglement at sea. In Tasmania, the number of these uncut plastic loops coming ashore has been reduced through a well-supported educational campaign mounted by the Parks, Wildlife and Heritage



Service in Hobart. Anxious Bay beachcombers on nearby Waldegrave Island in 1991 saw a young hair seal in distress off the beach, entangled in plastic strapping and box thorn, but couldn't get to the animal to free it.

When plastics float at sea, they provide an ideal surface for the growth of marine bacteria, algae, or larger fouling and encrusting organisms. At Anxious Bay, however, there was little obvious marine fouling of the plastic litter, and so no indication of how long the litter had been afloat before stranding. However, plastic containers were often pierced by shark teeth or nibbled by fish. Most plastics degrade more slowly at sea than on an open beach where they are exposed to ultraviolet light and become brittle, breaking into pieces. However, very little is known about the dynamics of abandoned plastics in either marine or terrestrial environments. To test for movement and breakdown of plastics on the beach, I left 50 standard polypropylene markers at Anxious Bay after the 1993 litter clearance. (The markers I used were actually the foaming devices retrieved from inside tall Draught Guinness cans!) In this year's beachcombing survey (October 1994), we will be looking for these markers to see where they have got to and to assess their condition and weight after a year on the beach.

In the sand along the Anxious Bay tidelines, tiny bits of coloured plastic smaller than a finger nail are abundant. Analyses of the surface beach sands have so far yielded no plastic fragments smaller than the sand grains themselves except for tiny twisted bits of coloured plastic fibres from disintegrating rope and netting. This suggests that, as the plastic on the beach breaks up, bits smaller or lighter than the sand grains are blown away to the dunes. If fragments of plastic are thus 'deflated' by the wind, are we building up a new kind of wind-borne sediment in our salt lakes and other depositional sites inland?

In contrast to plastics, glass is heavier than water; like sand it sinks. Glass that floats ashore is always in the form of closed containers (empty bottles with stoppers or caps, light globes, 'fluoro' tubes etc.). Of the 233 glass bottles we found in 1992, all but five of the 70 without stoppers came from the ends of the beach, where shore drinkers must have left them. Experiments with marked bottles left on the beach at the five- and ten-kilometre markers, and retrieved near the same places a year later, suggest that unstoppered glass bottles do not move far from where they were dropped, despite the action of the waves.

Few of the hundreds of bottles at Anxious Bay have been 'echoes', which suggests that the refundable bottle deposit scheme in South Australia is working. Two beer bottles were clearly marked with the statement "This bottle

LITTER BOX

Litter Collected at Anxious Bay, Eyre Peninsula, South Australia

		1991 Total	1992 Total	1993 Total
NATURAL FLOTSAM	Marine plants (seaweed and seagrass remains)			
	Plant resins ('dammar' from dipterocarp trees)			
	Animal remains of dead birds (scavenged by foxes?)			
	Dead fish			
	Dead insects			
	Bitumen, tarballs			
	Pumice			
BUOYANT HUMAN FLOTSAM & JETSAM = MARINE LITTER	**HARD (MOULDED) PLASTIC**	122kg	121kg	56kg
	Liquid containers (bottles, tops, fragments)			
	Drums, buckets (and fragments)			
	Crates, boxes (and fragments)			
	Bait baskets (especially Burley baskets)			
	Red craypots (and fragments)			
	Buoys, floats (and fragments)			
	Fisheries drift-cards and fish-tags			
	Syringes			
	FOAMED & SOFT (FLEXIBLE) PLASTIC	119kg	127kg	64kg
	Rope (mostly yellow and orange fragments)			
	Nets (mostly thick trawl fragments, orange)			
	Trawl-net cod ends			
	Monofilament fishing line (mostly tangles at beach ends)			
	Bags and polythene sheeting (mostly tattered fragments)			
	Buoys and floats			
	Polystyrene fragments			
	Strapping tape (12mm wide, mostly blue)			
	Beer can yokes			
	GLASS (weight includes unstoppered bottles etc.)	103kg	123kg	49kg
	Bottles with stoppers			
	Jars (mostly with plastic lids)			
	Light globes (including large floodlights)			
	Fluorescent tubes			
	METAL	not weighed	20.5kg	47kg
	Drums (mostly engine lubricants) and rusty fragments			
	Fishing floats and buoys			
	Aerosol cans			
NON-BUOYANT OR TEMPORARILY BUOYANT JETSAM = LAND LITTER	Unstoppered glass bottles and jars (mostly at beach ends)			
	Metal cans (beer, soft drink and food, mostly at beach ends)			
	Food wrappers and packaging (windblown, mostly at north end of beach)			
	Newspapers, cardboard cartons (mostly at north end of beach)			
	Motor vehicle parts			

NIGEL WACE

Volunteers sort the mixed ocean and land litter collected at the north end of Anxious Bay. Loops of blue strapping tape, black bait baskets, plastic pipe and containers, and orange netting were found in abundance.

remains the property of ...". One belonged to the Swan Brewery Company and the other to the NSW Bottle Company. I wonder what the legal standing is of interstate manufacturers whose bottles, over which they claim perpetual ownership, now litter a beach within a South Australian Conservation Park, where it is an offence to leave such rubbish? But whatever their origins, most bottles were anonymous, and it would be difficult to find out where they came from. Interestingly, whisky and gin bottles were the most abundant. Light globes (including spotlights, and large floodlights used in squid fishing) and 'fluoro' tubes were also anonymous but had probably been jettisoned from vessels at sea.

Among the bottles and plastic and other human litter on the beach is the natural flotsam such as pumice, tarballs and bitumen; plant resins, drift seeds, seaweed and seagrass; and animal remains such as cuttlebones, dead fish, insects and seabirds. Tar and bitumen on beaches may come from tanker spills, but also from natural seepages on the sea-floor. Natural flotsam reaches the beach entrained in the same currents as the human litter, and may therefore help in tracing its origins. Analyses of the plant resins and the bitumens from Anxious Bay suggest they come from Indonesian rainforest trees, and from Sumatran oil seeps. Such incursions from the tropics would be by way of the warm Leeuwin Current, flowing south along the coast of Western Australia and round Cape Leeuwin into the Great Australian Bight. So far, no coconuts have been found in the Anxious Bay surveys (it is doubtful they float for more than four months), but other tropical drift seeds have been found on beaches in the south-west of Western Australia.

Pumice on the east coast of Australia usually originates from submarine eruptions near Tonga in the south-west Pacific, carried south in the East Australian Current. At Anxious Bay, and elsewhere along the south coast of the continent, analyses of the pumice suggest it comes from as far away as the South Sandwich Islands in the South Atlantic. Other items that probably travelled long distances to Anxious Bay were Argentine and Uruguyan liquor bottles, a battered plastic milk crate belonging to Creamline Dairies of Durban, and a South African drift-card jettisoned just south of the Cape in 1982.

THESE INCURSIONS OF NATURAL FLOTsam and human artefacts from afar may be of geographical interest, but they generally form a tiny proportion of

NIGEL WACE

The Scientific Expeditions Group from Adelaide quickly became expert beachcombers and collected 100 kilograms of litter between the five- and 12-kilometre marks at Anxious Bay in 1991.

all the stranded material on the beach. Analysis of the litter at Anxious Bay shows that we are mainly fouling this remote coast with the litter generated by fishing and shipping activities on the nearby continental shelf. In 1990 Australia signed the International Convention for the Prevention of Pollution by Ships at Sea, more commonly known as MARPOL. This convention prohibits the jettisoning of all plastics at sea, however no assessments have been made to see whether its provisions are having any effect. Judging by the composition of the ocean litter we have collected in three years of systematic beachcombing at Anxious Bay, commercial fishermen working in the Great Australian Bight do not seem to be aware of MARPOL. As such, establishing a baseline for ocean litter stranding at Anxious Bay is a first step in monitoring the pollution of our seas with floating litter and garbage. More sites will be needed in order to monitor litter in the other seas and coastal regions around Australia.

We live on land, but more than two thirds of the surface of the Earth is occupied by sea. Does it matter if we use the world's oceans as a huge tip for the free disposal of our global garbage? Perhaps not, provided the materials we discard do not damage us or other animals or plants, and provided they can be recycled within natural systems, or hidden away in the Earth's crust for gradual processing like coal, oil and natural gas. But nowadays there are so many of us processing more and more of the natural world into human and industrial wastes that we can no longer expect natural systems to absorb all our rubbish. For this reason we need to monitor our wastes, find out how much there is and work out where it is all going. Systematic beachcombing in places far removed from land-based litter is one way of finding out what we are doing to our oceans, and thus helping to protect a vital part of our planet's life support system. ■

BOTTLES ON THE BEACH

Glass bottles on a beach are not only unpleasant, but a menace to bathers and other barefoots when smashed. If, for some reason, glass bottles cannot be carried away from a beach and disposed of for recycling, the best thing to do is put them back in the natural mill from which they came. Smash them on inaccessible exposed rocks among the waves, where neither scuba divers, swimmers nor rock scramblers venture. The pounding surf will soon grind the sharp fragments smooth to join the pebbles and other quartz grains that make up the sand on the beach and the sea-floor. If there is nowhere safe to smash them, their stoppers should be removed and the bottles filled with water and hurled as far as possible out into the surf.

Under MARPOL, ships within 12 nautical miles (about 22 kilometres) of land are required to break glass up in a grinder before disposal at sea. A simple way to reduce the number of glass bottles ending up on our beaches would be to persuade mariners not to replace the caps when they have finished drinking the contents. An unstoppered glass bottle will soon sink at sea and, although perhaps a problem for some inhabitants of the sea-floor, it is less objectionable in marine sediments than lying on a beach.

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Dr Nigel Wace is a botanist, interested in weeds and plant dispersal. He is a Visiting Fellow in the Department of Biogeography and Geomorphology at the Australian National University, Canberra.

The beachcombing at Anxious Bay would have been impossible without the help of school children and their teachers from Adelaide in 1991 (Scientific Expeditions Group), from Streaky Bay and Elliston in 1992 and 1993, and from the South Australian Research and Development Institute (SARDI). Financial support was kindly provided through the Federal Government's Ocean Rescue 2000 program. For information on future litter surveys at Anxious Bay, contact SARDI (Aquatic Sciences) in Adelaide.

We're making sure Eric doesn't become bone idle.

Having been around for 110 million years it would seem only fair to let Eric take it easy. However, before this takes place we do feel that everyone should have a chance to see him. That's why at Akubra we are extremely proud to be the sponsors of his nationwide tour.

So who and what is Eric? Eric is a Pliosaur, a long extinct marine reptile predator that lived during the Age of Dinosaurs, 110 to 120 million years ago. This magnificent specimen was found by a miner, Joe Vida, in Coober Pedy in 1987. Interestingly all the original bones in Eric's skeleton had become opalised with white opal, a preservation unique to Australia.

The many fragments that went to make up this fascinating skeleton were carefully put together with over 450 hours of patient work. This reconstruction was entrusted to the Paleontology department of the Australian Museum under the supervision of Dr. Alex Ritchie.

To keep this wonderful and probably unique specimen in Australia, we were delighted to be able to assist the Museum financially together with the many thousands who responded to the recent Quantum appeal, to save Eric from possible sale overseas.

Over the years of course, our truly Australian family owned Company, that is now in its fourth generation, have proudly sponsored many Australians well known to us all. Also since 1956 we have been supplying hats for our Olympians and from well before that, the famous Slouch Hat that clearly identifies our Army. It's no wonder Akubra is known as Australia's most famous hat.

Our latest introduction has more than one great connection with Eric. The very aptly named Coober Pedy hat. It is quite suitable for either town or the country and features an opal in pride of place on the band. It is also a very fitting tribute to the adoption of the famous Opal as the National stone of Australia. The Coober Pedy and our many other Akubra hats are available from leading department stores, hat shops and saddleries nationwide.

So instead of idling his time away, Eric began his national tour in late September in Perth and from there will travel around Australia for about two years. Details will be advised in your local press.

AKUBRA

Along with ants and cockroaches, scorpions are among the world's great survivors.

NIGHT STALKERS

BY ADAM LOCKET

HAVE YOU EVER COME ACROSS A scorpion in the wild? Few Australians have, yet there are plenty of them, living in various habitats from desert to rainforest and sea-level to mountains. Why then are they so seldom seen?

Part of the answer is simple: scorpions are mainly nocturnal and we, by and large, are not. So scorpions are not about in the daytime when they would be visible, nor are they easily seen by torchlight at night. There is, however, a great way of spotting them that depends on a remarkable property of scorpion cuticle: like T-shirts at a disco, scorpions fluoresce under ultraviolet ('black') light. The story goes that this was first noticed by some Californian 'rockhounds' using portable UV lights to find mineral specimens in the desert. To their astonishment, one of the stones got up and walked off! Now black-lighting is a favourite way to study scorpions in the field.

KATHIE ATKINSON

Australia is home to an abundance of scorpions yet few people ever see these secretive, nocturnal creatures. Scorpion researchers, however, have discovered an easy way to spot them, thanks to a remarkable property of their cuticle, which fluoresces under ultraviolet light.

Ancient scorpions were more diverse and much bigger than today. Some were giants a metre long, compared with 30 centimetres for the longest alive today.

Scorpions are ancient animals that have survived with little structural change since Silurian times, some 360 million years ago (that's 170 million years before dinosaurs began!). All have a pair of claws at the front and a sting on the tail, which can strike forwards over the scorpion's back at an intruder or at prey held in its claws. Scorpions do not have true jaws (mandibles) but there is a pair of small jaw-like pincers (chelicerae) in front of the mouth with which food can be torn to pieces. Like their fellow arachnid relatives, the spiders, they have four pairs of legs and slits under the body leading into special breathing organs called book lungs. Although they have shared the same basic body plan, ancient scorpions were more diverse and much bigger than today. Some were giants a metre long, compared with 30 centimetres for the longest alive today. They were also marine.

Prominent in legends of early Mediterranean civilisations, scorpions have always had an evil reputation, but do they deserve it? Certainly in some parts of the world they do; in Africa, the Middle East, Central and South America and parts of Asia deadly species threaten humans and animals alike. In Australia, however, none is known to be particularly dangerous. There has only been one recorded fatality in Australia, but we do not know what scorpion caused it as the toddler's father understandably stamped on it. Night training during World War 2 brought soldiers crawling through bush into close contact with the Inland Robust Scorpion (*Urodacus yaschenkoi*), whose painful sting kept them off duty for a day or so, but most scorpion stings are no worse than that of a bee. Although rightly feared in parts of the world where they are dangerous, scorpions do not seem to induce the instinctive horror that many people feel towards spiders, snakes or sharks.

Scorpion venom is a cocktail of nerve toxins. It is particularly useful in the study of human and other nervous systems because the different toxins can block specific chemical pathways. However, it is largely by chance that the venom of certain species may be dangerous to humans, since the scorpions were around long before we were, and their venom is adapted to their usual prey, not to us. The scorpion's sting is smooth, unlike that of a bee, so can be used repeatedly without harm to its owner. The venom, made in a pair of venom glands in the base of the stinger, is replenished when used, and in countries where scorpions are a health problem serum institutes keep thousands of scorpions that they 'milk' for the production of antivenoms.

ALL SCORPIONS ARE CARNIVORES AND will eat practically anything that is alive and the right size. How big that is depends on the scorpion, but insects, spiders, occasionally small lizards and particularly other scorpions fall prey to them. They seldom eat ants, and some slaters and millipedes are rejected.

Often scorpions subdue their prey using claws alone, but struggling prey can be stung as well. Once secured, the prey is torn up with the 'jaws' and predigested outside the body by drooling saliva onto it. The resulting soup is sucked in through the narrow gullet, and absorbed into the same gland (the hepatopancreas) that produced the saliva, a storage organ as well as gland. A scorpion's metabolism is so slow that the stored food from one meal lasts for months. Its food provides almost all the water it needs, and scorpion cuticle is so waterproof that many never need to drink. Water is also conserved by excreting dry nitrogenous waste products, as spiders and some reptiles do.

Scorpions have several prey-catching strategies. Some walk about on the surface at night, catching whatever they bump into. Others, such as certain sand-dwelling scorpions of western North America, can pick up ground vibrations from prey on the surface, which they then catch by a swift rush and a grab with the claws. They can even detect burrowing cockroaches beneath the sand, plunging their claws down to catch the insect. Australian sand-dwelling scorpions like the Inland Robust Scorpion can probably do this

AUSTRALIAN SCORPIONS

Worldwide there are nine scorpion families occurring in warm and temperate climates. Four families (listed below), containing at least 30 and perhaps up to 80 species (depending on taxonomic viewpoint), are represented in Australia.

Buthidae

Includes all the dangerous scorpions in the world. Large in some countries, but small (less than five centimetres) and harmless in Australia. Most have small claws and stout tail. Includes the Little Marbled Scorpion (*Lychas marmoreus*), the Alexandrine Scorpion (*L. alexandrinus*), and the endemic Spider-hunting Scorpion (*Isometroides vescus*) and Dry Lake Scorpion (*Australobuthus xerolimniorum*).

Scorpionidae

Includes some very large examples, e.g. the Emperor Scorpion (*Pandinus imperator*) from Africa, 20 centimetres long. Represented in Australia by the endemic genus *Urodacus*, including the Inland Robust Scorpion (*U. yaschenkoi*) and Yellow Sand Scorpion (*U. armatus*) that dig burrows, and the Black Rock Scorpion (*U. manicatus*) and Flinders Ranges Scorpion (*U. elongatus*) that live under stones.

Ischnuridae

Represented in warm, wet areas of Queensland, Northern Territory and countries to the north of Australia. Includes the Smooth-clawed Scorpion (*Liocheles waigiensis*). Live under bark, in crevices under stones, in leaf litter and in rotten logs.

Bothriuridae

Occur in temperate parts of South America and Africa. Represented in Australia by the endemic genus *Cercophonius*, which includes Tasmania's only scorpion, the Southern Scorpion (*C. squama*). Small and harmless, litter-dwellers.

Deadly to humans in other parts of the world, most of Australia's scorpions are relatively harmless with their sting no worse than a bee's.

too; they certainly startle at a footstep, but may not be as sensitive as their American relatives.

Many scorpions, including the Inland Robust Scorpion, are expert diggers in sandy soil and sit in the mouth of their burrow waiting for prey to come by. These burrows can be up to a metre deep, and are used to avoid extremes of heat and drought, as well as a retreat from predators and as a brood chamber. The Inland Robust Scorpion's burrow has a characteristic entrance, with a crescentic mouth and a lip over the top. Outside is a spoil heap from the original excavation and from frequent cleaning out of fallen or blown sand, done at nightfall. This habit can be used to catch the inhabitant; a tin dug in at the burrow mouth will collect the scorpion as it emerges. Give one a bucket of firm sand and you can watch it burrow, at least until it disappears below the surface. The 'jaws' are used alternately to loosen the soil, which is then gathered up by the front two pairs of legs. Using these as a basket, the scorpion backs out, finally sweeping the sand aside with its tail. This technique is very effective, and a burrow half a metre deep can easily be dug overnight.

Although the mouth of the burrow looks simple, underground things are different; the scorpion spirals as it digs. The spirals may be very tight, and do not always twist the same way. Sometimes the twist changes part way down (possibly because a root or rock is in the way), but always the burrow ends in a chamber where there is room to turn round.

The Spider-hunting Scorpion (*Isometroides vescus*), which is unique to Australia, is a dry-country wanderer that has a special prey-catching technique. It invades the burrows of trapdoor and

Scorpions will eat practically anything, including other scorpions. This Yellow Sand Scorpion has captured a dung beetle.

ADAM LOCKET

Unlike most scorpions, which favour a solitary way of life, the Little Marbled Scorpion can often be found aggregating together under bark during winter.

wolf spiders, where it kills and eats the owner, remaining in the burrow afterwards. Particularly effective venom accounts for the Spider-hunter's success against these large, fierce, spiders, although they do not always get their own way. Once I fed a Fiddleback Spider (*Loxosceles rufescens*) to a Spider-hunting Scorpion, which attacked and stung it immediately. Within ten seconds the spider's legs were curling up; but the spider had got a bite in too and, in less than a minute, both spider and scorpion were dead.

Not all scorpions live in burrows. Many kinds live under stones, where they excavate a small scrape to live in. Even quite large scorpions do this, including the Flinders Ranges Scorpion (*Urodacus elongatus*), which grows to about ten centimetres. The Smooth-clawed Scorpion (*Liocheles waigiensis*) from northern Australia is well adapted for living in rock crevices. Its claws are large and heavily armoured, and form a semicircular defensive shield when backed into its lair. This is perhaps just

Helpless, pale and soft-skinned, these hatchling scorpions (*Urodacus* sp.) will remain with their mother until their first moult, when their claws and sting will harden.

as well, as its tail is weak and so short that it looks as if it could not reach anything in front of the body, although in fact it can. Other scorpions from rainforest and drier wooded places live in leaf litter or under loose bark on large trees, although they do not get into the foliage as their relatives overseas sometimes do. The Little Marbled Scorpion (*Lychas marmoreus*) lives both under stones on the ground and also under bark; the latter particularly in winter, when a dozen or more may be found close together. This tendency to aggregate is unusual; most scorpions are solitary, although in western North America the Bark Scorpion (*Centruroides exilicauda*), a dangerous relative of the Little Marbled Scorpion, aggregates in the hollow remains of dead cacti.

The Dry Lake Scorpion (*Australobuthus xerolimniorum*) is a small, pale scorpion that occupies a most inhospitable habitat—the surface of dry salt lakes. Unlike other members of its family (see box), it burrows, digging into

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ADAM LOCKET

the salty mud under bits of debris. Retreating down the burrow from the heat of the day, the scorpion emerges at night to hunt on the surface rather than using sit-and-wait tactics.

THE MATING DANCE OF SCORPIONS IS well known; indeed Walt Disney set it to a square dance in his film "The Living Desert". The male takes the female by the claws, and there may be 'fencing' with the tails, although without dangerous intent. The male walks backwards until he finds a suitable piece of ground where he deposits a double packet of sperm. He leads the female over this and she takes it up into her genital tract where fertilisation of the eggs later takes place. The young develop slowly, and may not be born for almost a year after mating, which takes place in the summer months.

All scorpions give birth to live young, rather than lay eggs, and as they are born the hatchlings, up to about 40 of them, clamber onto the mother's back. At first they are helpless, pale and soft-skinned and don't have the hardened claws and sting they acquire at first moult. But they do have plenty of food reserves in their digestive gland, and so do not need to feed until they are several weeks old. At this stage they moult, leave their mother and start to fend for themselves. Young scorpions are small and many do not survive, partly due to cannibalism by other larger scorpions of the same or different species. Those that do survive may live for years; the Inland Robust Scorpion does not reach maturity until it is six years old, and may well live another ten.

With claws and sting and relatively large size scorpions are well protected, but even they have their predators. Apart from other scorpions, of their own or other species, scorpions fall prey mainly to nocturnal predators, including goannas and owls. Carnivorous marsupials like quolls will certainly tackle them and feral cats have been found with their stomachs full of scorpions—a plus or a minus in the cat debate?

Although humans do not catch scorpions to eat, they may be more destructive—unintentionally—than any natural predator. Like all animals from jaguars to jellyfish, scorpions depend on their particular habitat, varied as that may be, and where habitat has been destroyed by building, farming or other land clearing the scorpions have gone. This, together with their secretive, nocturnal habits, probably explains why they are so seldom seen; where we now live and work, they don't. So does that mean Australia's scorpions are threatened? I don't think so: they have managed well by having a sound life strategy, being relatively large, tolerant of harsh conditions and keeping out of harm's way. With ants and cockroaches, scorpions are among the world's great survivors, and will probably be walking the nights long after humans are gone. ■

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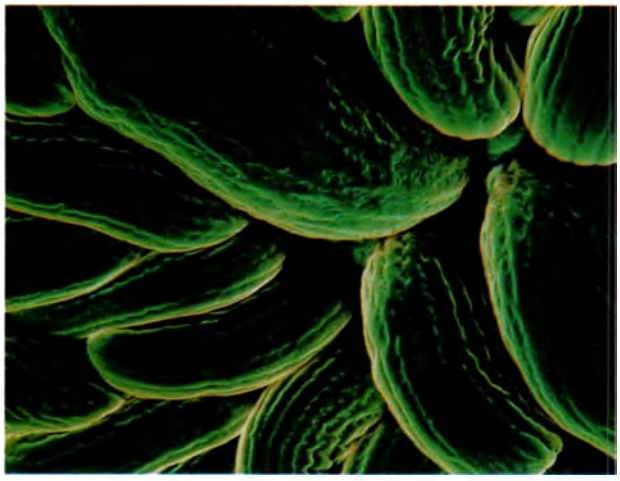
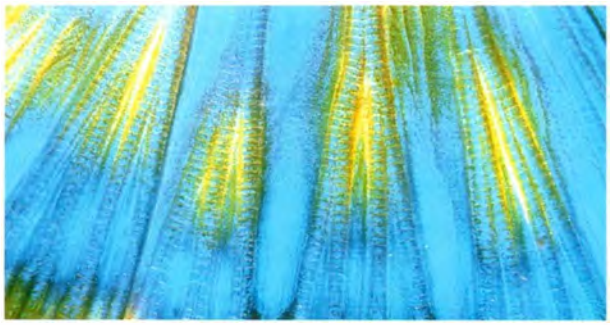
Dr Adam Locket teaches in the Anatomy Department at Adelaide University. He has studied scorpions since coming to Australia from the UK 14 years ago. He also works on vision in deep-sea fishes.

A basket star, *Conocladus australis*, wraps its arms around a gorgonian in Bass Strait.



These bubble-like vesicles actually make up the outer body wall of *Phlyctenactis tuberculosa*, a large anemone that is common in the waters of temperate Australia.



Detail from the caudal fin of a male Shaw's Cowfish (*Aracana aurita*).

UNDERWATER ABSTRACTS

BY JON BRYAN

The variety of life in the sea is staggering. Glowing rainbow colours and a multitude of structures and shapes are living advertisements for the wonderful diversity of nature. Opportunities for photography seem endless.

While interesting subjects are common in the ocean, it is often difficult to find one that can be isolated from its surroundings to form a useful image on film, particularly if you want more than just a simple record shot.

Close-up photography is a great way to pick out the essential features of many subjects. Magnifications of between half and twice life size often provide views of common marine organisms that reveal delightful patterns formed by colours, shapes and textures.

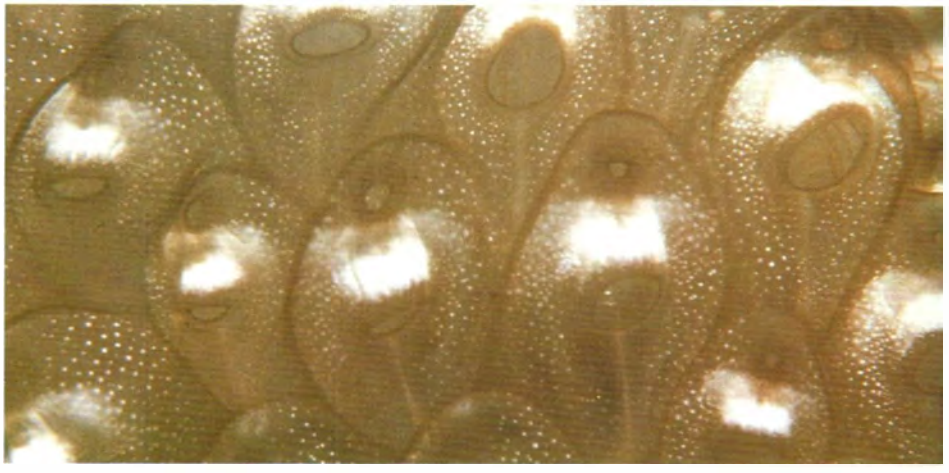
The range of possible abstract images under water is intriguing and limited only by imagination. Abstract images of marine life don't just produce pretty patterns—they can transport us into an enchanting part of the natural world that is normally hidden from our experience.

P H O T O A R T

Stony coral from the Maldives.

Tentacles and body wall of a tropical anemone from the Maldives.

UNDERWATER ABSTRACTS



Colonial ascidian or seasquirt.

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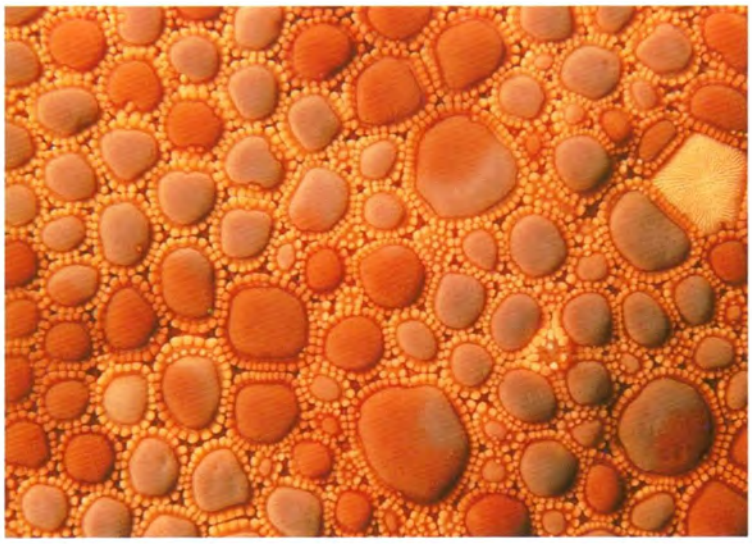
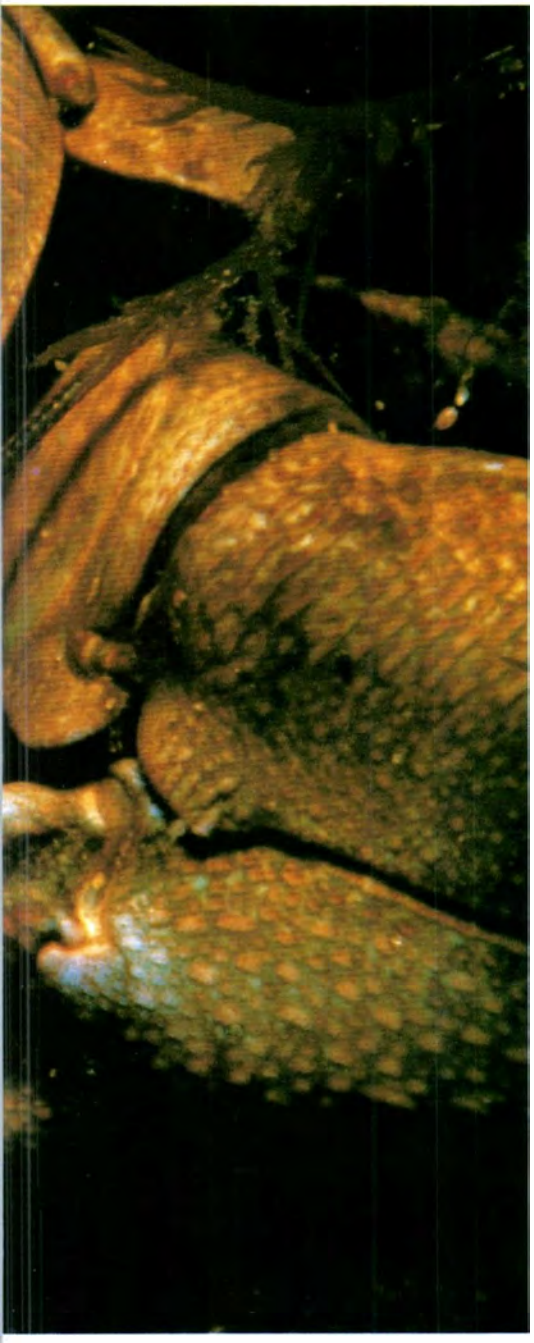
Like many other starfish, *Tosia australis* is armoured with a patchwork of multicoloured plates.



A tiny section of a fan-shaped gorgonian coral produces an image that reveals feeding polyps less than a millimetre across.



UNDERWATER ABSTRACTS

Porcelain crab (*Petrolisthes elongatus*), Tasmania.

Northern Australia may harbour the largest concentration of this dolphin, yet it remains largely unknown to most Australians.

THE IRRAWADDY DOLPHIN

BY ALEX BORTOLI

In 1868, zoologist John Anderson was sailing up the Irrawaddy River in Burma (now Myanmar) when he noticed what looked like a small school of dolphins behaving in a bizarre manner. In his monograph of 1879 he wrote "They swam with a rolling motion near the surface, with their heads half out of water...they ejected great volumes of water out of their mouths, generally straight before them, but sometimes nearly vertical...".

On closer inspection, Anderson noticed the dolphins lacked a beak (their head was almost rounded in appearance) and had a distinct, functional neck. More unusual still, officials and fishermen in the area told how each village along the river had its own 'guardian dolphin' that would apparently herd fishes into the fishermens' nets. Believing the animals to be a new species, Anderson christened them Irrawaddy Dolphins (*Orcaella fluminalis*) after the river in which they were first found. It is now generally recognised that the animals Anderson observed belonged to an earlier described species, *Orcaella brevirostris*, but the common name Irrawaddy Dolphin has been retained.

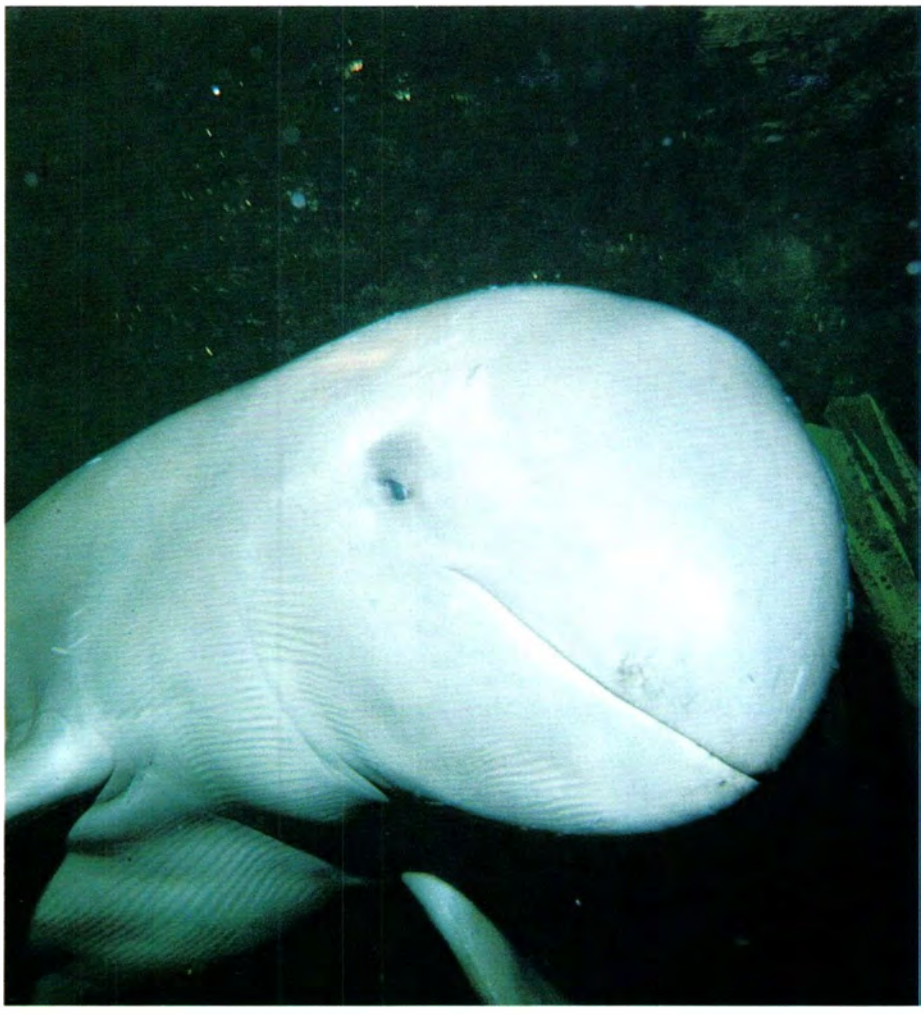
We now know Irrawaddies range from the Bay of Bengal in India, down through the Indo-Malay Archipelago and into the northern reaches of Australia as well as Papua New Guinea. Irrawaddy Dolphins (also called Snubfin Dolphins because of the small dorsal fin) occur as far south as Yeppoon, Queensland. Recent surveys suggest that northern Australia harbours the largest concentrations of this dolphin, yet it remains largely unknown to most Australians.

Part of the explanation for this lies with the habitat and behaviour of these dolphins. Irrawaddies prefer coastal and estuarine habitats or the muddy, protected waters of rivers and lakes. They rarely show much of the body when rising to the surface to breathe and live their lives largely hidden from the prying eyes of humans. Incredibly, not a single photograph of Irrawaddy Dolphins in the wild has been published (most are shots of a group of captives at the Jaya Ancol Aquarium in Jakarta, Indonesia). Further mystery surrounds the ancestry of the Irrawaddy Dolphin. While superficially the species has features common to all true dolphins (family Delphinidae), internal characteristics such as the structure of their earbones and their neck mobility more closely resemble that of the Arctic Belugas or White Wales (*Delphinapterus leucas*, family Monodontidae).

So, are Irrawaddy Dolphins really the "equatorial equivalent" of Belugas as suggested by Dr Edward Mitchell of the Canadian Department of the Environment, Fisheries and Marine Service? It's definitely a possibility. A fossil monodontid whale (similar to the Beluga) discovered in Mexico suggests these whales once had quite a wide distribution, existing not only in the Arctic but also in warmer areas. Thus it is possible that the common ancestor of Irrawaddy Dolphins and Belugas could also have been widespread and, as the climate changed over time, one group of animals may have become restricted to the Arctic while the other group adapted to tropical conditions, resulting in the two completely separate ranges of the species that we see today.

But not everyone agrees with this theory. Research in progress by Drs George Heinsohn (James Cook University of North Queensland) and Peter Arnold (Museum of Tropical Queensland) suggest that Irrawaddies swim firmly in the dolphin camp. They have been comparing the skeleton and other features of various dolphins, porpoises (family Phocoenidae), Belugas, Narwhals (also known as Unicorn Whales, *Monodon monoceros*) and the primitive river dolphins, such as *Platanista* spp. Using the computer program 'Hennig', they can compare a wide range of anatomical features (such as skull, earbones, post-cranial skeleton, nasal sacs, cranial sinuses) rather than treating only one or two of these features on their own. Although results are still preliminary, all analyses carried out so far closely link Belugas and Narwhals and separate them clearly from Irrawaddy Dolphins. The latter consistently link with the true dolphins and porpoises.

This view has received recent support from studies on DNA by Drs S. Gretarsdottir and U. Arnason from the University of Lund in Sweden. They showed that the repeat length of DNA base pairs (that is, the matching bases



Irrawaddy Dolphins remain largely unknown to most people. The shots were taken at Jaya Ancol Oceanarium in Jakarta, Indonesia, where a number of the dolphins are housed in a freshwater pool.

within nucleotides that make up a DNA strand) in most toothed whales (including Belugas and Narwhals) was around 1,750 pairs. In the true dolphins of the family Delphinidae, however, the length was approximately 1,580 pairs. When they examined the DNA of an Irrawaddy Dolphin from Australia, the repeat length of base pairs was 1,583—an almost identical match-up to all other delphinids examined.

Thus the classic idea that Irrawaddies belong to the dolphin family seems secure. How then can we explain the outward similarity of Irrawaddy Dolphins to Belugas? Is it, as some people think, simply a case of convergent evolution, where two species have evolved to look like one another under similar conditions (for example a coastal habitat)? Or does it lie much further back in evolutionary time? Dr Arnold believes it is the latter. The studies on morphology suggest that Irrawaddies are one of, if not the most primitive of, the living dolphins. This would explain the similarity in looks—Irrawaddies have simply retained certain primitive features shared with river dolphins, Belugas and porpoises.

For the Irrawaddy Dolphin though, time may be running out. The IUCN *Red Book* of endangered species currently lists its status as "Insufficiently Known". Within northern Australia, an unknown number of animals is killed in net fisheries and they have been caught in shark nets set off northern beaches. Elsewhere along the Irrawaddy Dolphin's range, development is putting increasing pressure on this gentle creature. In Kalimantan, Borneo, for example, it is strongly suspected that logging along the lower parts of the Mahakam River may have caused their disappearance there. While some mysteries about the Irrawaddy Dolphin are being resolved, much work remains to be done. Field work will lead to a more accurate count of Irrawaddy Dolphins left in the wild, especially in northern Queensland and the Northern Territory where large populations are thought to exist. In this way, specific areas can be identified and possibly protected so that the species remains free to live in its natural environment. ■

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He would like to thank Dr Peter Arnold (Museum of Tropical Queensland, Townsville) for his help in compiling this article.

IRRAWADDY DOLPHIN

Orcaella brevirostris

Identification
Average 2.1 metres long, although 2.75-metre adults have been measured. Unlike most dolphins, Irrawaddy Dolphins range in colour from pale to dark bluish grey, lack a distinct beak, have a blunt head and a distinct and functional neck. Their dorsal fin is small and rounded at the tip. In the Irrawaddy River (but not Australia) they have been seen squirting water out of their mouths in a high, cylindrical arc.

Habitat and Distribution
Tropical rivers and estuarine and coastal habitats, from as far south as Yeppoon, Queensland, to as far north as India, Bangladesh and Burma (now Myanmar). Irrawaddies have been reported over 1,400 kilometres upstream in fresh water.

Diet
Bottom fishes, squid and shrimp.

Reproduction
Little known. Lifespan estimated to be about 30 years, with age of maturity about 4 or 5. One captive female gave birth to an 85-centimetre-long baby after a gestation period of 14 months.

Status
Little known. Preliminary surveys in Borneo indicate Irrawaddies are still fairly common in major river systems. In Australia, they are thought to be widespread in the tropical north, but no systematic survey has been conducted.

TONY PREEN

Clearly, whatever these creatures are, they are neither simple worms nor simple arthropods.

VELVET WORMS: NON-MISSING MISSING LINKS

BY MICHAEL ARCHER

ALTHOUGH ANXIOUS TO snatch another soul from Satan, the woman was having trouble getting her Bible inside my screen door. If she was unnerved by my confession that I was a palaeontologist it was not apparent. Without missing a beat she launched into her anti-evolutionary diatribe from the front step. It began with the joyful news of the Good Book before quickly moving onto the ungodly concept of evolution and the non-existence of links between the basic created kinds. Seeing no weakening of resolve in her intended prey, she fixed me through the screen with a predatory eye and challenged, "If the 'apemen' were so superior to apes, how come they died out but apes are still here?"

I sighed as I looked into those narrowed peepers wondering where to begin. "The 'apemen'—australopithecines—did not die out. We are those apemen, just as living apes are members of the group from which they descended. In the same way, dinosaurs didn't die out—they're still alive and kicking as modern birds. All that's happened is an evolutionary change through time in the shape of the creatures in these long-lasting lineages." Although the word 'dinosaur' caused an eyebrow to flicker, the rest appeared to produce a sour taste in her mouth. After a moment of awkward silence, she refreshed her grip on the Good Book and launched into the rest of her well-rehearsed litany. My response to her question was not going to be discussed.

The fossil record abounds with evolutionary links like australopithecines (linking humans to other apes). Most are intermediate species that link other species through time but some link high-level groups. *Archaeopteryx*, for example, flies across the gap between reptiles and birds, mammal-like reptiles pulverise the gap between reptiles and mammals (ANH Winter 1991) and archaic Eocene whales with small but functional limbs link the limbless and fully aquatic whales to land-dwelling mammals.

In contrast to evolutionary links, 'living fossils' are organisms that have maintained the basic form of their own ancient ancestors—biological exemplars of the adage 'When you're on a good thing, stick to it!' An example is the modern Platypus, which has Australian ancestors up to 110 million years in age and a 63-million-year-old Argentinian cousin, all with incredibly similar teeth despite the vast spans of time separating each from the other (ANH Summer 1990–91). Another is the Coelacanth (*Latimeria chalumnae*), a lobe-finned fish belonging to a group thought to have become extinct 80 million years ago—until 1938 when a 1.5-metre golden-eyed fish with fleshy limb-like fins nearly bit off the hand of the South African fisherman who tried

KATHIE ATKINSON

An unnamed peripatus collected from the forests near Macquarie Harbour on the west coast of Tasmania. This location is where Michael Archer saw his first specimen and it is just one of the many newly discovered species from Australia.

to pull it out of his net.

Among 'living fossils', some have the additional distinction of being descendants of groups that were also 'missing links'. Living peripatus or 'velvet worms' (onychophorans) are just such a doubly significant group. My first encounter with some of these extraordinary creatures was on a cliff face at Macquarie Harbour, Tasmania. We were searching early Tertiary rocks, desperately trying to find fossil mammals that would link Australia's living kinds to those that wiggled whiskers at the moonlight of a united Gondwana. With my nose only centimetres from the cliff struggling to determine the identity of a tiny enamelled tooth fragment, a diminutive brown sausage mounted on two rows of stubby little legs 'flow-walked' right in front of my eyes before vanishing into the vegetation overhead. Although the most graceful 'worm' I had ever seen, it looked like something that belonged in *Alice in Wonderland*.

I was to learn later that it was a peripatus, one of perhaps 100 species thought to exist in Australia (only ten of which have been formally described). Because these creatures seem to be half-worm (many-segmented worm-like body, soft skin and excretory tubules in most body segments) and half-arthropod (walking legs, antennae and a tracheal system for gas exchange), they have long been regarded as an interphyletic link between annelids (earthworms, leeches, marine worms) and arthropods (insects, spiders and other joint-legged invertebrates), two groups otherwise separated by a gulf, rather than a gap, of morphology.

As descendants of an ancient interphyletic link, peripatus should have a very old fossil record. Consequently, few were surprised when palaeontologists working on the Cambrian Burgess Shale deposit (now secured in Yoho National Park in Canada) discovered *Aysheaia*, a 530-million-year-old marine onychophoran. In this ancient community, it coexisted with familiar creatures like jellyfish and sponges, and totally unfamiliar beasts like the incredible predator *Anomalocaris*, the vacuum-cleaner-nosed, five-eyed *Opabinia* and the weird 'whatsit' *Hallucigenia*. This was a period in Earth's history when phyletic biodiversity was at its highest. By comparison, Earth's species-rich modern oceans are an embarrassment of phyletic poverty.

Fortunately, descendants of *Aysheaia* hung on, made the crossing to damp forests on land and now maintain a rubbery leg-hold in the shadowy places of the modern world. Noel Tait, Dave Briscoe and Mandy Reid from Macquarie University have been studying these midget carnivores for eight years (ANH Autumn 1989). Their discoveries, combined with studies of African peripatus, make it clear that this group is indeed extraordinary! Some males, for example, mate with their heads, dropping or ramming a spermatophore onto the female's skin. She dissolves a hole in her body under the offering, sucks it in and then mix-matches its genetic contents with her own. In some forms, the unborn young are nourished by means of a placenta similar to that which nourishes unborn mammals. Then, again depending on the species, some are popped into the world as an egg that can take an incredible 17 months to hatch, while others are squeezed out live like pale little bits of legged string. Clearly, whatever these creatures are, they are neither simple worms nor simple arthropods.

In view of the 530-million-year-old *Aysheaia*, no-one has challenged the 'living fossil' status of peripatus. But their role as a 'missing link' between annelids and arthropods has been questioned. For example, it was suggested on the basis of molecular studies using mitochondrial DNA that onychophorans might be a specialised group of arthropods that became secondarily annelid-like.

But most recently Ward Wheeler (American Museum of Natural History) and his colleagues have flattened all prior scepticism. With new and far more detailed molecular data, and a critical review of previous arguments, they conclude that onychophorans are unmistakably between annelids on the one hand and arthropods on the other—so they are, on the best evidence available, non-missing 'missing links' after all. The irony of this is that it has taken some of modern science's most sophisticated techniques to rediscover the same conclusion reached over 50 years ago by Robert Snodgrass (US Department of Agriculture) on the basis of good 'old-fashioned' anatomical studies. Science lurches ahead.

As my would-be saviour at the kitchen door droned on about the nonsense of missing links, I couldn't help wondering what she would have done if she saw a little velvet worm gliding towards her across the open pages of her Good Book, bringing her the Good News about missing links. ■

Further Reading

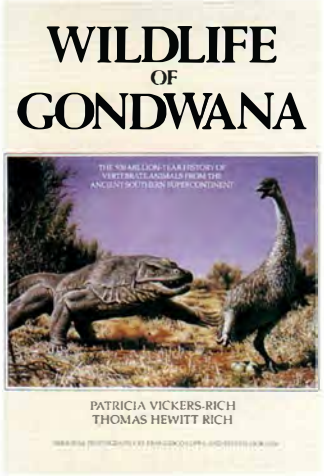
Gould, S.J., 1989. *Wonderful life.* Hutchinson Radius: London.

Snodgrass, R.E., 1938. Evolution of the Annelida, Onychophora and Arthropoda. *Smith. Misc. Coll.* 97: 1–59.

Wheeler, W.C., Cartwright, P. & Hayashi, C.Y., 1993. Arthropod phylogeny: a combined approach. *Cladistics* 9: 1–39.

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



Wildlife of Gondwana

By Patricia Vickers-Rich and Thomas Hewitt Rich. Reed Books, NSW, 1993, 276pp. $59.95rrp.

After years of having to subsist on Northern Hemisphere books presenting Northern Hemisphere fossils, Australia has in the past decade or so finally acquired a suite of good, home-grown publications dealing with its home-grown fossil record. One of the prominent publishing events of that period was Mary White's *Greening of Gondwana*. This book details the evolution of Australia's plant life, putting it into a global context and bringing it to life with a lavish array of colour photographs of the fossils themselves.

It has taken until now for a complementary volume on the vertebrate animal life to appear, and *Wildlife of Gondwana* follows a similar general format to *Greening of Gondwana*.

The preliminary part, "Gondwana in Perspective", provides a framework of ideas to support the illustrated fossil record that forms the bulk of the book. In the introductory section, the geological history of Gondwana is explained, after which the reader is taken on a quick trip through the major evolutionary events of each time period until the present. The second part, "The Search for Beginnings", is a brief history of Australian vertebrate palaeontology, introducing the major events and workers until the present.

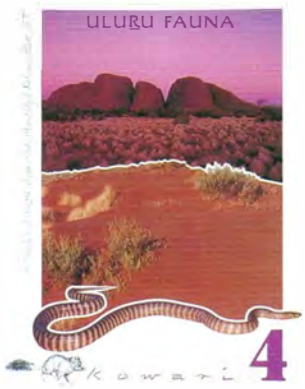
The third part constitutes the major section of the book. "Fossil Vertebrates of Australia" moves chronologically from the appearance of Gondwana's first vertebrates, over 500 million years ago, passing through such notable events as the Age of Fishes, the emergence of the first land vertebrates, the appearance of the dinosaurs, and the rise and fall of the megafauna. The specimens are presented in high-quality colour photographs, most of which were taken especially for the book by Francesco Coffa and Steven Morton. These are complemented by good text illustrations and some excellent reconstructions by artist Peter Trusler that make the reader wish that more had been included.

The book concludes with a quick look at "Gondwanan Faunas in Global Context", a photographic survey of significant vertebrate fossils from other southern continents once connected to Australia. This is followed by a glossary of terms.

Wildlife of Gondwana should appeal to a varied audience. For the secondary or tertiary student it provides good background material introducing the history of vertebrates and palaeontology in Australia. For the fossil enthusiast, and even the casual browser, it contains an invaluable compilation of excellent photographs that has no equal as a pictorial record of Australia's vertebrate history.

Pat Vickers-Rich and Tom Rich are to be congratulated on their efforts in bringing this impressive work to publication. It deserves to have a wide reception. It is obvious that I am not the only one who likes this book. The authors received the Eureka Award for *Wildlife of Gondwana* as best book for 1993. And a worthy winner it is too.

—Walter Boles
Australian Museum



Kowari 4: Uluru Fauna

By J.R.W. Reid, J.A. Kerle and S.R. Morton. Australian National Parks & Wildlife Service, Canberra, 1993, 152pp. $30.00rrp.

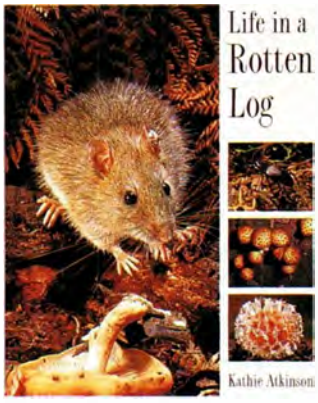
Uluru fauna reports the results of the most detailed ecological survey of vertebrate animals that has been carried out in arid Australia. Working at eight sites in Uluru National Park, Northern Territory, the authors took a census of vertebrates on seven occasions between September 1987 and March 1990, and obtained records of three frog, 70 reptile, 117 bird and 25 mammal species. Valuable though this survey information is, the real importance of *Uluru fauna* lies in three further aspects.

First, an attempt is made to identify the functional processes that produce patterns in the distribution and abundance of species within the Park. Rainfall and fire are most obviously important, but the probable impact of feral species such as rabbits, foxes, cats and camels is also acknowledged. Second, detailed recommendations are given for monitoring and active management within the Park to indefinitely maintain its current complement of vertebrate species. Management is essential to mitigate the effects of feral species and of tourism in areas such as Yulara Village, Kata Tjuta (the Olgas) and Uluru itself. Finally, and perhaps most importantly, extensive information has been contributed to the survey by Anangu, the traditional owners of the Land. This information includes detailed knowledge of the biology of many vertebrate species, their Anangu names, and insight into the practices that Anangu use to "look after country". Some knowledge is intriguing and should surely stimulate further investigation. For example, novel insight is provided into the food-hoarding behaviour of the Spinifex Hopping Mouse (*Notomys alexis*), vocalisations are documented in reptiles such as the Sand Python (*Aspidites ramsayi*) and Burton's Snake-Lizard (*Lialis burtonis*), and nurturing of young is described in others such as the skink *Menetia greyii* and goanna *Varanus eremius*. Linking Anangu knowledge with the conventional scientific approach, *Uluru fauna* produces recommendations for management of Uluru National Park that are more extensive and better informed than for any other reserve area in arid Australia.

Fourth in a series of book-length publications produced by the Australian Nature Conservation Agency (formerly Australian National Parks and Wildlife Service), under the Kowari title, *Uluru fauna* maintains the same unusual spiral-bound format, high-quality presentation of scientific information, and tradition of superb colour illustrations. My only (minor) quibbles with this book are that two components of the Uluru fauna—frogs and bats—are dealt with very briefly and that the quality of several computer-generated figures is rather poor. There is also some tendency for repetition between sections (for exam-

ple, much earlier material is restated in Chapter 8), perhaps inevitable in a multi-authored book. Nonetheless, *Uluru fauna* is an important, pioneering work and, at $30.00, represents excellent value. It is essential reading for anyone concerned with the biology of arid Australia.

—Chris Dickman
University of Sydney



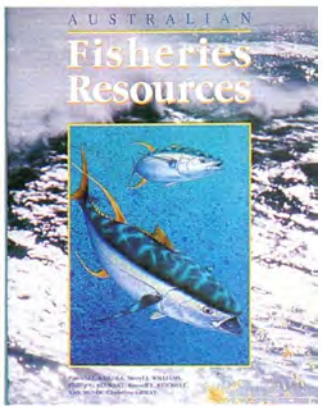
Life in a Rotten Log

By Kathie Atkinson. Allen & Unwin Press, NSW, 1993, 32pp. $16.95rrp.

For children who are interested in natural history the title alone should make this book a prized possession. *Life in a rotten log* takes the reader on a trip through the steady march of decay from the initial collapse of a tree in a forest to its final scattering amongst the litter and humus on the forest floor. It even points to new beginnings with the start of a new tree in the ruins of the old. This book shows that, far from being an uninteresting and unpleasant process, the rotting of a tree provides food and lodging for a whole succession of organisms. This is amply illustrated by Kathie's excellent colour photos that make even leeches appear attractive camera subjects.

The text is concise without being dull or unreadable and boxes appear on various pages with additional "did you know"-type information. It should be readily assimilated by young readers or easily interpreted by parents for even younger listeners. Accuracy seems excellent and there is even some ground-breaking information with the unidentified producer of a bizarre egg sac being finally revealed (upon hatching of the sac) as a land leech. Pedantics like me will find it difficult to pick errors or discrepancies. The copy I saw was a hard cover and reasonably priced. It runs 32 pages including the index. All in all, an excellent book for the budding naturalist.

—Martyn Robinson
Australian Museum



Australian Fisheries Resources

Ed. by Patricia Kailola et al. *Bureau of Resource Sciences, ACT, 1993, 422pp. $120.00rrp.*

At last! Fellow fishers, students, gourmets and budding economists take note. Here is an entertaining encyclopedia of Australia's commercial fish and fisheries. Even to a teacher of fish biology, Australia's fisheries are bewilderingly diverse. Over 200 species of fish, 60 species of crustaceans and 30 species of molluscs pass through our nation's markets, making our fisheries one of the most complex in the world. And, the last overview of Australia's fisheries was a map and explanatory booklet published in 1965! Since then the Gulf of Carpentaria prawn fishery developed and stabilised, the gemfish and Southern Blue Fin Tuna catch bloomed and collapsed, aquaculture increased to almost a fifth of total fisheries production, the 200-nautical-mile Australian Fishing Zone was declared and, most recently, we have witnessed the Orange Roughy gold rush.

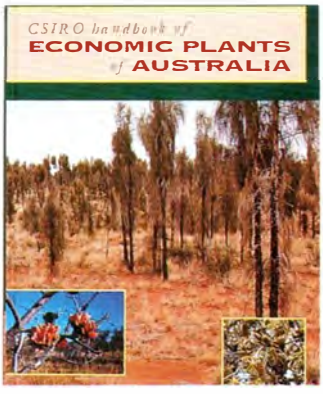
How can anyone keep tabs on all these species? How often is one asked how and where are Ocean Perch caught? Where do our other fish and invertebrates come from and how are they caught? Much of this information has languished in filing cabinets and unpublished theses or fisheries pamphlets for years. Patricia Kailola and fellow editors have now assembled this disparate information into one solid and high-quality reference on 101 species of fish and 45 species of invertebrates (with another 172 less common species noted in brief). To do this, they acknowledge nearly 500 experts from around Australia who provided information and reviewed the text.

In the first chapter, Australia's fishery is placed into an international context. It ranks 55th in the world with only 200,000 tonnes caught annually, and yet has the third largest fishing zone in the world. The reasons are found in the next chapter, describing the pivotal role of Australia's nutrient-starved oceans, and the relatively small continental shelves. Fish habitats such as coral reefs, coastal environments, estuaries and rivers are reviewed, and the environmental threats are highlighted. Next we are introduced to the main types of fishing gear, marketing, fish quality and taste.

The central chapter is the gem. It is a goldmine of fisheries information on distribution, price, reproductive and feeding habits—all gleaned from many sources and documented in a consistent fashion for each species. Did you know bream and Barramundi can change sex during their lives (as do many other species)? It is hard to fault this book (other than the unfortunate price and a list of corrections that seems excessive). Perhaps a few more photographs with more extensive captions, and a section on basic fisheries management. Fish must be left in the ocean to spawn at least once, yet our ability to do this with highly advanced fishing techniques is difficult to achieve. When the next version comes out (on CD ROM the editors propose), let us hope that our main money makers in Australian fisheries will still be with us.

Australian fisheries resources is available through the Bureau of Resource Sciences, Can-berra, and Patricia Kailola c/- Fisheries R. & D. Corp-oration, PO Box 9025, Deakin, ACT 2600.

—Iain Suthers
University of NSW



CSIRO Handbook of Economic Plants of Australia

Ed. by M. Lazarides and B. Hince. CSIRO, Melbourne, 1993, 330pp. $50.00rrp.

This is a disappointing book. It claims to be an "authoritative collation of information on important economic plants found in Australia", and one of its major objectives is to provide preferred common names for these plants. Unfortunately, it falls far short of these aims.

Most of the book is an annotated index of plants, listing each plant's scientific name, preferred common name (where available), growth form and references. Native, cultivated and naturalised plants are included where these are significant as fodder plants, weeds, foods, medicines, timber trees, poisons, crops or ornamentals.

The many shortcomings of the book fall into three main categories: omissions, poor name choices and errors.

First the omissions. I was amazed to find no mention of the very first plants I looked up, Powderpuff Lillypilly (*Syzygium wilsonii*) and Cherry Alder (*S. luehmanii*). Both are very popular native garden plants, and the latter is a mainstay of the bush foods restaurant trade

(marketed as "Riberry"). Other remarkable omissions include Coast Pandanus (*Pandanus tectorius*) and Brown Pine (*Podocarpus elatus*). It is also odd that no common names are given for *Ipomoea pescaprae* (Goats-foot Convolvulus), *Billardiera scandens* (Common Appleberry), *Tacca leontopetaloides* (Polynesian Arrowroot), *Ficus benjamina* (Weeping Fig), *Mallotus philippensis* (Red Kamala), *Jagera pseudorhus* (Foambark) and many others, although the plants themselves are listed under their scientific names. 'Polynesian Arrowroot' is well known overseas and in Australia by this common name and its omission from the book, like many others, seems inexplicable.

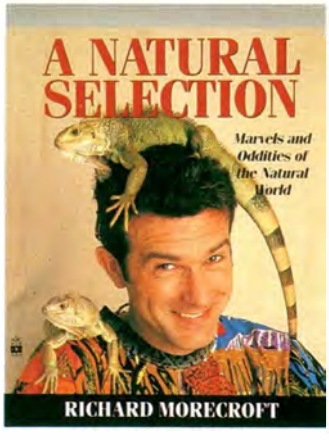
Some of the recommended common names also seem poor choices. Unbelievably, 'Snotty-gobble' is proposed as a common name for the genus *Cassytha*. Three *Cassytha* species are listed in the book, yet (fortunately) none is given this common name or variants of it. However, one of the three, *C. filiformis*, is listed as 'Dodder', thereby ensuring confusion with true dodders (*Cuscuta* species), which are entirely unrelated plants. The same common names are also shared by other groups of plants, for example 'White Mahogany' for *Eucalyptus acmenoides* and *E. umbra*. The compilers have not heeded the preface of this book, which states: "It is essential that the common names we apply to these plants do not cause confusion".

There are many other common names that may prove unpopular, for example 'Furze' for Gorse (*Ulex europaeus*), 'Common Sida' for Sida Retusa (*Sida rhombifolia*), and 'Leichhardt Pine' for *Nauclea orientalis*, which is not a conifer. The CSIRO should take a cue from the Royal Australasian Ornithologists Union, and explain how its more contentious common names were chosen.

Of errors noted in passing, the most extraordinary was the listing of the Pistachio (*Pistachio vera*) as an Aboriginal food, with an incorrect reference. Incorrect references were also noted for *Piper* and *Pipturus*. *Solanum aviculare* is wrongly listed as an introduced plant. I didn't go looking for errors and there are no doubt many more.

This book obviously suffered major problems during production. Too few references were consulted, too little consideration was given to choice of common names, and too little care was taken in compilation. The CSIRO should act swiftly to produce a corrected edition. To their credit, the editors invite comment on common names, errors and omissions. But where to begin?

—Tim Low



A Natural Selection

By Richard Morecroft. Simon & Schuster, NSW, 1993, 108pp. $19.95rrp.

People tell me that some women have fantasies about Richard Morecroft, but I could never see it myself. That is, until I saw the picture of him with an iguana on his head. Now I realise the secret of his magnetic effect on the opposite sex.

Although iguanas don't feature in Richard's new book, lots of other interesting things do. Richard has teamed up with the expert writers and photographers that contribute to *Australian Natural History* magazine (ANH) to produce a fascinating pot pourri of international wildlife facts.

For instance, did you know that tiny snails are slowly munching their way through the rocks of Israel's Negev Desert, or that frogs swallow with their eyes, or that preying mantises have only one ear and it's between their wings?

In the book's introduction, Richard says discovering the diversity and richness of life in the wild is like "having a huge box of intriguing chocolates to keep sampling. Go on, try another," he says, "It's a natural selection".

This book is divided into six chapters on topics such as what's good for dinner, raising babies, how animals' bodies work and, of course, good old sex. The latter unsealed section begins with a few basic evolutionary lessons. It points out that males need to pass their genes on to as many females as possible, but that females need only the best genes for their offspring. This explains a lot of animal (and other) behaviour.

The bodyworks chapter has some gems. The book discusses the unusual *Uraba lugens* caterpillars, which keep their old head capsules stuck onto their new heads. Richard has wisely used Densey Clyne's wonderful common name of "hatterpillars" for these nifty critters. This chapter also contains the extraordinary tale of the shrimp-like stomatopods. These charming creatures either smash or impale their prey by flicking out their front claws like futuristic boxing gladiators in a terminator movie. It is claimed they have the power of a .22 bullet in their claws. Hard to believe isn't it?

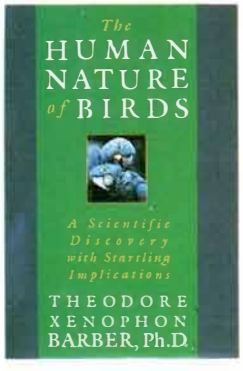
Did you know that snails are munching their way through the rocks of the Negev Desert?

This book is lavishly sprinkled with many of the great photographs that accompanied the original items in ANH. And, it is full of fascinating information written in an interesting style and at a level that is easy to understand. Each topic is covered in a few hundred words, so it's a great book for dipping into at bedtime.

Finally, I couldn't agree more with Richard when he says he can't help feeling that the more people find out about our remarkable and unusual creatures, the more they will be concerned about them. This is why the venerable institution of ANH is such a great concept!

Oh yes, and Richard, can I borrow one of your iguanas next Saturday night?

—John Dengate
The Environment Protection Authority



The Human Nature of Birds: A Scientific Discovery with Startling Implications

By Theodore Xenophon Barber. Bookman Press, Melbourne, 1993, 226pp. $29.95rrp.

T.X. Barber has not conducted research on birds but he has read a lot about their behaviour and concludes that "birds are fundamentally as aware, intelligent, mindful, emotional and individualistic as ordinary people". He believes this fact to have been hidden by an "official taboo" on the part of "orthodox scientists" who "will strive to remove it from scientific consideration by ridicule and direct and indirect attacks". Against such extravagant claims and defence, one does not need to employ ridicule but there is room in this brief review for some direct attacks.

First, Barber's central claim is false; few, if any, workers in the field of bird behaviour treat these creatures as nothing but instinctual automata. Time and again, apparently purposive behaviour is discovered to

be instinctive, but every investigator recognises that there is an element of individual learning in the fine-tuning and expression of such inherited patterns. "Orthodox" zoologists recognise flexibility in bird behaviour but, unlike Barber, we do not call this "intelligence".

Second, Barber is culpably selective. Among some 500 citations there is not a single reference to such outstanding authorities on bird behaviour as Tinbergen and Lorenz. He refers to the "intelligence" of cuckoos without mentioning what might, in contrast, be called the "stupidity" of their hosts. Inflexible aspects of bird behaviour are largely disregarded.

Third, in his effort to equate the behaviour of birds and humans, Barber exaggerates the part played by instinct in the latter. In making a case for birds, he is led to such meaningless statements as birds are superior to humans in being "able to earn a living and raise a family without special aids or tools".

Fourth, he is sadly uncritical. A large section of the book is devoted to accounts of the behaviour of parrots that have been trained, or have learned, to associate certain behaviours with rewards. These birds undoubtedly display a high level of learning and discrimination but, as the long debate on the use of sign language by apes has been demonstrated, it is very difficult to distinguish between elaborate conditioning and the rational use of symbols. Extending his argument to other animals, including fishes and ants, Barber dwells for a while on apes and is sufficiently impressed to cite an instance when, using sign language, a Gorilla supposedly discussed its views on death and what happens to Gorillas when they die.

Barber undoubtedly means well but, having rediscovered the wheel, he has interpreted it as a juggernaut. This is a confused and confusing book that will probably be well received by animal liberationists and New Age devotees who share the author's fuzzy sentiments.

—Ronald Strahan
Australian Museum

Just Published

May

Systematic & Applied Entomology
By I. Naumann. Melbourne University Press, Vic. $49.95.

June

A Field Guide to Crustaceans of Australian Waters
By D. Jones & G. Morgon. Reed Books, NSW. $34.95.

Australian Beetles
By J. Lawrence & E.B. Britton. Melbourne University Press, Vic. $39.95.

Name That Flower
By I. Clarke & H. Lee. Melbourne University Press, Vic. $29.95.

July

After the Greening
By M. White. Kangaroo Press, NSW. $69.95.

Restoring the Land: Environmental Values, Knowledge and Action
By L. Cosgrove, D.G. Evans & D. Yencken. Melbourne University Press, Vic. $29.95.

Propagating Native Plants
By Blombery & Maloney. Kangaroo Press, NSW. $19.95.

August

Mammals of New Guinea (revised ed.)
By T. Flannery. Reed Books, NSW. $75.00.

Ferns and Allied Plants of Victoria, Tasmania and South Australia
By B. Duncan & G. Isaacs. Melbourne University Press, Vic. $29.95.

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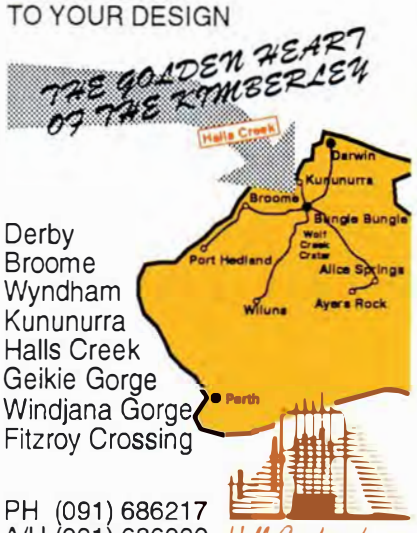

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ANIMAL WELFARE

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

Contact: Glenys Oogjes, Director

An umbrella body for 40 animal welfare/rights groups. Joining fee $30. A quarterly magazine *Animals Today* covers Australian, New Zealand and overseas animal welfare issues.

BIRDS

Australian Bird Study Association
PO Box A313, South Sydney,
NSW 2000.
Phone: (02) 688 0861

Contact: Graham Cam, President

Join us and promote Australian bird studies: receive 5 readable issues on researching Australian birds: newsletters provide current trends and events: participate in bird banding.

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

Contact: Zoe Wilson, Manager

Australia-wide network of bird-watchers. Members receive *The Bird Observer*, a monthly birdwatching magazine. Birdsong catalogue available. Participants welcome in conservation program and current "Birds and Wattles Survey".

Cumberland Bird Observers Club Inc
PO Box 550,
Baulkham Hills, NSW 2153.
Phone: (02) 872 4185
(answering machine)

Contact: Frances Czwalinna,
Hon Secretary

Monthly meetings at Community Hall, cnr Old Northern Road and Old Castle Hill Road, Castle Hill. Field outings for adults and children, campouts. Newsletters.

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

Contact: Robyn Hill,
Hon Secretary

Monthly meetings at the Australian Museum, field outings, Pelagic trips, newsletters & journals, Birdline 267 8961, New Year's campout. Occasional coach, camping and o/s trips.

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

Contact: Michelle Rice,
Development Manager

Everyone interested in birds welcome to join; receive colour newsletter, join social and educational activities, support bird conservation projects, visit observatories, discounted optical equipment.

EDUCATION

CSIRO's Double Helix Science Club
PO Box 225,
Dickson, ACT 2602.
Phone: (06) 276 6643

Contact: Lynn Pulford,
Membership Secretary

Double Helix offers young Australians a fascinating and fun link with scientific research - a bimonthly magazine, national experiments, competitions and many local events.
Over 20,000 members.

Gould League of Victoria Inc
PO Box 446,
Prahran, Vic 3181.
Phone: (03) 510 1493
Fax: (03) 521 1217

Contact: Gayle Seddon,
Environmental
Education Officer

Provides resources for environmental education and waste minimisation programs. Annual membership ($20) including 6 issues of the newsletter *Greenprint*; Platypus Creek Club for young people ($5).

INSECTS

The Australian Entomological Society Inc
c/- Dept of Crop Protection
Waite Campus,
University of Adelaide,
PO Glen Osmond, SA 5064.
Phone: (08) 370 2987

Contact: Dr Paul Madge,
Hon Secretary

Society aims to advance and disseminate entomological knowledge. Quarterly journal and news bulletin are produced; annual scientific conference held on 24-28 September in Adelaide.

MOLLUSCS

Malacological Society of Australasia
c/- Australian Museum,
Division of Invertebrate Zoology,
6 College St, Sydney, NSW 2000.
Phone: (02) 339 8275

Contact: Alison Miller, Assistant
Secretary

Society fosters the study of molluscs and environmentally responsible shell collecting in Australia. Branches throughout Australia, regular meetings, talks, discussions and excursions. Quarterly newsletter and annual journal.

MUSEUMS

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

Contact: Susan Bridie,
Executive Secretary

Society members enjoy free admission to the Museum, receive ANH magazine as part of their membership, and also enjoy an exciting and diverse program of activities.

Friends of the Queensland Museum
c/o Queensland Museum
Association,
PO Box 3300,
South Brisbane, Qld 4101.
Phone: (07) 840 7555

Contact: Sandra Mann,
Executive Officer

The Queensland Museum Association provides a program of education and recreational events which encourage greater understanding of the natural resources and history of Queensland.

The Waterhouse Club
South Australian
Museum,
North Terrace,
Adelaide, SA 5000.
Phone: (08) 207 7389

Contact: Mary Lou Erskine,
Secretary

The Club offers members stimulating involvement with the Museum through activities such as the annual September Flinders Ranges Expedition led by three curators, and 'behind the scenes' tours.

NATURAL HISTORY

The Biological Society
Botany Dept,
University of New England,
Armidale, NSW 2350.
Phone: (067) 73 3006

Contact: John T. Hunter,
President

For anyone interested in natural history. Members enjoy social interchange, reduced costs at functions, BBQs, field trips etc., and receive a quarterly newsletter.

Field Naturalists' Society of SA
GPO Box 1594,
Adelaide, SA 5001.
Phone: (08) 272 9368

Contact: Mrs G. Briggs, President

Actively promotes the study of nature and its protection: offers monthly bus excursions, field trips by private car and lectures by knowledgeable leaders.

Linnean Society of NSW
PO Box 457, Milsons Point,
NSW 2061.
Phone: (02) 929 0253

Contact: Mrs. B.J. Stoddard,
Secretary

The Linnean Society aims to promote research in natural history with research grants, a fellowship, publication of research papers, lectures, field trips and newsletters.

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

Contact: Mr. J.F. Wallman,
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.

SCIENTIFIC RESEARCH

ASSAB, Australasian Society for the Study of Animal Behaviour
c/- Dept of Zoology,
University of Queensland,
St Lucia, Qld 4072.
Phone: (07) 365 2491

Contact: Dr Kevin Warburton,
Secretary

Open to all interested in the study of animal behaviour, research on a wide range of vertebrate and invertebrate species, newsletter, directory, annual conference.

ZOOLOGICAL

ASZK, Australasian Society of Zoo Keeping
PO Box 248,
Healesville, Vic 3777.
Phone: (059) 62 4022

Contact: Carla Srb, Membership
Officer

Join the ASZK and you will discover more about wildlife, zoos and conservation through our journal, newsletters, conferences and discounted entry to zoos. All welcome.

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Q&A

Cat Napping

Q: *As I am a great cat lover, I would like to know how many hours a day a cat would spend asleep?*

—S. Josephi-Taylor
Mount Lawley, WA

A: Domestic cats have been known to sleep for about 17 hours per 24-hour day. However, this behaviour by no means applies to all cats. Age, sex and food resources can determine how active a cat is. Most of the time they are, of course, engaging in 'cat napping' rather than the continuous period of deep sleep we are familiar with.

—Linda Gibson
Australian Museum

Just how many hours do cats spend sleeping?

Popular Palms?

Q: *Are the orange fruits of the Royal Palm (which is planted in many of the gardens of the north coast) edible? If so, do they require any special preparation? I've seen many bees and Rainbow Lorikeets enjoying the pollen from the flowers, but are there any birds or mammals that eat the fruits?*

—T. Mihe
Sawtell, NSW

A: I think the palm you are inquiring about is the Queen Palm, not the Royal Palm. Both are frequently used on the north coast but the Queen Palm is by far the most common. The Queen Palm (*Syagrus romanzoffianum*) has orange fruit in large bunches, while the Royal Palm (*Roystonea regia*) has small purplish fruits. There are reports of the fruits of the Queen Palm being eaten by children in the USA and they are said to have a "fibrous pulp rich in mucilaginous sweetness". No special preparation is apparently required. A starchy food is made from the pith of the trunks in its native Brazil and the young buds are eaten locally in oil or vinegar. On the north coast of New South Wales, bats have been seen to eat the fruit. I would suggest that the fruit is not toxic but on the other hand not particularly palatable or there would not be as many fruits lying under the thousands of plants being grown in resorts and private gardens of the subtropics.

—John Wrigley
Horticultural Consultant
Coffs Harbour, NSW

DENSEY CLYNE/MANTIS WILDLIFE

A wingless female Blue Ant.

A Case of Mistaken Identity?

Q: *The article on funnel-web spiders by Mike Gray (ANH Summer 1992–93) prompts me to inquire if Mike is aware of which species of funnel-web inhabits the north-western region of Queensland in which I live (the Lawn Hill area on the eastern edge of the Barkly Tableland some 350 kilometres north of Mt Isa) and, if so, how its toxicity compares with the Sydney Funnel-web (Atrax robustus).*

—B. Kubala
Adels Grove, Qld

A: I would be very interested in seeing any spiders from the Lawn Hill area suspected of being funnel-web spiders. That area is outside the current understanding of funnel-web distribution (currently believed to be confined to the wetter east coast and highlands of Australia). There are several other spiders in the area that could be mistaken for funnel-webs—many genera of the ground-dwelling spiders have the same general appearance (various trap-door spiders, for example). However, one never knows—send a specimen to me at the Australian Museum!

—Mike Gray
Australian Museum

HORIZON

The Ant and the Mole Cricket

***Q**: I photographed a large, ant-like insect that is called a 'bluebottle' here in southern Victoria. Its body is a deep, shining blue and it has orange legs. I took the photograph just after watching the insect paralyse (or kill?) a mole cricket. I have always assumed that it is some kind of wingless wasp. Can you tell me anything about its life cycle?*

—Nick Romanowski
Colac, Vic.

A: The metallic blue ant-like insect you describe is actually a wingless female wasp of the species *Diamma bicolor* (family Tiphiidae). They are popularly known as Blue Ants. Although most female tiphiid wasps are wingless, the males are of normal appearance with fully developed wings. The males are, however, much smaller and black in colour, except for some small yellow abdominal markings. The wingless female wasps hunt mole crickets. The crickets are dragged from their tunnels and immediately immobilised by a single sting. Each female stocks her own tunnel, which she has previously excavated, with a cricket and lays an egg on the limp but still living body. The wasp larva feeds and develops on the paralysed cricket, which remains alive throughout much of this ordeal.

—Max Moulds
Australian Museum

Answers to Quiz in Quips, Quotes & Curios (page 18)

1. **An elephant bird**
2. **Fraser Island**
3. **1859**
4. **An African Grey Parrot**
5. **Australian Conservation Foundation**
6. **Patricia Watson**
7. **A Great Sperm Whale**
8. **Murray Island (Mer)**
9. **An underground fungus**
10. **A type of flatworm**

CARL BENTO

P I C T E A S E R

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. Autumn's Pic Teaser was a closeup of the chest feathers of a bird—the African sunbird *Nectarinia senegalensis*.

Braised kid goat and smoked wild boar are just as tasty, lean and free of contaminants as any other product coming off the rangelands.

BEYOND THE KANGAROO

BY DAVID FREUDENBERGER

Eat 'em or wear 'em: what's good for kangaroos is good for the rest of the mob.

FORD KRISTO

WE'VE HEARD THE argument that kangaroos should be shot for human consumption. Eating premium-quality kangaroo products should raise its value to the point that pastoralists can make money out of kangaroos and afford to run fewer sheep, thus giving the land a break. Through the persistent efforts of Professor Gordon Grigg (University of Queensland) and others, kangaroo is now on the restaurant menu in all States and is appearing in the supermarkets. Kangaroo marketing is currently a $62-million dollar business with the potential for a five- or six-times increase. It's now mainly a matter of time to see whether Gordon's hope of better land management through better use of kangaroos is fulfilled.

In the meantime, commercial harvesting ought to pay for the huge kangaroo management programs. Millions of dollars are spent each year monitoring the conservation status of 30 million kangaroos. Yet the large kangaroos are secure in their vast numbers; there are more of them than sheep in the rangelands! Far more attention and resources should be given to the Rufous Hare-wallaby, the Northern Hairy-nosed Wombat, the Bilby and so many other species on the brink of extinction.

Kangaroos are not the only free-ranging animals on the land. There are uncontrolled millions of feral goats, rabbits, pigs, donkeys, camels and horses out there. Combined with domestic stock, these multitudes of animals are eating the heart out of the continent. What's good for kangaroos, the land and us is appropriate for the rest of the mob. Braised kid goat and smoked wild boar are just as tasty, lean and free of contaminants as any other product coming off the rangelands. Harvesting free-range rabbits won't make a dent in their population but returns from harvesting can at least help pay for the fuel to bulldoze warrens—an effective rabbit control measure.

It would be great to exterminate these pests, but who is going to pay for the monumental cost to do so? It took hundreds of hours over six months to exterminate the last few feral goats on Woody Island (26 square kilometres) in Hervey Bay, Queensland. Yet, goats are running across 35 per cent of the continent. The only solution is to create enough demand for their meat or hide to pay for sustained and indefinite control.

Some argue that shooting these animals is cruel and unnatural; I argue that to do otherwise is wrong. The alternative to instant death in the paddock from a bullet is slow starvation. We have little choice but to act as a swift and efficient predator if we want to lessen the suffering of the arid lands and its animals. Prior to the extinction of the Thylacine, local extermination of the Dingo and development of stock water, the arid lands took care of themselves. Populations of kangaroos would have built up during years of average rainfall, plummeted in drought years due to rapid death (by dehydration), and the predators would have ensured that numbers remained low until the land had a chance to recover. Today, only malnutrition and starvation reduce the multitude of free-ranging animals. Without human predation, overgrazing is chronic, grasses rarely have a chance to recover, and the land degrades.

What predators remain are the wrong ones: foxes and cats. They do little to reduce the overabundance of the dominant grazing animals. Yet they are responsible for the extinction and endangerment of too many birds and small mammals. For the moment the same solution should apply; shoot 'em and wear 'em. The animal liberation movement has a lot to answer for. Few dare to wear a fox skin coat. There is no demand to shoot foxes, and so their numbers go unchecked. Feral cats belong around our necks as wonderfully soft shawls or hats, but who has the nerve these days? Although commercial harvesting for skins will not eliminate the threat imposed by these exotic predators, it will at least give some of the smaller native species a better chance of survival.

But it's not just our pest species that need to be culled. I must insist that sheep are shot too. It is cruel to allow sheep to starve, and the land suffers as well. It is wrong that 3.5 million sheep starved during the recent drought in western New South Wales. Pastoralists widely advocate shooting kangaroos and ferals, but sheep need to be reduced for the same reason; their numbers build up due to plenty of stock waters and few predators. The extra sheep that can be carried during unusually wet years must be seen as a bonus. When normal dry conditions return, they should be sold or placed on agistment. If this is not possible, then they must be shot.

Harvesting is only a tool of sustainable land management. Without individual and community motivation to act wisely, the land and its resources will continue to degrade. A desire to care is the well-spring for sustained motivation. Let us show we care by expanding our palates and our wardrobes and, in so doing, help reduce the plethora of animals driving the land to dust. ■

Dr David Freudenberger is a research ecologist with the National Rangelands Program, CSIRO Division of Wildlife and Ecology. This essay is based on a paper presented at a Horizons for Science Forum at the University of Technology, Sydney.

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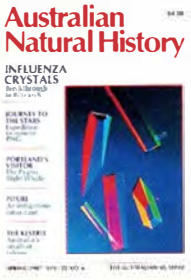

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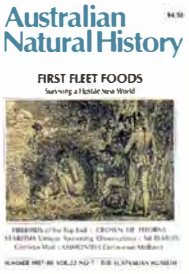

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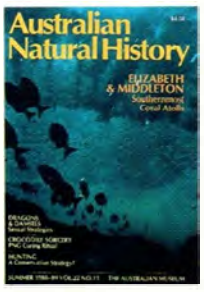

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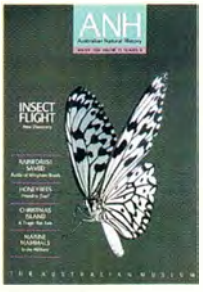

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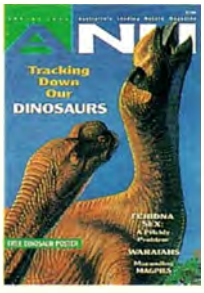

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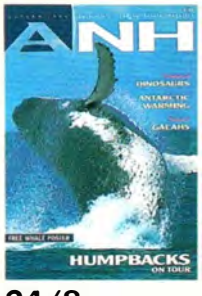

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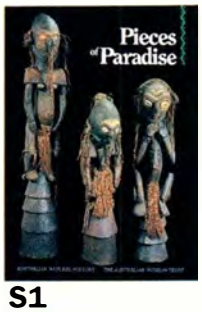

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