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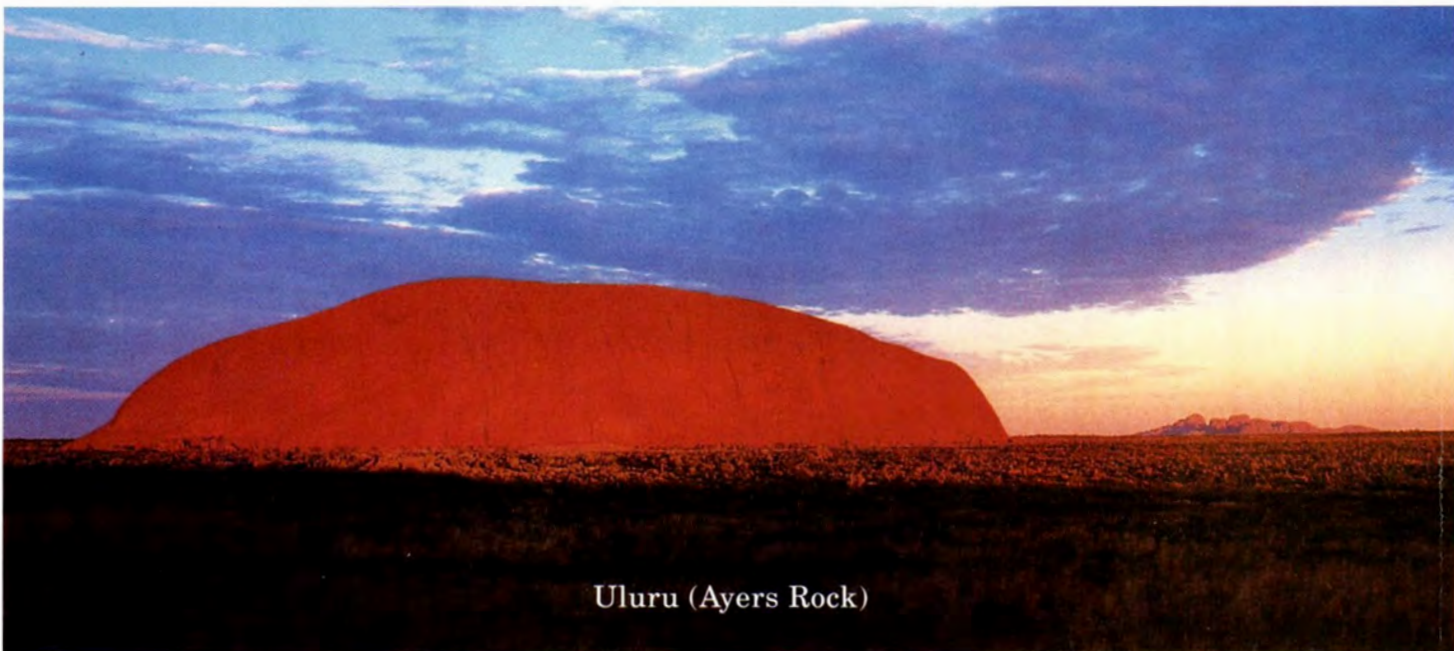
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HUMPBACKS
ON TOUR

These places are world famous.



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

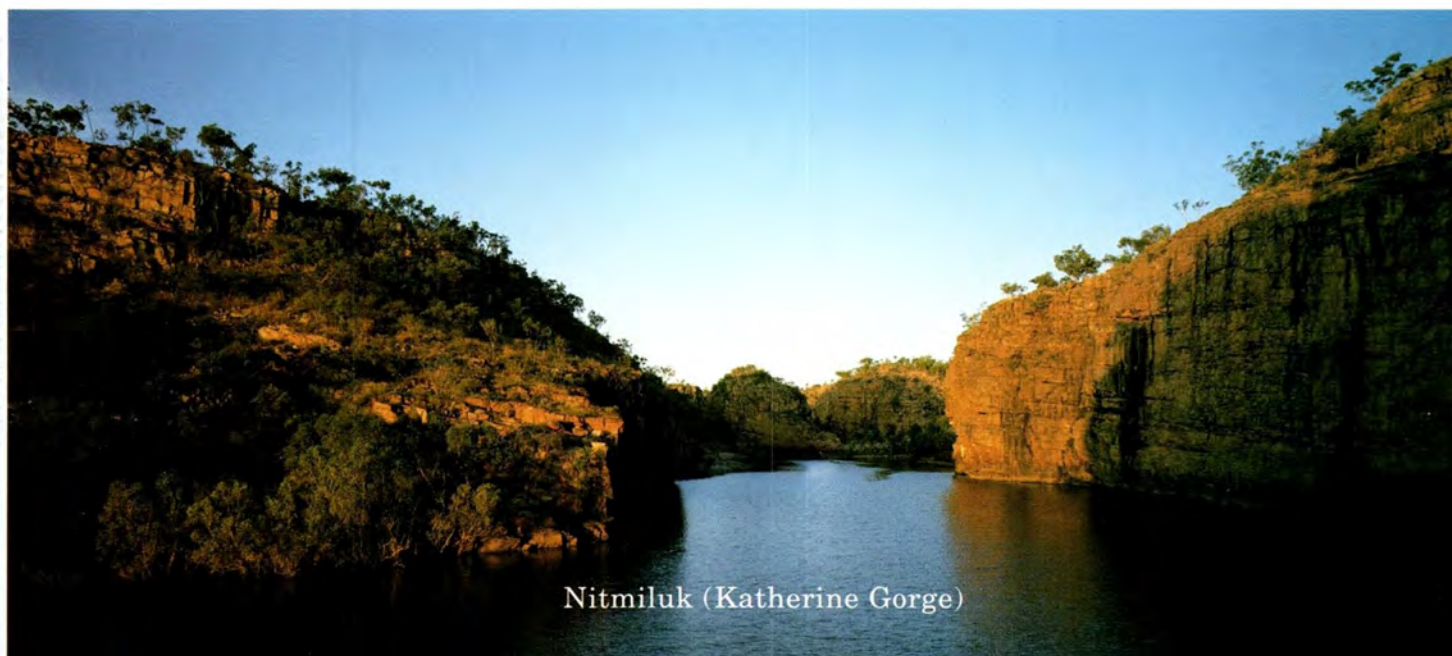
Sadly, many tourists fly the 1,500kms that separate Uluru (Ayers Rock) and Kakadu, missing out on the wealth of experiences

that lie hidden 10,000 metres below them.

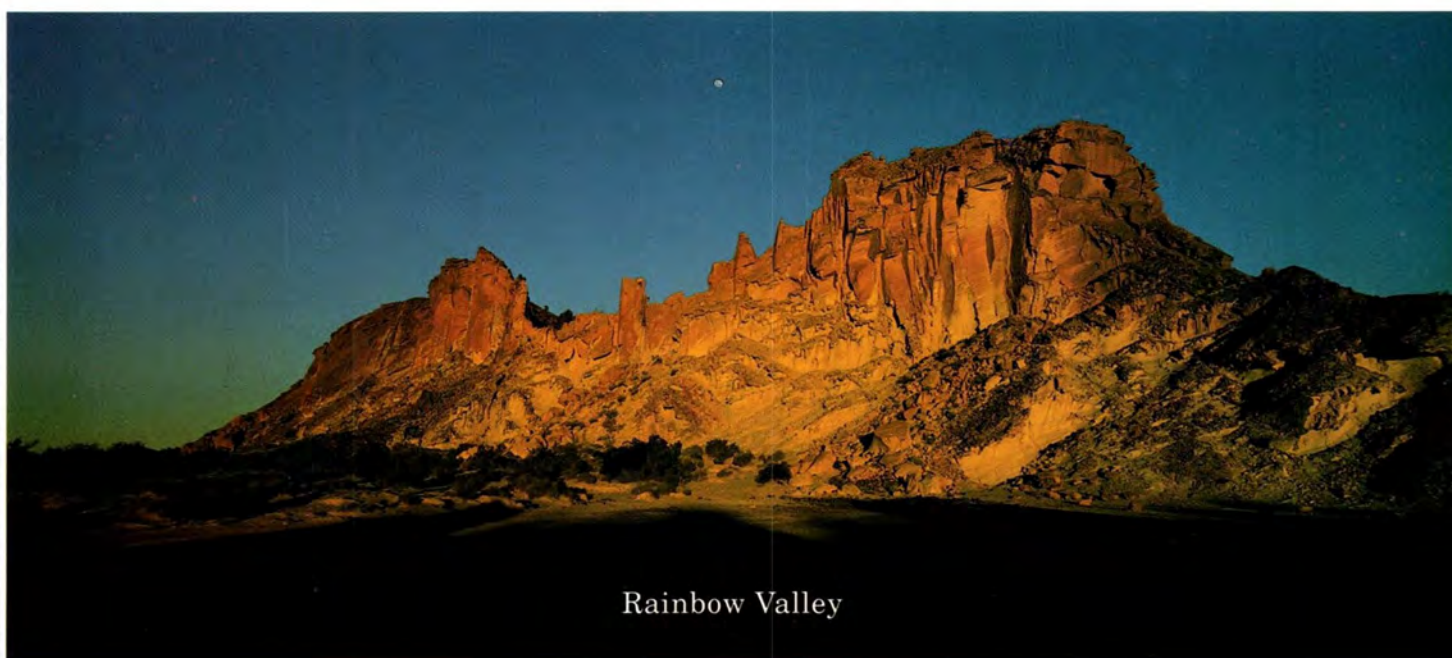
Never mind, their loss is your gain.

You will have a more private viewing of Nitmiluk (Katherine Gorge) with its thirteen, immense water-filled gorges; of Litchfield National Park which rivals Kakadu; of the

These places aren't. Yet.



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

Win a free weekend away for two

ANH Subscriber Jennie Williams runs the delightful Warrawee Guest House set in a beautiful bushland just 4km from Bendigo, Victoria. It's home to wild kangaroos, birdlife, frogs and other fauna (as well, of course, as the guests themselves!). You can win the chance to enjoy the peaceful surroundings, abundant wildlife, and excellent cooking in our simple competition.

All you have to do is answer the question: "In which Australian state is Baw Baw National Park?" and send your answer, together with your name and address to ANH Warrawee Competition, Australian Museum, PO Box A285, Sydney South 2000 by 11 April 1994. The first name drawn on that date wins a free weekend for two at Warrawee.

(Enquiries to Jennie Williams, Warrawee, Sheltons Rd, Kangaroo Flat, Vic 3555, tel: 054 477194)

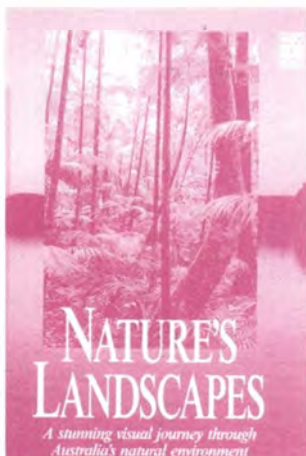
And finally, still on the subject of winning, don't forget our fantastic subscriber draw for a *Discovery Ecotours* holiday in the Spice Islands - see inside back cover for details.

PRACTICAL SHORTS

Community Aid Abroad's annual **Walk Against Want** takes place on 20 March at locations all over Australia to raise money for the world's needy communities. Participants of any ability are welcome to join the fun. Telephone 008 034 034 toll-free for details.

Mark David of Mosman, NSW was the first person to correctly identify the *Summer Pic Teaser* as a mosquito pupa...

Win a video!



TAMS NEWS

TAMS (The Australian Museum Society) is hosting a series of seven lectures on Reptiles of Australia by renowned herpetologists at the Australian Museum on Wednesday evenings throughout March and April. (Entry: TAMS

members: \$9 each lecture or \$55 the series; non-members: \$12 each lecture or \$70 the series.)

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 a full program and more information about TAMS call Christine on (02) 339 8225 or use the form on the other side.

With this issue you can win one of these exciting new videos

- "*The Last Husky*" and "*Nature's Landscapes*"!

"*The Last Husky*" records the end of the era of sledge dogs in Antarctica. Featuring the final expedition of the huskies from Mawson Station, this fascinating program also documents the extraordinary contribution they have made to polar exploration over the last 100 years. Join these hardy working dogs on the epic journey to their new home in Minnesota.

From the award winning ABC Natural History Unit, "*Nature's Landscapes*" is a stunning visual journey through Australia's magnificent environment, accompanied by classical music and natural sound effects. Be swept along with the sights and sounds of our majestic land.

Both videos have just been released by ABC Video and Roadshow Entertainment, and are available from ABC shops, ABC

The Last Husky

The final journey of Antarctica's sledge dogs



centres, leading department stores and video retailers, for just \$29.95rrp each.

We have five copies of each video to give away, courtesy of Roadshow Entertainment. To win one simply write, on a postcard or envelope, your name, address, and your preference for either "*The Last Husky*" or "*Nature's Landscapes*." Send it to ANH/Roadshow Autumn Video Giveaway, Australian Museum, PO Box A285, Sydney South 2000 by 11 April 1994. The winners will be the first ten names drawn on that date.

"The Story of the Easter Bilby" SPECIAL BOOK OFFER

Launched in March, written by Ali Gamett and illustrated by Kaye Kessing, the book tells the story of the Easter Bunny handing over to the bilby the job of distributing Easter eggs to the children of Australia, saying "I think Australia should have an Easter Bilby."

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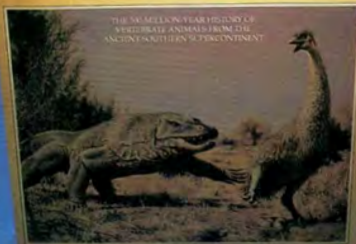
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WILDLIFE OF GONDWANA



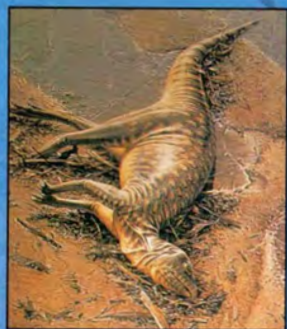
PATRICIA VICKERS-RICH
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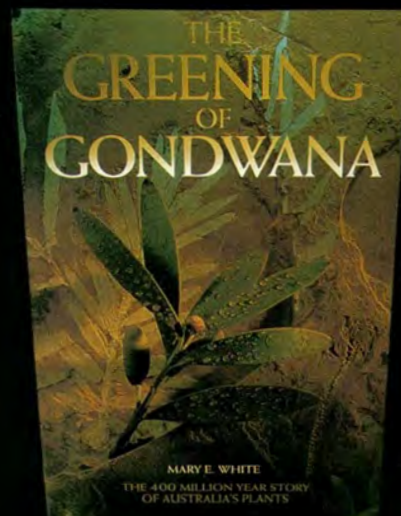
The fascinating story of Australia's floral heritage



Australia -in-Gondwana
Fossil flora to modern
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Up Front

For many of us the common catchcry "Australia: the lucky country" is still true. But where it was once based on what we could exploit, it is now centred around what we have to cherish. Compared to many overseas countries that have squandered their wilderness areas in search of a quick gain, Australia, more by good fortune than good management, still has a rea-



Victoria's beautiful Willsons Promontory National Park.

sonable amount of wilderness area left (see what Victoria has to offer in this issue's photoart). And the rest of the world is becoming more and more willing to pay dearly to experience that wilderness. Enter ecotourism.

Nowhere is all of this more evident than with the popular pastime of whale-watching—an industry that not only highlights the benefits of ecotourism but also the pitfalls. In this issue of ANH we concentrate on Humpbacks. People love to watch whales. When the Humpbacks migrate along the Australian coastline relatively close to shore, they provide a perfect opportunity for both scientific

research and a lucrative industry. However, although Humpback numbers seem to be on the increase, they are still dangerously depleted, and circumstantial evidence from the Northern Hemisphere seems to indicate that the pressure of whale-watching boats can affect the presence of Humpbacks in a particular area. The industry needs to be carefully monitored and all the impacts on the whales understood before it's allowed to expand.

Economic success and wilderness preservation can go hand in hand if we want it to. With careful long-sighted management of our remaining wilderness areas, Australia will always be the lucky country and the envy of the rest of the world.

—Jennifer Saunders

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UNCLUTTERED
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Front Cover

A Humpback Whale in full flight. As these massive animals migrate along the Australian coastline, they can be seen leaping from the water in a behaviour known as breaching. This is just one of the many behaviours displayed by these spectacular animals. Photo by Paul Hodda/Australian Whale Conservation Society.

S T R I P E D T R E E S



Articles

"WHAT A GALAH!"

Despite an unpopularity with many Australian farmers, Galahs appear to lead a charmed existence. But this has not always been the case, and the road ahead may not be all grain and hollow trees.

BY IAN ROWLEY

22



THE RATS AT NEPTUNE'S TABLE

Within the safety of Stradbroke Island's crocodile-free mangroves, the author discovers what life is like for a highly spirited mudflat gourmet—the False Water-rat.

BY STEVE VAN DYKE

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KEEPING WATCH ON GREAT WINGS

Whale-watching has become one of our most popular—and also controversial—pastimes. We take a look at one of the most acrobatic of the great whales—Humpbacks, and fill you in on the best places to see them, and the meaning behind all that slapping and whitewash.

BY ALEX BORTOLI

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COLD WAR OVER WARM ICE

That Antarctica was once a much warmer place than today is readily accepted. What is not, is when this warming event occurred. Could it have been as little as three million years ago, and what implications does this have for the predicted greenhouse warming we face today?

BY BARRIE McKELVEY

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Regular Features



THE BACKYARD NATURALIST

BRUSHTAIL BUSINESS

Love them or hate them, one thing's for sure: you can't ignore them when Common Brushtail Possums take up residence near your home.

BY STEVE VAN DYCK

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RARE & ENDANGERED

ADELAIDE PYGMY BLUETONGUE

For 33 years this reptile wasn't seen, and so the rating of 'extinct' loomed large. Then three were found in 13 days, but all in the bellies of predators! It took many frustrating hours before researchers were finally rewarded with a live Pygmy Adelaide Bluetongue.

BY MARK HUTCHINSON

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WILD FOODS

THE GOOD OIL ON THE EMU

For decades we have farmed hard-hoofed livestock, damaging the land in the process, when all the time native soft-footed alternatives have been around. The benefits of one avian soft-foot—the Emu—are no longer being ignored.

BY TIM LOW

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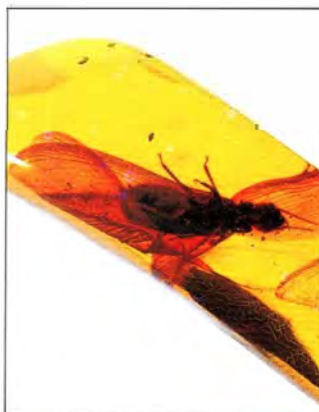
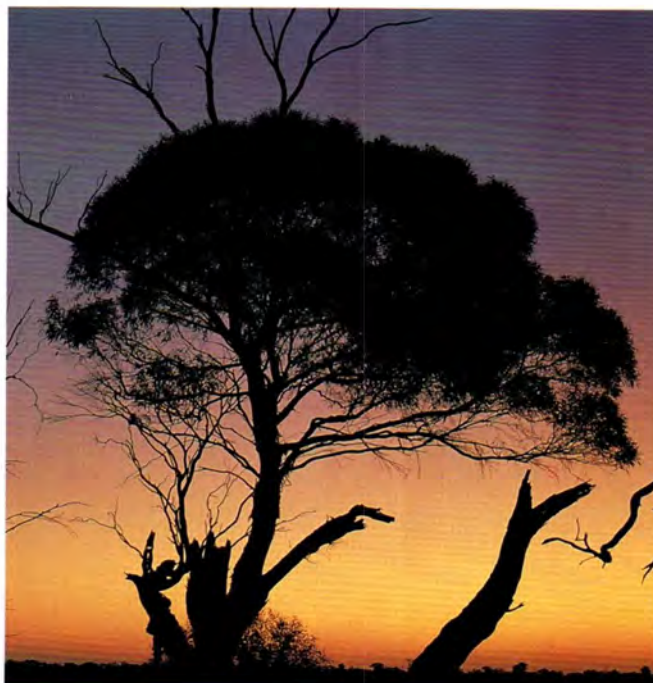
PHOTO ART

WILD PLACES OF VICTORIA

Natural landscapes can create a sense of wonder and these images from Victoria help remind us just how precious and beautiful our wilderness areas are.

BY PAUL SINCLAIR

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VIEWS FROM THE FOURTH DIMENSION

LAZARUS LIZARDS AND UNDEAD DINOS

Does genetic engineering represent science gone mad, or does it provide hope of a future for endangered animals and the possibility of 'life after death' for extinct ones?

BY MICHAEL ARCHER

60

THE LAST WORD

FOODS THAT REVOLT: A TALE OF SURVIVAL

Does the thought of snacking on a large tapeworm revolt you? How about a weevil larvae pie, or a piece of mould-ridden cheese? It seems that our revulsion of other people's dietary habits is an artefact of a world of travel and a necessary part of our survival kit.

BY PETER D. DWYER & MONICA MINNEGAL

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QUIPS, QUOTES & CURIOS

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LETTERS

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

Understanding Cetaceans

I was most interested to read the QQC item (ANH Autumn 1993) concerning the study by P. Shoemaker and S. Ridgway (Naval Ocean Systems Center) into the 'bumpy' nature of the skin of toothed whales. The researchers apparently speculate that the function of these surface irregularities may be related to swimming efficiency. All of this is of course interesting to readers of ANH. However, I am a little perplexed as to how this phenomenon can be claimed to be new.

In 1936, J. Gray discovered that small whales swam seven times faster than the available horsepower from their muscles would allow. His conclusion was that either cetacean muscle was up to seven times more efficient than typical mammalian muscle (it is not), or that the animals were somehow able to avert the development of turbulent flow and

resulting drag during swimming. 'Gray's Paradox', as it came to be known, was largely resolved as the structure of whale skin became more intensively studied during the 1950s.

By the early 1960s the relationship between the fine, mobile sculpting of cetaceans' skin and their remarkable hydrodynamic performance was known and discussed by eminent whale scientists, including P.E. Purves of the British Museum of Natural History. In fact Purves, in 1963, compared the dermal ridges of whale skin to human finger prints in appearance (as apparently do Shoemaker and Ridgway), but further explored the underlying neuro-vascular-muscular structures, which seem responsible for imparting the sculpted appearance to the epidermis, which is itself smooth. A technical point perhaps, but might it be permitted in this context to point

intending whale researchers to the vast literature devoted to these endlessly fascinating creatures, and in so doing hopefully avert yet more unnecessary expenditure of scarce research resources and resulting reinvention of the wheel?

Given the inevitably military emphasis of the interest in whale biology shown by the Naval Ocean Systems Center, perhaps I could make a preemptive strike on behalf of potentially experimental cetacean subjects? There is little to be gained in the imitation of small whale physiology to submarine design. This is because volume (and thus potential for power storage and generation) increases with the cube of the linear dimensions, while surface area (and therefore potential resistance to movement) increases only with the square. As an aside, it is for this very same reason that the legs of large land animals, such as elephants, must be proportionately much thicker than in smaller ones, like pigs. Thus, it is necessary for small animals like dolphins to overcome relatively much greater resistance than their similarly shaped but much larger cousins, the balaenopterid whales (the fast-swimming rorquals—

Can study of cetacean skin structure be likened to reinvention of the wheel?

Blue, Fin, Minke etc.). It is probably not coincidental that dermal sculpture of this type is most pronounced on small dolphins and porpoises. Maybe the ultimate application objective is in torpedo or other small sub-surface missile design? This would be potentially less terminal for dolphins than training the animals to locate enemy submarines with high explosives strapped to their backs, as was the case in the 'cold war' years of the '60s!

—Graeme Greenwood
University of Tasmania

Diamonds in Clay

The Spring 1992 issue of ANH carried a balanced and thought-provoking article by John Merson on the Human Genome Project. I believe that this project could represent a disastrous misallocation of financial and scientific resources.

Almost all the DNA in humans (and, indeed, most other species) does not form genes. More than 90 per cent of it has no more function than bubble wrap. This evolutionary junk DNA might take some of the knocks from viruses and other genome-damaging factors, and it may keep some of the working genes appropriately separated, but it remains essentially junk and, unless there are significant indications to the contrary, it is wasteful to sequence it.

The *Alu* sequences are a particularly telling example. These are short sequences that are repeated, with minor variations, approximately half-a-million times in the overall human genome. They represent at least five per cent of the total genome and are defective versions of a functioning gene. Little would be gained by determining this sequence. Indeed, it would be close to my idea of scientific hell to have as an allotted task the sequencing of *Alu* repeats. Somebody would have to do it, according to the stated objectives of the Human Genome Project.

Genes are scattered through the genome like diamonds in clay. By all means let us make a map to guide us to the genes. Indeed, we already have ones based on chromosome banding and certain DNA signposts—techniques that will help us to locate genes, sequence them



BECCA SAUNDERS / AUSCAPE INTERNATIONAL

and understand their genomic context on a 'need-to-know' basis.

The Human Genome Project is a program that could blight the imagination of an entire generation of biologists and that might, even more importantly, distort scientific funding so badly that medical progress is significantly retarded.

—Don Colgen
Australian Museum

Bilbo Bilby

*Let's forget the rabbits,
With their unwelcome habits,
We'll introduce the BILBY to
the EASTER BRIGADE.*

*Stop the Easter bunny,
Then we can spend the
money,
Promoting BILBO-BABY¹
with an OZ accolade.*

*In our wide green land,
Burrowed in the sand,
This marsupial should
flourish,
Give three hearty cheers
For the chap with big ears.*

*Let's hear it for the BILBY,
With his long nose and trilby²,
Our happy HAIRY hero of the
EASTER PARADE³.*

Footnotes:

¹The original BILBO is the hero of *The Hobbit* by J.R.R. Tolkien and also of the book *The ballad of Bilbo Baggins*.

²A trilby is a soft felt hat.

³Music by Irving Berlin.

—Dr Len Green
Vaucluse, NSW

Save Endangered Species

I have been prompted to write after reading Bowman and Whitehead's *Last Word* (ANH Winter 1993). I don't understand why there is such a swell of criticism towards endangered species programs. Many of the arguments used against these programs are hard to support. One such argument, for example, that reduced genetic diversity arising from small populations leads to that population becoming unsustainable, is untrue. The often quoted Cheetah has been doing just fine with its reduced diversity for an estimated 10,000 years. Even now, with its declining numbers (due to human pressures), it's no worse off than a lot of other declining but presumably diverse species like Hunting Dogs, Tigers and



Australia would do well if the Easter Bunny was replaced with the Easter Bilby.

Snow Leopards. I can't think of a single species that has died out as a result of reduced genetic diversity. Examination of human mitochondrial DNA by Dr Stoneking of the University of California at Berkeley has led him to believe that there are very few genetic differences among human races. "In terms of our mitochondrial DNA we're much more closely related (i.e. less genetically diverse) than almost any other vertebrate or mammalian species." Yet we seem to be a very successful species. I'm not saying that reduced diversity doesn't matter; just that it may not be the death sentence we're led to believe. A large genetic diversity doesn't seem to save a species any more than a reduced diversity dooms one.

Another common argument is that introducing members of another population to boost a reduced population is said to change the local gene pool. Does it matter? The genes of the reduced population aren't

lost; they are just incorporated into the new population. If the choice is to lose the threatened population altogether or dilute its existing gene pool, isn't it better to do the latter? The main thing we should be trying to achieve is a repaired ecology. It matters little to the local environment whether it's a mainland Eastern Native Cat or a Tasmanian Eastern Native Cat. The important point is that it *functions* as an Eastern Native Cat within the ecosystem. Obviously the closer the match genetically and geographically, the better; and there would need to be screening against disease. Remove a key species, and the ecological 'house' is in danger of falling down.

Even failed attempts at introduction provide valuable information. When captive releases have failed, close monitoring often reveals some hidden cause responsible for the species' disappearance in the first place. Appropriate management can then be im-

plemented to the benefit of both wild and captive released endangered species.

There can be other benefits too. The land required to support a condor, for example, is immense and provides for the needs of more animals than just the target species. Endangered species protection is a new and rapidly evolving field. It is one we must master quickly, learning as we go because—sadly—the queue is getting longer.

—Martyn Robinson
Australian Museum

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

QUOTES & CURIOS

QUIPS

COMPILED
BY
GEORGINA
HICKEY

Why do Belugas Rub?

Since the late 1970s it has been known that Killer Whales (*Orcinus orca*) actively seek out certain pebble beaches on which to rub their bellies. This curious behaviour, for which there is no clearly defined function, was introduced to many of us in David Attenborough's TV

documentary "Wolves of the Sea".

But Killer Whales are not the only cetaceans that seem to enjoy a good rub. A similar behaviour has been documented for the Arctic Belugas or White Whales (*Delphinapterus leucas*).

Over a period of 12 years, Canadian biologist Thomas

Belugas. like us, enjoy a good rub.

Smith and colleagues have watched the annual summer movement of Belugas into the warm, shallow waters of Cunningham Inlet. There and in the main river channel that empties into it, adult Belugas spent much of their time rubbing themselves against the substrate, which consisted of pebbles and sharp limestone. The deliberate rubbing action produces abrasions in the skin and also deep cuts that, in the past, have been attributed to Polar Bear attacks. Pieces of skin found washed up on a nearby beach were confirmed to be from Belugas and free of inflammation (and thus unlikely to have been sloughed due to disease).

It was also noted that the adult whales, after entering the estuary, would change from a yellow colour to a chalky white. The researchers



believe exposure to the fresh warm waters hydrates and softens the dead skin that builds up over the previous winter. Perhaps it's analogous to the way calluses on our feet turn white after a long soak in the bath. And, just as the podiatrist files away the softened calluses, so too might the Belugas scrape their bodies against the rough substrate to remove the build-up of dead skin and promote new growth.

By exploiting a specific set of seasonally available conditions, Belugas are able to accelerate the moulting process and growth of new skin. As Smith and his colleagues state, "Such synchrony in the moulting process, unknown in other cetaceans, appears to be part of an evolutionary response to life in an extreme environment."

—G.H.

Tale of the Toxic Avenger

If you disregard the various animals armed with venomous bites or stings, there is still an array of species equipped with toxic armament, albeit more subtly concealed in the skin or other body tissues. Well-known examples include Cane Toads and pufferfish (uncooked). Indeed, most major animal groups boast at least one or two such dangerous members. Prominent among those left out of this circle of honour have been the birds—but recent research by a University of Chicago ecologist has changed that.

While working in New Guinea, John Dumbacher and colleagues found certain songbirds of the genus *Pitohui* (pronounced 'pit-o-hooey') to carry the toxic chemical homobatrachotoxin, known previously only from the South American poison frogs of the genus *Phyllobates*. In pitohuis, the toxin is most concentrated in the feathers and skin, with smaller amounts in the muscle and internal organs. Overall, both the concentration and total amount of the toxin in pitohuis is much less than that in the frogs. This is fortunate for anyone working with pitohuis because the toxins are among the most powerful known. Small extracts, when injected,



W. PECKOVER / NPWW

can kill a mouse in under 20 minutes.

Dumbacher and colleagues noted that the birds had a characteristic sour smell and, when handled, would cause sneezing, numbness and irritation of mucous membranes. This is also true of old museum specimens, as I can personally attest. What's more, I have found that a headache is virtually guaranteed if the specimens are handled for any extended period without gloves (at least in my case).

The function of homobatra-

chotoxin in these birds is uncertain. It has been proposed, not unreasonably, that it serves as a defence mechanism. This suggestion is supported by the conspicuous orange and black pattern of the Hooded Pitohui (*P. dichrous*), the most poisonous species, which recalls the bold warning markings of many other toxic animals (poison frogs, wasps etc.). Hugh Cott, from the University of Cambridge, conducted taste tests on different species of birds starting in the 1940s, concluding that there

Does the Hooded Pitohui's bold colouration advertise its poisonous plumage?

was “a general inverse correlation between conspicuousness of the plumage and palatability of the flesh”. Bird of paradise flesh, for example, has been described by A.E. Pratt as “truly abominable”.

Why these particular birds evolved such a chemical defence to repel predators is uncertain. Armed with sturdy hooked beaks, powerful clawed feet and bad attitudes (another feature to which I can personally attest), pitohuis seem less in need of chemical weaponry than other, less equipped species. This feature does convey a certain degree of protection from New Guinea hunters who regarded them as unpalatable ‘rubbish birds’, best avoided as food. (Perhaps the New Guinea name ‘pitohui’ refers to the sound made

by an unsuspecting person upon sampling the bird’s flesh!)

Australia has several familiar close relatives of the pitohuis—the whistlers (*Pachycephala* spp.) and shrike-thrushes (*Colluricincla* spp.). These are represented throughout the country and are often common in wooded areas near human habitation. They are also frequently captured by bird banders. Whether this has practical health considerations for Australian ornithologists is as yet unknown. Their lack of a comparable sour smell and failure to induce headaches in preliminary sniff tests, however, do tend to hint that they are, in fact, benign cousins of the pitohuis.

—Walter E. Boles
Australian Museum

Frog Cures Herpes

University of Adelaide researchers have discovered that kissing a frog may not be such a bad thing. This is because frog skin contains antibiotics that may be of use in the treatment of human infections.

Frogs have several kinds of glands in their skin. One type is the mucous glands that produce slimy mucus to keep the skin moist. Another type, called ‘granular glands’, had until recently been considered to contain only toxic compounds. This was because the granular glands of the well-known poison frogs of Central and South America contain poisons so virulent that, applied to the tips of darts, they would para-



A. BAUER

LOSING YOUR SKIN TO SAVE YOUR SKIN

Most of us have had firsthand experience of a lizard losing its tail. This is a well-known defence mechanism that allows the lizard to escape its would-be predator, albeit tailless. But tails are not the only things that lizards are prepared to sacrifice. As Aaron Bauer (of Villanova University in Pennsylvania) and Anthony Russell (University of Calgary) have discovered, several geckos also lose their skin.

Leaving your skin behind seems a very drastic way of

avoiding being eaten, but for the geckos being studied it usually works. It works because, on their dorsal (back) surfaces, the gecko’s skin has two layers. The inner layer is thin and tough, and the outer layer is thick and fragile. The layers are only loosely attached to one another. So, when a predator has a go at a gecko, a patch of the outer layer tears and comes off while the rest of the gecko gets away.

Most of the geckos that lose their skin live on islands. The researchers speculate this could

be related to differences in how island and mainland predators catch geckos. They noticed that predators of mainland geckos (such as birds of prey and carnivores) tend to kill their prey as they catch it. Whereas predators of island geckos (such as primates, non-raptorial birds, snakes and other lizards) usually grasp or pin down their prey before attempting to kill it. Thus a good escape strategy for island geckos is one that plays for time. And losing your skin certainly does that.

—C.B.

Villagers treat herpes by bandaging a frog upside down upon a wart.

lyse prey shot by tribal Indians. It was therefore assumed that the granular glands of all frog species were toxic to some degree to protect the frogs from predators. But recent studies have shown that not all granular gland secretions are toxic.

In 1977 a team of zoologists from the Universities of Adelaide and Melbourne discovered a giant green tree frog in the remote Kimberley of Western Australia. They named it *Litoria splendida*—the Magnificent Tree Frog. It was in many ways similar to the well-known Green Tree Frog (*Litoria caerulea*), common throughout much of northern Australia, but it differed in having a huge and bulging gland, overlapping the entire head like a soft academic hat. This gland is a vast reservoir of novel chemical compounds including a number of new antibiotics. The antibiotics are classified according to their activity: antibacterial, antifungal

or antiviral. Amongst the antibacterial compounds is one that is particularly virulent against *Staphylococcus aureus*, better known as 'Golden Staph' and a major problem if it contaminates hospital wards. Yet perhaps the most exciting discovery was that the Magnificent Tree Frog has a skin secretion with the ability to destroy the Herpes simplex virus.

In the Patagonian area of Argentina and in Nigeria, villagers treat Herpes by bandaging a frog (upside down) upon a wart and leaving the frog there until it dies. They insist that the wart disappears. The University of Adelaide team has independently corroborated that at least one species of Australian frog has a skin secretion that destroys Herpes. Modern science is showing that traditional folk medicine can be based on sound principles. Meanwhile the search for other new drugs in the skin glands of Australian frogs continues.

—Michael J. Tyler
University of Adelaide

The Magnificent Tree Frog stashes drugs under its hat!



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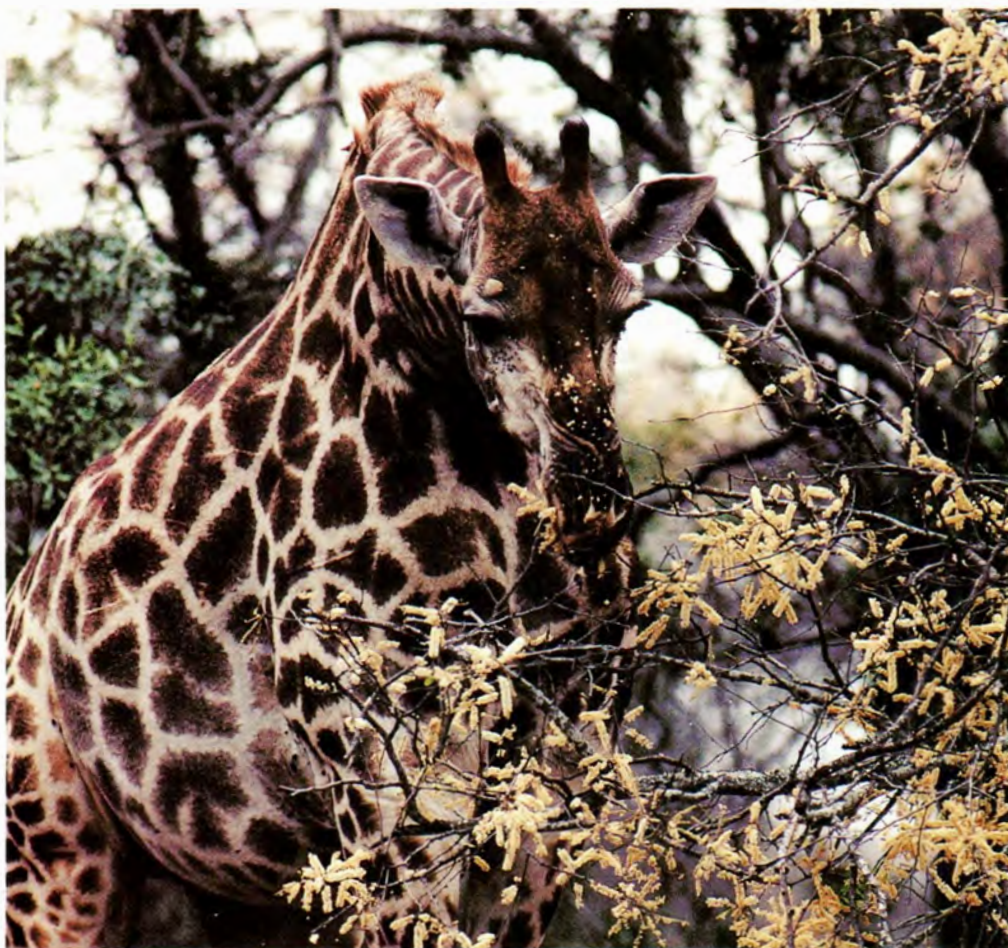
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A Giraffe is dusted with pollen as it feeds on blossoms of a Knobthorn Acacia.

Walking Tall among the Acacias

When we think of animals that pollinate flowers, we usually think of flying animals like birds, butterflies, or even bats. There is now evidence to suggest that the world's tallest animal, the Giraffe, may also be an important pollinator of certain plants.

Observations of Giraffes in South Africa's Kruger National Park have led to this idea. Johan du Toit of the University of Zimbabwe noticed that, during the dry season when there is little food, Giraffes obtained much of their nutrition by eating the flowers of the Knobthorn Acacia tree (*Acacia nigrescens*). The flowers are easy picking for Giraffes. They can reach up into the branches where other animals can't. Also, the Knobthorn's flowers aren't protected by long thorns the way many other acacia flowers are; nor do they appear to contain unpalatable toxins to deter browsers.

Plants usually ensure their survival through adaptations that prevent them from being eaten. Why then are Knob-

thorn Acacia blossoms so poorly defended against being eaten by Giraffes? And why do these trees bloom when Giraffes are most in need of food? Du Toit believes there could well be a trade-off; in return for providing food, the acacias are being pollinated.

He noted that the Giraffes' heads and necks become dusted with pollen as they feed. In fact, their ability to reach into the treetops and their wide ranges make Giraffes good candidates for cross-pollinators. So while some flowers are lost by being eaten, others may have their pollen transferred to acacias often long distances away.

To test whether Giraffes are indeed pollinators of Knobthorn Acacias, Giraffes would have to be prevented from reaching a sample of flowering Knobthorns. The effects on Knobthorn seed production would then have to be compared with another sample that Giraffes had access to. However, du Toit points out the difficulty in doing this: in a wildlife area such as Kruger National Park any Giraffe barriers he builds must also be elephant-proof!

—C.B.

Red Sea Parting

We'll probably never know if the waters of the Red Sea really did part for Moses and the Israelites while fleeing Egypt in search of the promised land. But, if they did, oceanographers Doron Nof, from Florida State University, and Nathan Paldor, from the Hebrew University of Jerusalem, believe that a perfectly Earthly explanation could account for such a 'miracle'.

The Gulf of Suez and the adjoining Red Sea is essentially a long, narrow, shallow channel joined to a large body of water. Using this simple conceptual model and the mathematical equations that govern the movements of water and wind within it, Nof and Paldor have identified the sort of conditions that could recreate the biblical event.

A storm of moderate strength, sending north-westerly winds of about 20 metres per second down the Gulf of Suez for a period of at least ten hours, could generate a sea-level drop of about 2.5 metres and a receding shoreline of around 1.2 kilometres along the northern edge of the Gulf. This would provide a crossing site for the Israelites where there would previously have been water.

If the wind were to suddenly abate or change direction, the waters could return, according to the oceanographers' calculations, at the rapid rate of about five metres per second, flooding the exposed area within a matter of minutes and drowning the Egyptian armies in pursuit.

—K.McG.

Cocky Want a Cow Pat?

Sulphur-crested Cockatoos (*Cacatua galerita*) can be a real headache for farmers who must constantly keep them from eating their crops and stored grain. But a flock of cockatoos in the dairy farming district of the Numinbah Valley, west of the Gold Coast, has found a novel way of getting the seed—from cow pats.

On one particular property cockatoos have been seen regularly dipping their bills into fresh cow pats to eat the grains

of lightly milled barley and maize that have passed through undigested. This behaviour was not observed anywhere else as other farmers tended to hammermill (and thus totally disintegrate) the grain before feeding to cattle. The birds were first seen working through dung during a dry spell several years ago, when their natural food would have been limited. Studies by amateur ornithologist Mervyn Cobcroft have shown that partially milled barley, fed to the cattle all year round, has become a major part of the birds' diet.

In the Numinbah Valley, cockatoos are succeeding where dung beetles have failed. They break up the cow manure. This means there are no solid cow pats to reduce the growth of precious pasture underneath, or to be used as breeding places for bush flies. Native dung beetles fail to do this job because they can't process the large quantities of manure that cattle produce. And introduced dung beetles don't do well in the rainy climate.

The cockatoos' unusual behaviour benefits the dairy farmers and the cockatoos themselves. But what do the cows think?

—C.B.

Dung birds? On one Queensland dairy farm, Sulphur-crested Cockatoos break up cow pats to eat the undigested seed.

Watery Webs

Each morning just before dawn, the European Garden Cross Spider (*Araneus diadematus*), like several other non-hunting spiders, devours her web and builds it anew. The behaviour is not simply a case of obsessive housekeeping. It now seems that each time she spins her web she is looking to trap more than just a meal.

In a recent study of Garden Cross Spider webs, Donald Edmonds and Fritz Vollrath, from the University of Oxford, found that droplets of glue laid by the spider along the capture threads were capable of taking up relatively large quantities of water from the atmosphere. This absorbed water not only enhanced the glue's effectiveness but also, when eaten with the web, represented an important proportion of the spider's daily fluid intake.

Spiders need to ingest relatively large quantities of water each day to replace the moisture they lose from their lungs during respiration. Unlike hunting spiders, the Garden Cross and other orb weaving spiders cannot afford to leave their webs in search of water because they could miss opportunities to seize prey snared in their sticky traps.

Edmonds and Vollrath showed the uptake of atmospheric water by the web to be greatest when the humidity



D.W. GREENSLADE / ARDEA

Part of the Garden Cross Spider's daily routine is to eat her web and build it anew.

was highest—just before dawn when the dew is heaviest. By building before sunrise, Garden Cross Spiders ensure that the glue droplets reach their maximum possible size, enhancing their effectiveness for capturing prey. And devouring the web also before dawn (the following day) allows the spiders to take in as much

atmospheric moisture as possible. Edmonds and Vollrath believe the amount of water eaten with the web to be about ten per cent of that lost by the spider during respiration.

—K.McG.

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



KEN GRIFFITHS



Inefficient and environmentally unfriendly fridges may soon be a thing of the past.

Sounding Cool for the Future

Glass blowers over the centuries have observed that when they heat one end of a glass tube it sometimes 'sings'. The singing is a sound wave that is generated by the temperature gradients along the tube.

Scientists wondered whether this effect would work in reverse. In other words, could sound be used to cause a temperature gradient, which could then be put to some useful purpose? In the 1980s, physicists from the Naval Postgraduate School in Monterey, California, and Los Alamos National Laboratories in New Mexico succeeded at doing just this. Using the principles of 'thermoacoustic heat transfer', they have now developed the world's first sound-powered refrigerator.

Conventional refrigerators rely on a refrigerant fluid that is evaporated to provide cooling and then compressed with a piston pump so it can be evaporated again. The most common refrigerants are

CFCs, which do not react with the lubricant used to seal the piston, but these eventually escape into the atmosphere and damage the ozone layer. In the new design, sound waves generated by a loudspeaker compress and expand inert gases that are environmentally harmless. Within the thermoacoustic resonator, the sound is extremely loud (100,000 times more intense than an INXS concert!), although outside the device there is no audible sound. These large acoustic pressure swings cause correspondingly large tempera-

ture fluctuations in the gas, which are then used to cool the fridge.

The 'acoustic fridge' has several advantages over conventional fridges. Apart from not using any CFCs or their toxic replacements, it has fewer moving parts, requires no lubrication and has high efficiency. The Naval Postgraduate School is currently working with General Electric and further research and development will hopefully see the acoustic fridge being used as a common kitchen appliance and also as air conditioners in cars and homes.

—C.B.

Fungus in Floral Costume

The parasitic rust fungus *Puccinia monoica* has been exposed as one of nature's masters of manipulation. Like most rust fungi, *P. monoica* needs insects to bring its sex cells together. And, as Bitty Roy of the University of California has discovered, *P. monoica* attracts the insects by engaging its host (small mustard plants) in a sophisticated ruse.

Wind-borne rust spores infect their host plants towards the end of summer. The parasite spreads rapidly through the plant, eventually controlling its growth and altering its appearance. Most significantly the fungus stimulates its host to forgo production of its own

Infection by a rust fungus stimulates host plants to produce yellow 'pseudoflowers' packed with the fungus' sex cells. These are so much like real flowers that many insect pollinators are easily fooled.



flowers and to produce 'pseudoflowers' instead. These look more like the flowers of unrelated plants in their shape, colour, odour and sugar content. Yet their bright yellow surface is largely composed of the rust's sex organs and cells.

The deception is so clever that both prospective pollinators and their predators are fooled; crab spiders have been found waiting in the pseudoflowers to grab the many bees, flies and butterflies that visit. Even professional botanists have mistaken the pseudoflowers for real flowers.

The pseudoflowers contain as much or more sugar than flowers of other plants occurring nearby and, according to Roy, may be so good at attracting and occupying pollinators that the reproductive success of nearby flowering plants may be affected. It seems that, through an elaborate act of deception, *P. monoica* can influence the activities of not only its host plant but also insects, their predators, nearby plants . . . in fact, the whole natural community.

—K.McG.

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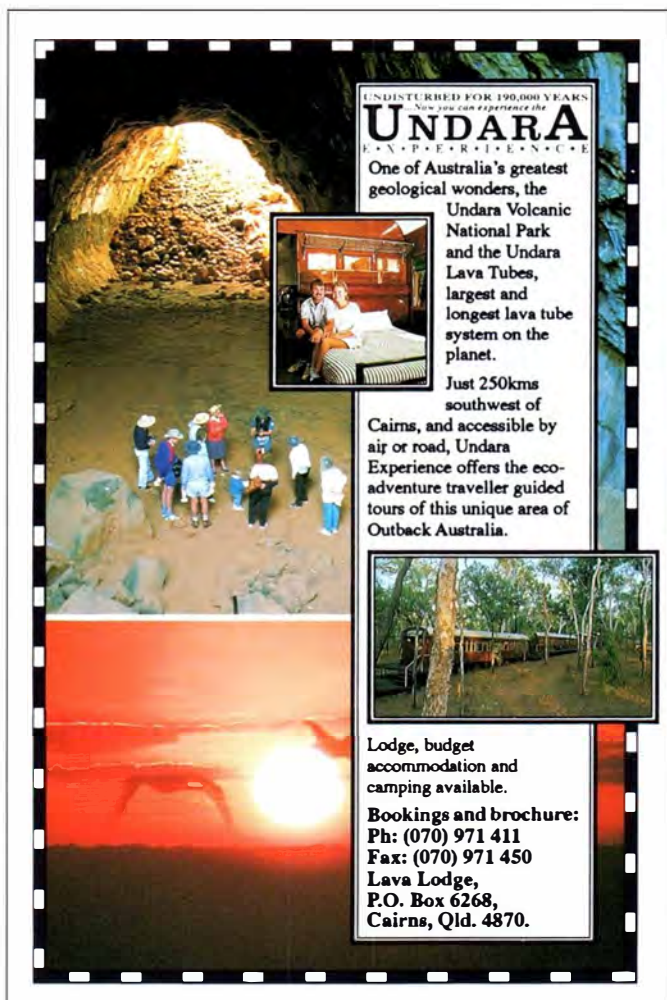
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QUICK QUIZ

1. Who is the author of the 1991 novel *Jurassic Park*?
2. What does CITES stand for?
3. What is a group of owls called?
4. How many sides do honeycomb cells have?
5. Where would you go if you wanted to see lots of Red Crabs?
6. Who is the Federal Minister for Environment, Sport and Territories?
7. What are tafoni?
8. What is the floral emblem of South Australia?
9. Name one of the three Australian fossil localities that have been nominated for World Heritage Listing.
10. What are the largest trees on Earth?

(Answers in the Q & A Section)



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Among the street lights of the suburbs, Common Brushtails occasionally get themselves into some sticky corners.

BRUSHTAIL BUSINESS

BY STEVE VAN DYCK

FEW AUSTRALIANS GET THEMSELVES into hot water more regularly than the Common Brushtail Possum (*Trichosurus vulpecula*). Undisputed champion of the suburbs and honorary entertainer around the camp fire, the Common Brushtail is responsible for more sleepless nights and wet ceilings than our wildest children and summer storms respectively. Yet how many camping weekends have been highlighted with a photo of a mother brushtail and her little

furry jockey eating the sausages Dad had let slide into the ashes? And how many times have the brushtail-wise quietly sniggered when tourists exclaim "... it was so friendly we could have taken it home with us ..."? In all fairness, perhaps the Common Brushtail is a poor man's Koala, but to bushwalker, camper and tourist he's as Aussie as gumnuts and damper.

Away from the moonlit bushland however, and among the street lights of the suburbs, Common Brushtails occasionally get themselves into some sticky corners. A few years ago, a Santa Claus Brushtail with a flair for interior decorating decided one night to leave the jacarandas overhanging historic Newstead House and investigate where the hole in the top of the chimney went. Newstead House is



ESTHER BEATON

While Mum is pretty safe, the progress of her young jockey will be closely watched by owls, snakes, dogs and older, more established brushtails.

a magnificent squatter's homestead built on the shores of the Brisbane River in 1846. It is meticulously maintained with each room furnished as if the occupants still lived inside and with plenty of realistic touches, such as a table laid out for afternoon tea.

With appetite quickened by the long dark descent, the brushtail made a bee-line for the authentic arrangement of cream buns and sponge cake. After clogging every finger and toe with confection, the possum hauled itself up the lace curtains, found one of the narrow picture rails three quarters of the way up the wall and then, in 'only-a-brushtail-could-do-it' style, flailed itself around all four walls. The wild activity whipped up a thick grey mortar of cake, mock cream and dust, which was plastered across the floral wallpaper for the perimeter of the room. When the curator of the house came to view the damage, the tell-tale footprints and grease smears had her close to tears ... until she went into the next room that used to display the more delicate glassware and Royal Doulton. Here the rearrangements were cause enough for a coronary and early retirement!

Common Brushtails, with their large (cat-like) size and black bushy tail, are so widespread, so readily observable, yet so variable throughout their broad Australian range that they have been confused for all sorts of things from wombats to giant rats. Mostly they are mixed up with either Common Ringtail Possums (*Pseudocheirus peregrinus*), which are smaller with thin, white-tipped tails, or with Mountain Brushtail Possums (*Trichosurus caninus*), which are usually charcoal-black with narrow bushy black tails. But the problem of identity becomes compounded in the tropical north where Common Brushtails might be as orange as a tangerine or their tails thin and sparsely haired.

With a look like this, all the indiscretions of brushtail street-kids are forgiven.



PAVEL GERMAN

Usually brushtails nest inside tree hollows and they feed on gum leaves, fruit and bark. In some areas they are known to live along estuaries and feed on mangrove leaves, however a possum hunter once reported the stomachs of brushtails he had shot there to be full of soldier crabs. On gum leaf diets it is thought that the toxins in eucalypt foliage make it necessary for them to top up the diet with pasture plants, and it is not unusual to see Common Brushtails 'doing a Victa' on clover and lawn weeds. The germ warfare that goes on in a brushtail's entrails to denature the toxic phenols and tannins of eucalypt leaves is enough to give any possum the pip. And the reason why you can leave a brushtail sitting on a branch, return three hours later and find it still there with the same detached look on its face is because its enormous churning paunch won't allow it to do much more.

So full of tough fibre are the nutrient-poor leaves, and so hard must its gut work to break them down and detoxify them, that there is little energy left for swinging from the chandeliers. And, if you were 20 metres up an ironbark packed to exploding with paper-pulp takeaway and with an intestine lunging around like a dying python, chances are you'd be staring straight ahead and hanging on tight too!

Because they are naturally inquisitive and a trifle insensitive, Common Brushtails often choose to take up habitation with people and are happy to share spaces in the ceiling, under the bath, inside the cupboards, over the hot water heater etc. Most people nowadays, forearmed with the knowledge that brushtails won't gnaw their woodwork or electric wirings, won't attack the children in their cots, or won't fill the house with lice, are happy to tolerate and even enjoy the guests' presence. If you move to an area where brushtails are reasonably common and really want to enjoy them, put up nest boxes in trees away from the house, and plant other trees that will encourage them. But don't feed them on the verandah. Human food is a brushtail's opiate, and what may start as true friendship very often turns sour. They really are more than happy with orange and apple halves nailed to distant tree trunks if the urge to feed them is irresistible.

Common Brushtails live for about ten years and females breed at least once each year. The single joey is born about 17 days after mating and spends about five months in the pouch and then another one or two months on the mother's back. Their capacity to reproduce and move into new habitats has been dramatically demonstrated in New Zealand where, in the Catlins district of the South Island, 36 Common Brushtails were released in 1894. In 1912, 18 years later, 60,000 brushtails were killed in that district for their skins. This talent for multiplication is offset by enigmatic past disappearances from central Australia and present dramatic declines in northern Queensland.

Part of a mother brushtail's biggest



DENISE CLYNE

One of the hidden costs of these unpaid chimney sweeps is fuzzy TV reception.

problem is getting rid of her 'jockey' and, because brushtails are persistent from an early age, much of the hissing coming from the backyard is often that of mothers announcing over and over again that the milk bar and saddle are now off limits. So, if you are woken by armies practising jungle warfare on your ceiling or caravan, if cascades suddenly start percolating through the gyprock or you wake to blood-curdling gurgles outside your tent, chances are that you, like 99 per cent of other Australians, have brushtails at close range. But hats off to the old brushie

—a dinkum survivor and a barrelful of laughs. ■

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

*After 33 years without a sighting
we now had three in 13 days!*

ADELAIDE PYGMY BLUETONGUE

BY MARK HUTCHINSON

EXTINCTION IS FOREVER, BUT when is a species extinct? Until October 1992, Australia's small but ardent community of herpetologists (those who study reptiles and amphibians) had all but decided that one lizard species, the Adelaide Pygmy Bluetongue, had achieved the dubious distinction of becoming Australia's first extinct reptile. The Adelaide Pygmy Bluetongue (*Tiliqua adelaidensis*) is distinguished from its relatives such as the familiar Common Bluetongue (*T. scincoides*) by several features. It is much smaller; adults are no more than 16 centimetres long, whereas the other six bluetongue species grow to 40 centimetres or more. Unlike its larger relatives, it has a pink (not a blue to purple) tongue. Its colour pattern of longitudinally arranged black speckles on a light brown back is unique.

Adelaide Pygmy Bluetongues had been seen only twice this century, the last time in 1959, and were known to science from only 20 museum specimens worldwide (more than half in Europe). The localities associated with the specimens were limited to a 160-kilometre strip running from Adelaide northwards to Burra, hence the species' scientific name. Virtually nothing was known about the species and people could only speculate on why it might have disappeared. Field work totalling hundreds, if not thousands, of hours during the '60s, '70s and '80s had failed to locate any trace of it. Officially, the Pygmy Bluetongue is rated as 'endangered'; the International Union for the Conservation of Nature (IUCN) rating of 'extinct' is only achieved after 50 years of non-sighting in

the wild, but an absence of 33 years, in spite of efforts to locate it, made things look pretty bad.

On 14 October 1992, during a joint Environment & Land Management/South Australian Museum vertebrate survey of the plains north of the Murray River in eastern South Australia, herpetologist Graham Armstrong was driving with biologist Julian Reid towards Burra. They stopped along the way and Graham noticed that an Eastern Brown Snake, recently hit by a vehicle, was lying dead by the road. They examined the body and felt the lump of a recent meal in its stomach. In the farming area where they had stopped, it (the lump) was assumed to be a feral House Mouse, a favourite prey of Eastern Browns. Still, to be absolutely certain, Graham opened up the snake and, instead of the expected mouse, found an adult Pygmy Bluetongue, in near perfect condition.

Graham and several helpers combed the area near where the snake was killed for the next three days, but didn't find any Pygmy Bluetongues. The next week, while visiting the region with Graham's brother Dave and herpetologist Brian Miller, I found a dead skink, lying belly up. On righting it I was boggled to find it

was another Pygmy Bluetongue, probably killed by an Australian Kestrel but dropped or discarded a short time before we arrived. This second specimen was found about eight kilometres north of the original discovery site. A week later Brian found yet another dead Pygmy Bluetongue, this one headless and eviscerated; again the likely predator was a bird of prey. After 33 years without a sighting we now had three in 13 days!

Trapping seemed the next obvious step, but to do this I needed to have someone based in Burra to monitor any traps set. The Australian Nature Conservation Agency (formerly the Australian National Parks and Wildlife Service) came to the rescue with funds for a field assistant, Tim Milne. During the first week of November, Tim, David, Brian and I spent two days setting up drift fences, pitfall traps and aluminium box traps at the sites where the dead specimens had been found. While setting up one trapline, we collected an Eastern Brown Snake that contained yet another dead Pygmy Bluetongue. It was becoming quite exasperating; judging from the predators' successes, the area seemed to be alive with Pygmies, yet many days of searching had been fruitless. Finally on 6 November I got a call from Tim saying he'd got one; a subadult had fallen into one of the pits.

Over the next few weeks more Pygmy Bluetongues fell into pit traps, including the first live female which, with the first two caught, is on loan to Adelaide Zoo. Observation of this trio will assist in learning more about the behaviour of this species, especially, we hope, breeding behaviour. Meanwhile, the other specimens were marked and released, to begin studies of home range, movements and population size. Two were temporarily fitted with tiny radio transmitters, enabling us to follow their movements and begin to discover where they forage and shelter.

The habitat of the site, remnant native grassland, has given us our first clue as to why the species has become so rare; agriculture and pasture improvement has drastically altered this habitat throughout temperate south-eastern Australia, and two other endangered reptiles, the legless lizard *Delma impar* and the eastern race of the Lined Earless Dragon (*Tympanocryptis lineata pinguiicola*), are also grassland specialists.

Field work is continuing, with recent important discoveries being information on preferred hiding places (spider holes), litter size (one to four) and the location of two more colonies. The two new sites are yet to be adequately explored but provide great encouragement that this species may survive. Graham Armstrong's alertness has given us an opportunity to get to know this little animal, some 130 years after it got its name. Not all of our fauna has been so fortunate. ■

Dr Mark Hutchinson is Curator of Reptiles and Amphibians at the South Australian Museum, a position he has held since 1990.

ADELAIDE PYGMY BLUETONGUE

Tiliqua adelaidensis

Classification
Family Scincidae

Distribution
Remnant native grassland near Burra, SA.

Behaviour
Little is currently known. Active by day, feeding mainly on invertebrates and hiding in spider holes. One to four young are born at the end of summer.

Threats and Causes of Demise
Probably alteration of native grassland habitat through agriculture and pasture improvement.

Status
Very rare and endangered.



"I rubbed it into the skin all over the body, and its slightly exciting properties proved very beneficial."

THE GOOD OIL ON THE EMU

BY TIM LOW

THE EXPLORER LUDWIG LEICHHARDT probably ate more Emus (*Dromaius novaehollandiae*) than any white person has before or since. His Port Essington journal tells many tales of Emu killing, cooking and gorging.

Near the Gulf of Carpentaria the big birds were his staple food, served up in huge (over a kilogram) portions for breakfast, lunch and dinner. The gigantic drumsticks were fried, stewed or grilled, and

many hearty feasts were had. At one high point Leichhardt exclaims: "we enjoyed a most beautiful moonlight night over a well grilled emu bone with so much satisfaction, that a frequenter of the Restaurants of the Palais Royal would have been doubtful whether to pity or envy us".

Other meals were less enjoyable. Emu meat that was carried for several days became tainted and fought with their bowels. And one bird was so bitter from eating bitter fruits that it was nearly inedible.

Leichhardt gobbled whole Emu carcasses, noting that "formerly, we threw the heads, gizzards, and feet away, but necessity had taught us economy; and upon trial, the feet of young emus was found to be as good and tender as cow heel".

His men also harvested Emu oil, for both food and medicine. "To obtain the

oil", Leichhardt wrote, "we skinned those parts, and suspended them before a slow fire, and caught the oil in our frying pan; this was of a light yellowish colour, tasteless, and almost free from scent. Several times, when suffering from excessive fatigue, I rubbed it into the skin all over the body, and its slightly exciting properties proved very beneficial. It has always been considered by the white inhabitants of the bush, a good anti-rheumatic."

Later colonial writers were not so enthusiastic about Emu meat, but confirmed the popularity of the oil in medicine. Its value was probably taught by Aborigines, among whom the oil was a popular remedy. Police trooper Alexander Tolmer in 1882 told a fascinating tale of his recovery using Emu oil from a condition in which his arms contracted towards the shoulders and his fingers became rigid. Doctors' embrocations achieved nothing but, according to Tolmer: "I got two of the most powerful troopers to rub the oil, one at each arm, two or three times a day, and wonderful to relate, the arms and fingers relaxed and regained their natural position . . ." The condition relapsed but was cured permanently by further treatment.

Tolmer's recollection comes from his autobiography, *Reminiscences of an adventurous and chequered career at home and at the Antipodes*. It is a quaintly titled tome, from an era long past when kangaroo-tail soup, Dugong ointment and other native animal products were respected and accepted. We can note with nostalgia the passing of those times. Or can we?

These yearling Emus at Barambah Emu Farm are almost ready for slaughter. Captive birds have more tender meat than wild birds, due to their sedentary lifestyle.



TIM LOW



TIM LOW

A range of therapeutic and cosmetic Emu oil products, displayed on Emu leather, and framed by Emu eggs, all from Barambah Emu Farm.

Something surprising has happened. In the last 15 years a new branch of primary production, Emu farming, has quietly taken off. There are now 35 Emu farms in Western Australia, and a scatter of others in Queensland and Tasmania. Emu farms have even sprung up in America, including a very large ranch in Texas. Emu meat and Emu oil can no longer be dismissed as Antipodean oddities; they are fast becoming big business.

Recently I visited Barambah Emu Farm near Kingaroy. Run by the Cherbourg Aboriginal community, it began six years ago as the first of Queensland's five Emu farms.

The size of the operation amazed me. Manager Cecil Brown led me past rows and rows of pens, and dazzled me with facts and figures. The farm holds 1,100 Emus, and is expanding. A breeding pair fetches \$5,000. Yearling birds are worth several hundred dollars apiece, yielding about 15 kilograms of meat at \$15 a kilo, \$100 worth of leather, and \$20–50 worth of oil. Unhatched eggs are carved or sold as curios. The birds are easy to maintain on a diet of grain, mainly wheat, with lucerne and vitamin supplements. The farm is even planning a program of selective breeding to improve egg output.

Cecil has high hopes for the lotions and balms developed by the farm. Emu oil, like goanna oil, is very fine, readily penetrating the skin without making it feel greasy. The yellow components in the oil have anti-inflammatory properties, according to Sydney arthritis specialist Associate Professor Peter Ghosh. He is co-author of a patent application for an Emu oil preparation and, like others in the industry, believes the oil may have great potential for treating rheumatoid arthritis.

Emu meat is low in saturated fats and thus very healthy. But, because it is red, it meets some resistance from diners who insist poultry should be white. For advice on how to cook it I turned to wild foods chef Jean-Paul Bruneteau (see ANH Winter 1992). Jean-Paul recommended taking cuts about the size of pork fillets and marinating them in virgin olive oil and black pepper for ten minutes. They should then be seared on a very hot cast-iron pan to create a crust that retains the



N.N. BIRKS / AUSCAPE INTERNATIONAL

Adult Emus fare well in captivity and breed readily. The eggs are brooded by the male.

water content. Otherwise the low-fat meat becomes grey and dry. After searing both sides for three to four minutes, the meat should be warmed for another five or six minutes inside a warm oven with the door open. Cooked on the outside, rare on the inside, it is then eaten warm. The flavour compares with beef.

Last year Qantas began serving Emu meat, as filet de l'emu, to its first-class passengers. Emu leg fillets marinated in juniper berries, basil and red wine, were also put on the menu of the Sheraton Mirage.

The Emu industry looks to have a promising future. It is an ideal industry for Aboriginal communities, although most farms are presently owned by whites. Because Emus yield a swag of products, good returns can be made based on realistic prices. Export prospects look good and government bodies are supportive. PhD students are being sought by the University of Queensland Gatton College to study Emu husbandry. The Queensland Department of Primary Industries is trialling the im-

pact of grazing Emus upon pastures with regenerating trees. These soft-footed native animals appear to be less damaging to grass and seedling trees than cattle and sheep. They can eat some plants that are toxic to cattle, such as bracken, and can drink fairly saline water. They may have a big future as an environmentally friendly alternative to the cattle and sheep that have degraded so much of Australia. ■

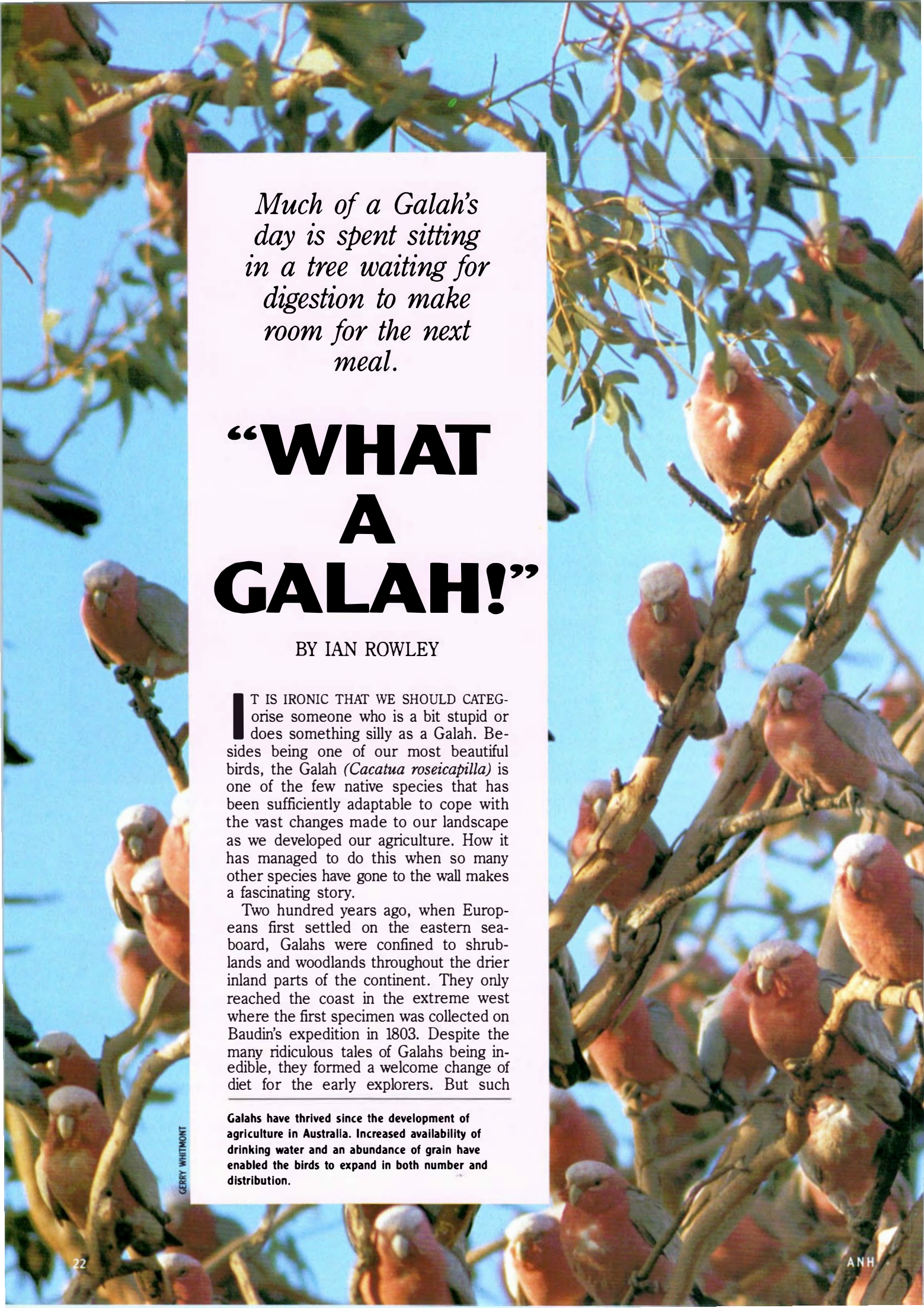
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Tim Low is a Brisbane-based environmental consultant and the author of four books on wild foods and medicines.



*Much of a Galah's
day is spent sitting
in a tree waiting for
digestion to make
room for the next
meal.*

“WHAT A GALAH!”

BY IAN ROWLEY

IT IS IRONIC THAT WE SHOULD CATEG-
orise someone who is a bit stupid or
does something silly as a Galah. Be-
sides being one of our most beautiful
birds, the Galah (*Cacatua roseicapilla*) is
one of the few native species that has
been sufficiently adaptable to cope with
the vast changes made to our landscape
as we developed our agriculture. How it
has managed to do this when so many
other species have gone to the wall makes
a fascinating story.

Two hundred years ago, when Europ-
eans first settled on the eastern sea-
board, Galahs were confined to shrub-
lands and woodlands throughout the drier
inland parts of the continent. They only
reached the coast in the extreme west
where the first specimen was collected on
Baudin's expedition in 1803. Despite the
many ridiculous tales of Galahs being in-
edible, they formed a welcome change of
diet for the early explorers. But such

Galahs have thrived since the development of
agriculture in Australia. Increased availability of
drinking water and an abundance of grain have
enabled the birds to expand in both number and
distribution.

GERRY WHITMONT





For the first seven weeks of their lives, young Galahs remain within the nest hollow where they are constantly tended by both parents.

comments are all we know about their early numbers and habits. We know they are seed-eaters and that, in their native state, they foraged in flocks on a wide variety of seeds (grasses, burrs, acacias) after these had ripened and fallen to the ground. Most of these plants flowered either seasonally or in response to favourable rainfall. Whatever the timing, they tended to produce a large quantity of seed in a short space of time over a relatively localised area. Before long, other competing species such as rodents or ants would arrive to share the feast or else the seeds would germinate and cease to be good food.

This problem of temporary abundance has faced most seed-eaters across the world. Many birds have solved it by developing highly tolerant flock associations. By taking advantage of their ability to fly, birds can achieve sufficient mobility to scour a large area in search of these localised abundances. The many pairs of eyes in such flocks not only provide a competent search for food but greater vigilance for predators. Sometimes they even provide 'lookouts' above the feeding flock, and the term 'cockatoo' has become part of the ritual attached to the illegal national sport of 'two-up', describing the person responsible for keeping an eye out for the law! Besides these practical advantages, the flock also allows young birds to serve their apprenticeship and to benefit from the accumulated experience of others.

Not only must Galahs find food, they need water, trees to rest and roost in, and hollows in which to nest. Before Europeans arrived, these resources were scarce and confined mainly to river frontages and ephemeral ponds following floods. These restrictions probably served to limit the number of breeding pairs and thus the total population.

It does not take much imagination to appreciate the bonanza provided by agricultural development—vast acres of seed-bearing crops ripening over an extended period that, even after harvest, leave an enormous amount of grain on the ground available for a specialist ground-feeder such as a Galah. Besides exten-



GALAH

Cacatua roseicapilla

Identification

Large (255–430 grams), fast-flying, pink and grey parrot, unmistakable for any other except the Gang-gang Cockatoo (*Callocephalon fimbriatum*), which has a much more restricted range (extreme south-west of Australia), does not occur in large flocks, flies at a much more leisurely pace and has a quite different call. Male Galahs (and immatures) have dark brown eyes while those of adult females are pink-red.

Classification

Family Cacatuidae (cockatoos). Two subspecies, a western and an eastern form, are separable on the basis of the colour of the crest (pink vs. whitish) and that of the eye ring (crusty white vs. light pink).

Distribution

Common and widespread throughout Australia, except for closed

forests, the extreme south-west, most of Tasmania and the tip of Cape York.

Breeding

Generally spring breeders throughout temperate Australia but most likely to breed in the Dry (winter) in the tropics (data are few). Clutch of 2–7 oval white eggs, laid every 2–3 days; incubation (22–26 days by both parents) starts before the clutch is complete, causing asynchronous hatching; nestlings remain in hollow for 45–59 days; fledglings fed by their parents for about 2 months before becoming independent. On average, each pair produces about 2 fledglings per year. About 80 per cent of breeding adults survive from one breeding season to the next. Form long-lasting pairs that nest in same vigorously defended hollow year after year.

sive areas of crops, the provision of watering points (such as dams or troughs) for domestic livestock released the birds from dependence on river frontages. This fortuitous emancipation would have provided breeding pairs with a far wider choice of nesting sites and led to the production of many more young. Under natural conditions, winter is the time of shortage for most grain-eaters; the provision of crops such as sorghum and sunflower, which may stand unharvested but ripe throughout many winter months, is yet another fortuitous benefit agriculture has bestowed on these birds.

SO THE GALAH HAS FOUND OUR FARMING methods very acceptable. But is there anything about their biology or way of life that has made them particularly capable of capitalising on this piece of good fortune? To answer this one needs to follow the bird from egg-lay to grave.

Galahs start their lives in the relative



JIRI LOCHMAN / LOCHMAN TRANSPARENCIES

security of a hollow, deep within an old tree. Four eggs are laid over eight days on a bed of green eucalypt leaves. For the next four weeks both parents take it in turn to incubate the eggs. The naked nestlings hatch in succession and for three weeks are kept warm by one of the parents while the other forages. For the rest of their nest-life the young Galahs are fed by both parents every hour or so. By the time they are 30 days old the young recognise the calls of their parents and communicate with them. They soon begin to climb up the hollow and to peer out of the opening. After seven weeks the first of the young leaves the hollow and, escorted by its parents, makes its debut flight with all the aplomb of a polished performer. It's difficult to tell which bird is the 'debutante' . . . until it crash-lands into a convenient canopy!

Because the nestlings hatch on different days, they fledge in succession and, since their first flight seems to be dictated

by the direction of the wind, the family usually ends up a bit scattered. During this period the parents have to divide their time between the fledglings and those nestlings remaining in the hollow. Galahs often nest quite close to other pairs, and a gathering point for fledged families soon becomes important. Certain clumps of trees appear to be particularly suitable and, used by several families, come to resemble the creches of our own species, with young all over the place and only a few adults to look after them. Even in the absence of some parents, the creche will take off and fly 'bumps and circuits'. Fast formation flying and flock coordination is an important part of their life, and the sooner they become proficient the better.

When all the family is reunited the members make their way to a convenient source of food. This is typically where a truck has cornered too fast with a full load, or where some other spillage has

Before the arrival of Europeans, a major restriction on the distribution of Galahs was their dependence upon river frontages for drinking water.

occurred, and there the young are taught to feed for themselves. Before long, young birds outnumber their parents and the juvenile flock tends to drift downwind. The adults keep up for several weeks and each night they, but not the young, return to the nest hollow. The next morning the parents commute back to the juveniles and spend most of the day with them. I have followed individually marked birds travelling 16 kilometres from their hollow to their young; but after that they gave up and the young were on their own. This 'weaning' takes place much earlier in Galahs than it does in other cockatoos and may help explain the species' rapid expansion into newly cleared wheatlands.

Despite rapid expansion, mortality of Galahs in the wild is high, especially for nestlings and young inexperienced birds. In some years, a virus can wipe out whole broods. Many birds are killed on the

Grain spilt by the roadside has become a major food source for Galahs, and is often where young are taught to feed for themselves, despite the inherent dangers of traffic.

roads; others are shot. Most Galah mortality occurs around winter. This is the time of food shortage for most grain-feeders, and starving birds make easy meals for cats and birds of prey.

Meanwhile the parents continue visiting their nest hollow throughout the year and usually roost in the canopy above. At least that's what happens in the remnant woodland of the Western Australian wheatbelt where I followed them for five years. Whether the semi-arid and arid birds can enjoy the luxury of returning home each evening remains supposition, but I think they probably try to do so until food becomes too scarce.

From the limited data we have from the field and the odd record from aviculturists, it looks as though Galahs, as other cockatoos, are long-lived. A long life, a permanent pair bond, a secure nest place (a hollow), a shared raising of four youngsters that are shed soon after fledging, all in the midst of an abundance of grain, appears to be an ideal scenario. It is small wonder they have thrived since Europeans arrived here.

THE STORY AS IT UNFOLDED IN Western Australia is typical of what happened earlier in the east. Before 1919, there were no Galahs in what today is Western Australia's wheatbelt. Following the war, it became a rapidly developing soldier settlement. The first birds appeared in the 1920s and soon settled in and multiplied so that by 1940 the district of Mukinbudin found it necessary to 'declare' them under the Vermin Act. In 1942-1943, a halfpenny per head was paid on 3,529 Galahs. Other districts followed suit and recipes for wholesale poisoning were readily available and used.

Conflict between farmers and Galahs worsened when the birds learnt to undo the stitching of the carefully filled bags of grain. This may seem trivial today, but to those of us who can remember spending a broiling day ramming grain into bags and then sewing up the tops, the infuriation when all this work had to be repeated because of the Galahs can still be remembered.

In the 1960s bags were replaced by steel bulk bins mounted on the backs of



RALPH & DAPHNE KELLER / ANT PHOTO LIBRARY

trucks. And soon the problem of the unstitched bags was replaced by farmers' resentment toward the large flocks as they fed on grain spilt from the trucks on the way to the silo; wasted grain, yes, but somehow it was like rubbing salt into the farmers' wounds. Besides, birds feeding in this way were a hazard to motorists, particularly young birds that were slow to take off. Broken windscreens and a few accidents didn't help endear these birds to the rural population.

Apart from feeding from spillage, many grain storage bins at the railway sidings had no roofs and so were easy pickings for the birds. Although other species of parrots and some pigeons were also involved in these depredations, Galahs, by virtue of their huge flocks, were by far the worst offenders. Not only did they eat the grain but they deposited a large amount of faecal material amongst it, enough for the Health Authorities to reject shipments intended for human consumption overseas. Dried bird faeces and cereal grains are much the same size and so it sometimes took three or four expensive sortings be-



WADE HUGHES / LOCHMAN TRANSPARENCIES

fore the grain was fit to be exported.

Recognition that weevils caused enormous losses to the industry led to new insect-proof silos at all railway sidings in the 1970s. By 1975 the feeding activities of Galahs around harvest time were limited to grain spilt in the paddock, on the roadside or amongst railway lines. And even the last became rare when new railway trucks and loading methods were introduced.

Today Galahs and farmers still conflict at other times of the year. At sowing time, if the seed is sown too shallowly or is spilt on the surface, the birds are attracted and will dig for the grain. This problem only lasts until the seed germinates but can be largely avoided by setting the drill correctly and not wasting the seed. Until the crop is harvested it is largely safe from

If all goes well, this western female Galah will have a long life, in which she will form a permanent pair bond, fledge two young per year and spend most of her time feeding on grain.

On some aerials the sheer weight of Galahs may become a significant factor undreamt of by the design engineer.

bird depredations. At harvest some grain will always fall to the ground but, again, this is available only until the autumn rain germinates it. On most farms there is enough grain on the stubble for both sheep and birds, and the latter do not represent an economic loss. Grain spilt carelessly around a silo, or even where it is trailed out on the ground for drought-stricken sheep, cannot be begrudged to birds; the temptation is conscious, obvious and removable.

Much of a Galah's day is spent sitting in a tree waiting for digestion to make room for the next meal. Perhaps through bore-

dom they nibble and prune the branches on which they perch, which is particularly infuriating if the trees have been planted for shelter belts or shade. Galahs also like to perch on power lines, causing these to sag, short-circuit, and even start a fire, and they like to perch on radio and television aerials, often chewing the fittings whilst they are there. On some aerials the sheer weight of numbers may become a significant factor undreamt of by the de-

Galahs are a favoured item of the illegal overseas bird trade, and many die while being smuggled out of the country.



D. & V. BLAGDEN / NPWW



GRAEME CHAPMAN



sign engineer. On many airfields unsealed areas are often sown with grass to stabilise the surface; careless management allows seed to set, which attracts the birds and causes a hazard to aircraft landing and taking off.

Bird-trappers like to pretend they can solve all the farmer's problems by catching his pests and selling them as pets to defray the costs. Unfortunately no animal trapper has ever solved a pest problem—they always give up when it gets too hard, leaving the farmer with an even more wary pest. And wild-caught birds make very bitey pets!

The only way to prevent a bird-pest problem is never to let the birds establish the habit of feeding or roosting in the target area. If they are discouraged from the start, the problem will probably never develop. Large-scale poisoning was widely

practised in the past but is not generally acceptable nowadays; it only ever provided a temporary palliative, skimming off the recent crop of young birds, most of which would probably have died anyway in a few months. Our efforts at reducing Galah numbers have not been noticeably successful. Present-day opinion tends towards learning to live with our competitors, and most cases of conflict with Galahs can be overcome by careful husbandry and not allowing the birds to become overfamiliar. In the long run, sadly, the problem of all parrot populations may well solve itself as the number of hollow trees continues to decline and these species, unable to breed, become endangered. ■

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Galahs are highly sociable and spend much of their time in huge flocks, which can comprise up to hundreds of birds.

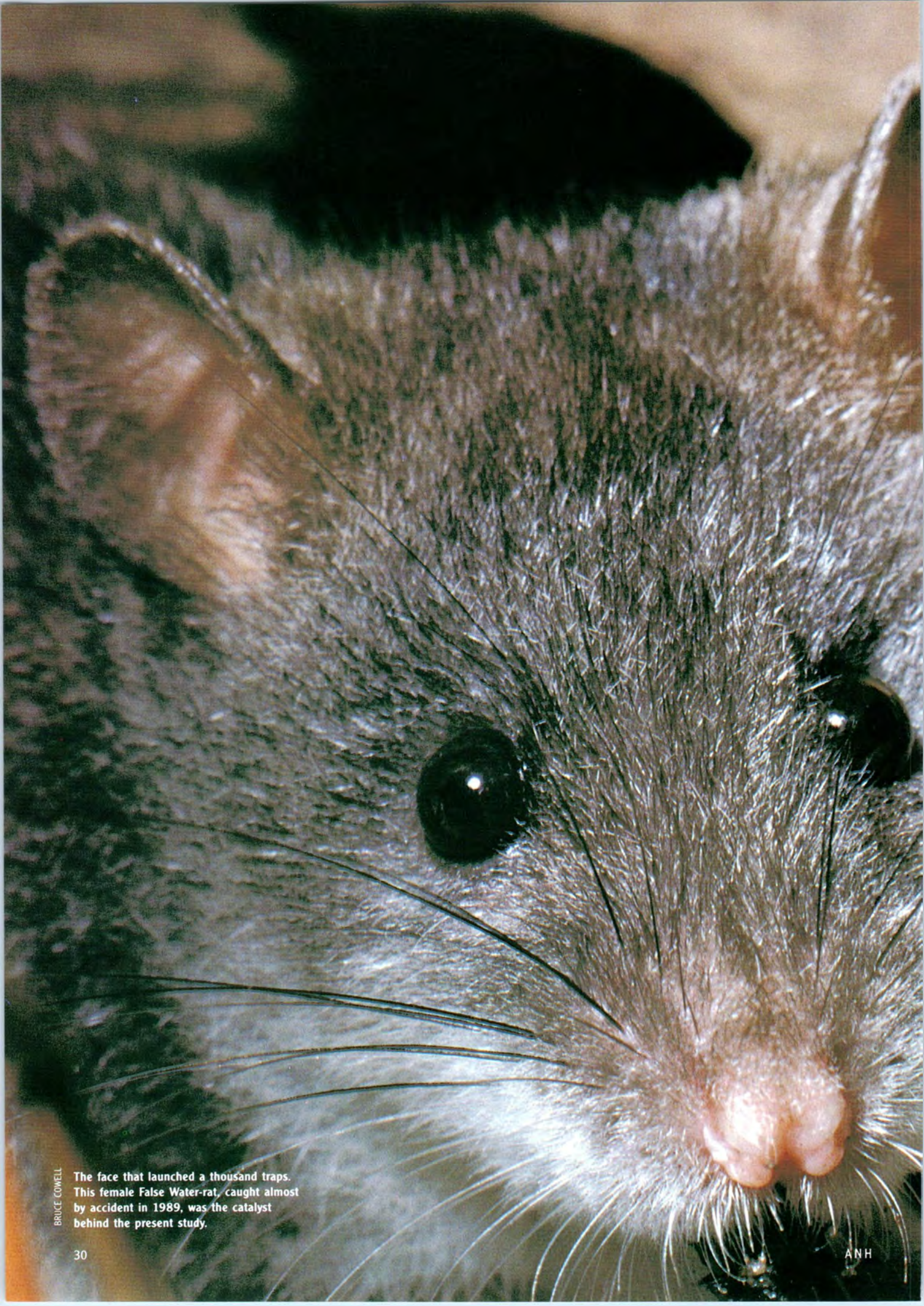
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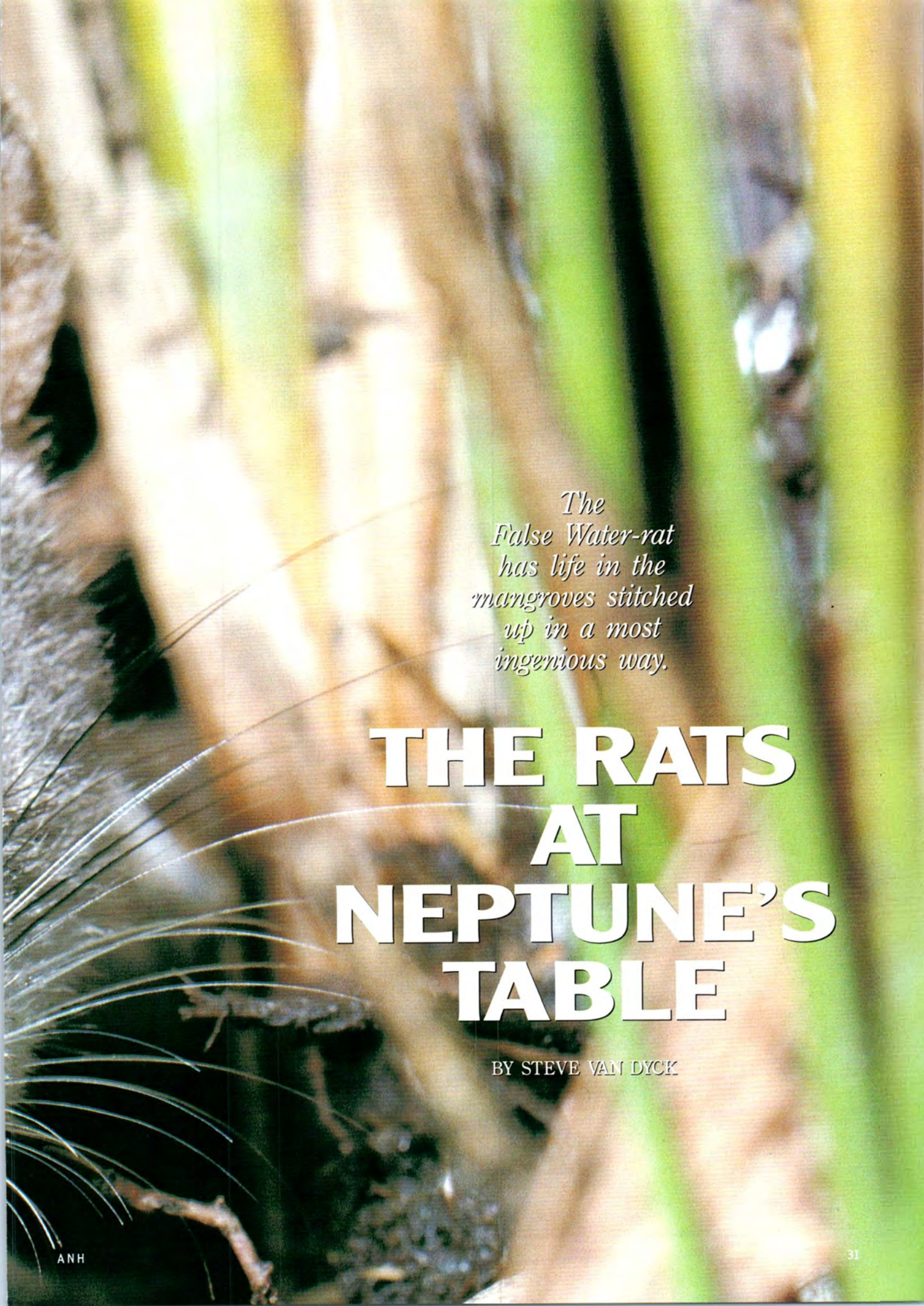
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Ian Rowley has recently retired after 40 years as a research scientist in the CSIRO Division of Wildlife and Ecology in Perth. Unable to give up, he is currently an Honorary Research Associate.

Despite their obvious success, Galahs, like all Australian parrots, are threatened by the increasing loss of hollow trees used for nesting.



BRUCE COWELL
The face that launched a thousand traps. This female False Water-rat, caught almost by accident in 1989, was the catalyst behind the present study.



*The
False Water-rat
has life in the
mangroves stitched
up in a most
ingenious way.*

THE RATS AT NEPTUNE'S TABLE

BY STEVE VAN DYCK

THEY WOULD NEVER ADMIT TO IT, but one thing that gets up mammalogists' noses is when someone who studies more humble forms of life (like reptiles) makes significant discoveries in the sanctified domain of hot blood and udders. And, until I recently took a nine-day interest in Great-billed Herons, it used to always strike me as funny that the only people who knew anything about False Water-rats were scientists who studied Saltwater Crocodiles!

What dealt the burgeoning heron interest a mortal blow was more to do with being eaten than anything else. If you want to see Great-billed Herons rocking the swamps with their bull-roaring love calls, you have to step inside tropical mangroves after dark . . . which means side-stepping the herons' greater-billed bed-fellows, the Saltwater Crocodiles, for which I have no stomach at all.

So that was it. Rare, mangrove-loving, nocturnal False Water-rats (*Xeromys myoides*) were, like the herons, a black science because no-one wanted to be swallowed studying them. And, apart from about 14 pickled museum specimens and the very significant but small handful of accidental rat observations made by crocodile researchers (who embrace being swallowed as an occupational hazard), the life of the False Water-rat has understandably remained something of a mystery since it was first described in 1889.

Unfortunately for mammalogists tantalised by the puzzle of what made these tiny rats tick, and for herpophobic cowards like me who wanted to skirt around the reptile part of the study, there are few known places along the northern Australian coast (between Melville Island and Brisbane) where False Water-rats exist in the absence of that more coarse-grained company.

But one exception is subtropical North Stradbroke Island, a massive 32-kilometre-long, crocodile-less sand island 40 kilometres east of Brisbane. While the eastern side of the island offers great chunks of paradise to surfers, beachcombers, fishermen and real estate agents, the western side unassumingly guards an embarrassment of biological riches in its freshwater swamps and dark mangroves. There are rare and endangered orchids and Water Daisies, golden Swamp Wallabies, disease-free Koalas, Mud Crabs, oysters, fish and marijuana nurseries . . . and a flourishing population of False Water-rats.

Late in 1991, Ellie Durbidge (secretary of the Stradbroke Island Management Organisation) and I stumbled over a large, reed-covered mound while slurping through the mangroves of Myora Springs. We had been whingeing to one another about how False Water-rats had not been seen on Stradbroke since a visiting group of Idaho students had caught one among the same patch of mangroves back in 1978. The gigantic 60-centimetre-high mound looked like a soggy termite nest with two pop holes in the top, but super-

A rare find. This enormous rush-covered mound at Myora is probably many decades old and the product of generations of industrious False Water-rats.

ficially similar to a weird nest described from Melville Island, Northern Territory (by crocodile researchers!) in 1976. That Melville Island nest had contained a mother False Water-rat and her two young ones, and was probably the most significant breakthrough ever made in *Xeromys* research.

As it turned out, the hummock we had tripped over also contained False Water-rats. In fact, by the end of 18 months of enraptured sloshings around Myora, we knew that at least an adult pair, five subadults and a juvenile of the tiny mud-daubing dynamos lived inside that one



FALSE WATER-RAT

Xeromys myoides

Classification

Order Rodentia; family Muridae; tribe Hydromyini ('aquatic rats')

Identification

Small (head-body length 8–13cm, tail 7–10cm); dark grey above (most of North Stradbroke Island adults white-spotted), white below; tiny eyes; no webbing on hind feet (as in Australia's only other aquatic rat, *Hydromys chrysogaster*).

Habitat and Distribution

Shallow coastal wetlands such as mangrove forests, freshwater lagoons, swamps or sedged lakes close to fore-dunes; north-central and north-eastern Australia; always in association with water.

Behaviour

Nocturnal, terrestrial, non-aquatic but mud-puddling; solitary forager; capable of breeding in any month of the year.

Nest

Usually in the supralittoral zone of mangrove flats and often among sedges, in simple tunnels, or in large mounds that raise them above the level of high tide. May nest in family groups.

Food

Includes aquatic invertebrates such as crabs, mud-lobsters, mussels, marine pulmonates (air-breathing snails and slugs), polyclads (a type of flatworm).





BRUCE COWELL



With teeth and temperament honed for crab butchery, adult False Water-rats, like this male, rarely wait for their photo before drawing blood from human fingers.

structure. Far more importantly, though, that period of research, which resulted in us handling over 100 individuals, provided a tantalising taste of the species' strange specialised life and its intimately dependent relationship with the mangrove community.

THE BIGGEST PROBLEM IN TRYING TO understand False Water-rats has always been catching them. Mangroves can be messy places to work, mosquitoes and sandflies can send you insane and, if you lay live traps out on the forest floor, the night tide, which is usually higher than the day's, will probably drown the animals before you get back to them in the morning. This has made setting traps up mangrove trees a tempting alternative. But one of the first insights that came through a long period of watching wild, radio-tagged False Water-rats was that, at least on North Stradbroke Island, they just don't climb. Perhaps if Stradbroke had crocodiles they would. They do crawl up inside inclined hollow trunks to a height of about two metres, but basically they are



BRUCE COWELL



Nesting mounds are big work for little bodies. The small mound seen here (centre right) has been under construction for about one year.

landlubbers, happiest with their soft, smooth feet in the mud below.

And they are not too fussed about swimming either. They certainly can swim well and the odd deep puddle or creek is crossed effortlessly, but they don't forage for food in the water or go out of their way to fling themselves into the rising tide. A swimming animal glides across the surface of the water like a battery-operated cork boat and their fur, so completely dry on emerging, reminds me of that remarkable floating water plant *Salvinia* whose hairy leaves so magically and repeatedly repel water to the last drop.

Such negative dispositions as non-climbing and non-swimming in a water-rat might go a long way toward explaining the animal's apparent rarity! But a closer look at its lifestyle reveals that the False Water-rat really does have life in the mangroves stitched up in a most ingenious

way.

For a start, on Stradbroke they don't nest inside the mangroves, but way up the tidal flats along the supralittoral zone that marks the extent of the very highest (spring) tides. Usually this is among the sedges of a narrow, well-defined reed band that skirts the upper mangrove edge. By nesting there, their access to the greatest share of the mangroves is only limited by the highest of those spring tides, which for a few hours they are happy to sit out inside the nest.

The pattern of night-time activity is always dictated by the tides. If the high tide is relatively low and way out in the mangroves, the False Water-rats will usually leave the nest on sunset and forage until sunrise. If the high tide is up to or surrounds the nest early in the night, the animals wait the three or four hours of inundation and follow it out as it recedes. If a big tide occurs late in the night, the rats forage back to the nest with the incoming tide, wait the period of inundation in the nest, then emerge again if darkness permits.

To nest inside the Stradbroke mangroves would result in intolerably long periods of inundation detracting from foraging time. It would also force them to swim and climb, would greatly limit nesting sites to the inside of trees, and would also mean the flooding of olfactory cues laid down on the mangrove floor.

It would seem that, apart from food, most of what False Water-rats take in of life goes through their noses, and most of what goes out is produced near their rear end. Unlike the bulk of other Australian rodents, False Water-rats have extremely small eyes that resemble more those of small insectivorous bats. They do, however, respond most positively to smells, and may themselves hum with a strong musky aura that resembles something between pilchards and mouldy leather. Part of this is undoubtedly produced in large anal glands found at the

The only gear needed for False Water-ratting is mullet-baited traps and No-Doze. If you go to sleep, the night's high tide could sweep through and drown your precious catch.



BRUCE COWELL

base of the tail, and presumably the excretion is judiciously dribbled on whatever the rats would like smelling of them. At ground level the remarkable pheromone survives daily washings by the high tides and persists inside favourite hollow trunks. In this way a foraging animal can follow its nose through predictable pathways over a prescribed home range in a manner suggesting the area was signposted, paved, fenced and neon-lit. The smell is strong enough to tickle human nostrils, and deep log-sniffing at mud level can often be used to help assess an area for the rats.

There are, however, more dignified ways to predict their presence. Most obvious of all are the large nesting mounds of which at Myora we found five. But with False Water-rats, nesting mounds are the exception and not the rule. Dotted between such mounds are very ordinary, unpretentious nesting tunnels dug wherever the lapping spring tide makes a small bank. There is good evidence suggesting that the more erosive high tides will eventually force the rats to make some of these into mounds of the future. So gigantic are some of the mounded nests and so obviously impossible for the rats to construct overnight that they may simply represent the historic position of the supralittoral shoreline, their form preserved and consolidated by the industry of the mud-daubing rats and the help of the covering sedges.

GIVEN THE PROSPECT THAT FALSE water-rats may be in an area even where there are no mounds to trip over, the next clue to look for can be found back inside the mangroves. There, where a great proportion of the trees are hollow at the base, table scraps left by the furry gourmets provide the clue. Small crab and mud-lobster shell middens are the most obvious, and are found inside hollow shelters. This is because False Water-rats like to take such relatively large prey items under protective cover to eat at leisure. It may take them 20 minutes to fastidiously pick their way through a crab the size of a ten-cent piece. Other smaller food items like green sea mussels (*Glaucanome* sp.) and the periwinkle-like marine pulmonate (air-breathing snail) *Salinator solida* might be opened and eaten on the run. Back in the sedge zone, small caches of another marine pulmonate *Ophicardelus quoyi* can be found under driftwood, and on a still night a well-pricked ear might hear the crunching of a False Water-rat as it breaks open the shell to extract the succulent body from within.

Many creatures in the mangroves are protected by a hard shell, but some of those that aren't are covered by so much mucus that you'd think a predator would gag before getting to the good bits. The False Water-rat, however, is not averse to slime-dressing with its supper. One remarkable example is that of its interest in a strange brown flatworm whose existence in the world was not suspected

While False Water-rats can't resist slimy polyclads, no other predator has yet been recorded for this usually toxic group of marine flatworms.

until the rats were recorded eating it. The predatory worm, similar in size and shape to a 20-cent piece, represents an undescribed group of marine polyclads (relatively large, aquatic and free-living flatworms), whose more brightly coloured relatives on the Great Barrier Reef are suspected of being so toxic that no known predator has been recorded for them. When a polyclad is bitten, mucus-generating cells disgorge during a muscular spasm that rips through the whole

False Water-rats behave as if every night was their last.

animal. This transforms it into an amorphous brown clot of goo that has resulted in the Stradbroke polyclad being affectionately christened 'snot-bomb' until a more conventional scientific name can be assigned. False Water-rats have had to be practically dragged from such meals before the object of their intense interest could be analysed.

The mudflat smorgasbord on Stradbroke Island is perfectly spaced out to keep False Water-rats in fat fettle regardless of the level of the tide. At low tide the rats can catch common species of crabs such as the Red-fingered Marsh Crab (*Parasesarma erythroactyla*) right out to the seaward limit of the mangroves. And during higher tides when access is blocked to the mangrove's most produc-





BRUCE COWELL

tive zones, crabs such as *Helice leachi*, which occur mainly on the high intertidal or terrestrial zones, can be eaten.

For all the delicious seafood spread out in front of them, False Water-rats behave as if every night was their last. They tear around through the roots like racing slot cars about to fuse. They are as flexible as ferrets and seem to slither like snakes between the spiky mangrove pneumatophores that forever stand in their way. An adult male that exhibited over ten hours of furious activity covered a linear distance of 2.9 kilometres before returning to his nest in the morning. Almost 90 per cent of that time was spent charging backward and forward between hollows, visiting

Seafood handout fit for a king. Clockwise from the thumb: unnamed marine polyclad, two types of marine pulmonates, green sea mussels and a female Red-fingered Marsh Crab—all standard fare at the False Water-rat's table.

other nests and scrapping with neighbours. Most False Water-rats had home ranges of about six thousand square metres, the outer edges of which overlapped with neighbouring home ranges. Each rat, however, spent about two thirds of its activity time in a non-overlapping two-thousand-square-metre core that was thoroughly scoured throughout the night.

But by day no-one would suspect the frenetic bustle of night-life among the mangrove roots. No-one would imagine grey and white sprites darting and sniffing between the slippery hollows. And few would want to dream of the fights and battles between so many sharp teeth, hard shells and nipping claws. But it does go on, and the whole exquisitely complicated process just reinforces what we now know about not judging books by their covers, rats by their drainpipes, or mangroves by their mud. ■

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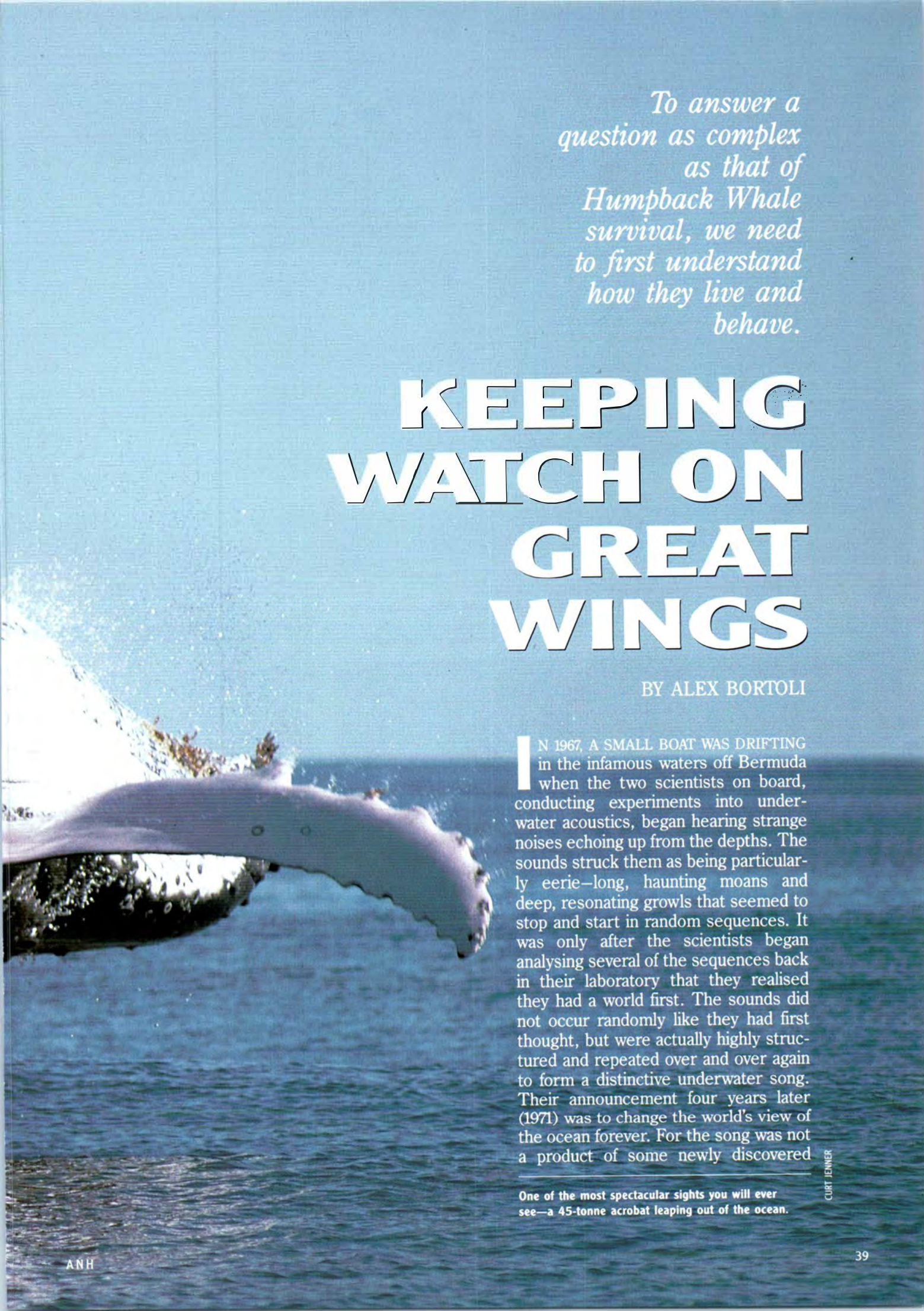
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Steve Van Dyck is a curator in the Vertebrate Department of the Queensland Museum. His Xeromys research was funded by the Endangered Species Unit (Australian Nature Conservation Agency), which made it possible to have the valued assistance of human mudskippers Barney Hines and Judy Conrad, to whom the spectacular double back flip and pike was par for the course.





*To answer a
question as complex
as that of
Humpback Whale
survival, we need
to first understand
how they live and
behave.*

KEEPING WATCH ON GREAT WINGS

BY ALEX BORTOLI

IN 1967, A SMALL BOAT WAS DRIFTING in the infamous waters off Bermuda when the two scientists on board, conducting experiments into underwater acoustics, began hearing strange noises echoing up from the depths. The sounds struck them as being particularly eerie—long, haunting moans and deep, resonating growls that seemed to stop and start in random sequences. It was only after the scientists began analysing several of the sequences back in their laboratory that they realised they had a world first. The sounds did not occur randomly like they had first thought, but were actually highly structured and repeated over and over again to form a distinctive underwater song. Their announcement four years later (1971) was to change the world's view of the ocean forever. For the song was not a product of some newly discovered

One of the most spectacular sights you will ever see—a 45-tonne acrobat leaping out of the ocean.

CURT JENNER

species, but that of a group of migrating Humpback Whales (*Megaptera novaeangliae*).

In a way, the Bermuda-based scientists were lucky to have recorded and identified Humpback songs even in 1971. Humpbacks travelling on their migration paths in the Northern Hemisphere stay well offshore and are notoriously difficult to locate and record at length, except in their breeding grounds. Australia does not have this problem. In fact, the opposite holds true. Migration paths tend to hug the coastline for many thousands of kilometres, with the whales then moving steadily northward to warmer waters and dispersed breeding areas off the east and west coasts of Australia. It is a feature that commercial whalers exploited to the fullest between 1949 and 1962, when they slaughtered over 10,000 Humpbacks along the east coast of Australia and New Zealand. Similarly, the whaling industry off the west coast took many thousands of Humpbacks during their annual migration. In both cases, the populations were reduced to very low numbers, possibly less than 1,000 animals in total.

And yet, 30 years on, these same migration routes are proving to be a boon both for the whales and for the scientists wishing to study their songs and behaviour. According to a number of land- and sea-based surveys, stocks on the east coast are increasing by about nine to 12 per cent each year (current estimates put

HUMPBACK WHALE

Megaptera novaeangliae

Family

Balaenopteridae

Identification

Length approximately 15 metres; weight approximately 45 tonnes; enormous flippers (approximately one third body length); characteristic hump in front of the small dorsal fin; knobbly protuberances, often with attached barnacles on head, jaws and flippers.

Reproduction

Maturity reached ten years or younger; gestation 11–12 months.

Prey

Small swarming crustaceans and fish.

Status

Population 1,200–1,500 individuals; endangered.

the total population at between 1,200 and 1,500 individuals). But the big question remains: are Humpbacks out of danger? It is, after all, very tempting to sit back and relax in the warm glow of such positive statistics, safe in the knowledge that

Humpbacks force water through feathery plates of baleen in order to extract the small crustaceans and fish upon which they feed.



DAVID HAMILTON / THE IMAGE BANK





A female Humpback and her calf leap from the water. Although Humpback numbers are increasing, they are not necessarily out of danger.

DAVID PATON / ANT PHOTO LIBRARY



Humpback Whales produce the longest and most complex sequence of sounds of all animals.

this species will continue to increase of its own accord. But is that really the case? Is time alone the most important factor in their recovery?

Recently US scientist Dr Steve Katona, who is helping to put together a Whale Recovery Plan for Humpbacks in the Northern Hemisphere, suggested there is now a suite of problems affecting whale populations that did not exist in the days of large-scale hunting. He notes that many of these threats are much harder to manage than was hunting, and their combined effects are not well understood. Factors such as the overfishing of krill and certain fish species, increased shipping traffic, pollution, coastal, recreational or industrial development near feeding and breeding grounds, and the long-term effects of greenhouse warming on polar food chains all loom as potential threats. To add to the complexity of the problem, research has shown that, while all Humpbacks from the Southern Hemisphere begin their migration from the cold waters of the Antarctic, those groups travelling up the west coast of Australia are distinctly different (genetically and socially) from those travelling up the east coast. There appears to be very little, if any, inter-

breeding between the two groups. Thus, in order to answer a question as complex as that of Humpback recovery and survival, it's necessary to first understand how Humpbacks live and behave in their watery world and then ask how best to manage them.

HUMPBCKS BELONG TO THE ORDER Cetacea, a group of air-breathing mammals whose ancestors returned to the sea some 50 million years ago. As a species, they are characterised by their incredibly long flippers (*Megaptera* means 'great wing'), their deep throat grooves and lumpy dorsal fin. Unlike dolphins and sperm whales, which have teeth, Humpbacks possess plates of baleen (a keratin-like substance similar to fingernails) that they use to sieve small crustaceans and fish from the water. The plates hang down from the top of their mouths in long feathery strips. Indeed, it is one of the true ironies of nature that the largest living animals, the baleen whales, survive on some of the smallest of the ocean's creatures.

As the fifth largest of the great whales, Humpbacks weigh in at a hefty 45 tonnes and grow to a length of 15 metres.



Although not in the same league as the Blue Whale (*Balaenoptera musculus*; another baleen whale that can grow to over 30 metres and weigh an incredible 200 tonnes), Humpbacks have lungs the size of a small car and can exhale air from their blowhole at the estimated speed of 450 kilometres per hour. Amazingly, they can replenish 95 per cent of their lung capacity in less than two seconds! But it is the complexity of their songs and their highly social behaviour that perhaps provide the most intriguing clues to their underwater lifestyle. It is also, not surprisingly, a highly controversial area of Humpback research.

Humpbacks are known to produce the longest and most complex sequence of sounds of all animals. Just as an opera explores different themes by telling a story in song, so the Humpback song is characterised by a number of distinct themes, each theme being represented by certain repeating phrases or sound units. Sounds can range from high-pitched 'squeals' to bone-chilling 'down moans' and barely audible 'whoops'. The majority of sounds, however, occur at frequencies of between 50 and 5,000 Hertz (well within our range of hearing).



It's hard to ignore 40 tonnes of Humpback when it slaps its tail on the surface of the water. This behaviour is just one of the ways Humpbacks communicate.

WHALE BEHAVIOUR

Of all the large whales, Humpbacks are considered to be the most acrobatic and playful. It is a truly humbling experience to see 40 tonnes of Humpback leap clear of the water, execute a perfect half twist with its splayed pectoral fins and disappear in a mountain of 'whitewash', all within the space of three seconds. But the breach as it is called, is only one of a number of spectacular Humpback behaviours. Below is a list of some of the more common behaviours often seen in the popular whale-watching areas.

The Blow

A powerful exhalation of breath and usually the first indication that Humpbacks are present in the area. Scientists can sometimes tell the species of a whale simply by looking at the height, size and shape of the blow. Owing to an emulsion of oil suspended in the blow, whale breath can be quite fishy to smell. This oil is said to absorb nitrogen during deep dives, thus helping to prevent the bends.

Fluke up Dive

Following a blow, a Humpback will often arch its back and roll forward until only its tail flukes are sticking up out of the water. Researchers have taken advantage of this particular behaviour by compiling a photographic register of the individual markings on each whale's tail. The characteristic arching of the whale's back prior to a 'fluke up dive' is also how the Humpback got its unusual name.

Pec Slapping, Tail Slapping

For Humpbacks, slapping their pectoral fins on the surface of the water is something akin to an acrobatic feat. Each pectoral fin weighs in the vicinity of several tonnes and can be five metres long from base to tip. It is believed the behaviour serves as a means of communication—a kind of "I'm here" splash! The same holds true for tail slapping, but it can also be used to indicate aggression.

Spy Hop

Humpbacks are, by nature, highly curious animals and it can be quite disconcerting to the first-time whale-watcher to see a full-size whale suddenly pop its head vertically out of the water and take a good look around before sinking under water again. It is thought this behaviour is one way Humpbacks orientate themselves on the long migration up and down the coast.

Fighting

When male Humpbacks come together in the breeding grounds and compete for primary escort position with a female, fighting occurs. Large males will battle it out through a combination of head-butting, snorting, bubble-blowing and inflated lunging (lunging with their mouths full of water in a bid to make themselves look larger than life). Males have also been known to 'motor boat' on rare occasions—a highly aggressive behaviour in which both males swim at the surface and surge through the water side by side, creating a huge bow wave. Dominant males may well have to prove themselves several times during each breeding season.



Humpbacks, like most slow-swimming marine vertebrates, often fall victim to the voracious Cookiecutter Shark (*Isistius brasiliensis*). Evidence of the shark's attacks can be seen as white circles on this Humpback's head.

Dr Doug Cato, from the Defence Science and Technology Organisation in Sydney, is one researcher who has been analysing the songs of Australia's east coast Humpback population for almost 12 years. In the course of his research off Queensland's Stradbroke Island, he and his coworkers discovered fascinating evidence that the songs of east coast Humpbacks actually evolve from one year to the next. Why the songs change and what their significance is to the Humpbacks themselves are subjects of fierce debate. Researchers in the Northern Hemisphere, faced with similar data, have suggested that Humpbacks actually pick up a song where they left off the previous migratory season. They say song patterns reflect a continuously evolving story rather than separate songs. But Cato believes the answer is not that simple. He thinks the songs may be intrinsically related to the social structure and reproduc-

tive success of a whale group.

The evidence certainly seems to support this. Whales on the east coast, for example, all sing the same song, despite the introduction of new phrases and themes during a migration period. Incredibly, changes are somehow relayed from one whale group to another along the entire 1,500 kilometres of coastline. And on the Northern Hemisphere breeding grounds, male Humpbacks are known to serenade females, perhaps in a bid to create an acoustic territory and lure females into courtship. A female probably listens for the male that is either the strongest or best singer. The song may be accentuated by spectacular behaviour such as pec slapping, breaching and tail slapping (see box). Astrida Mednis, a marine biologist working with the Australian Nature Conservation Agency (ANCA; formerly the Australian National Parks and Wildlife Service), has recently completed an analysis of east coast Humpback song recordings. She suggests that, while songs are generally quite stereotyped, small variations in the acoustics of each 'sound type' could change the meaning of



the song just enough to be significant for individual whales. A signature tune perhaps? It's a distinct possibility.

But while song analysis is a fascinating area of Humpback research, it is data on migration patterns and whale identification that take priority when it comes to Humpback management. In the case of Southern Hemisphere Humpbacks, two scientists in particular, Drs Bill Dawbin and Graham Chittleborough, laid much of the groundwork for today's research and management strategies. Dawbin, a former zoology lecturer at Wellington University, and Chittleborough, a CSIRO scientist, spent much of the early '50s and '60s living on whaling ships, sometimes wading knee-deep through rivers of blood and blubber in a desperate effort to get information on Humpback biology, stock numbers and migration patterns. They tagged some 2,000 whales in their time and were instrumental in introducing the whaling bans that saved a number of species from the brink of extinction. Dawbin subsequently went on to lead a team studying the songs of Humpbacks in and around Australian waters.

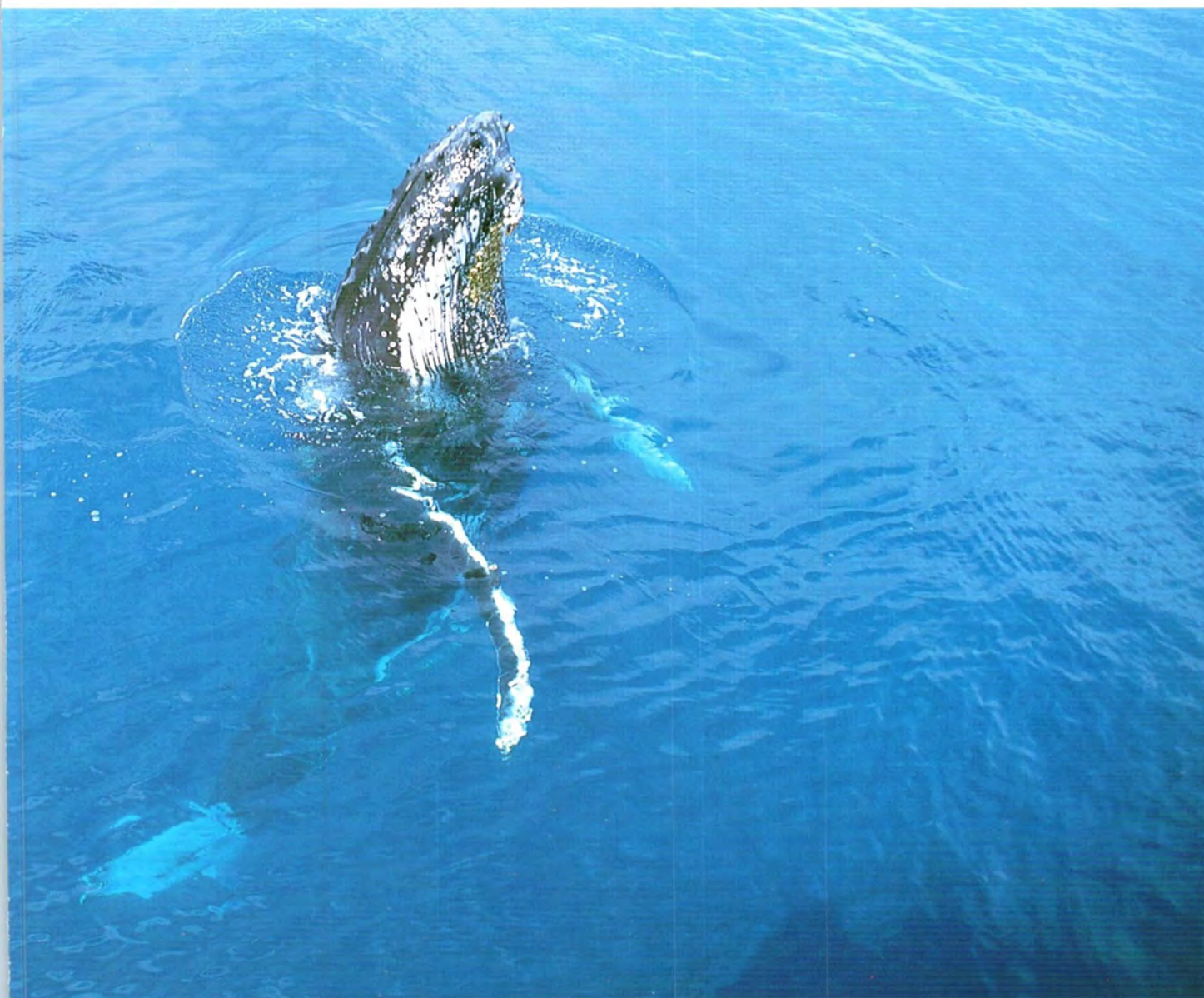
Thanks to new technology, these 'hands on' methods of research are no longer needed. Now the emphasis is on photo-identification and genetic analysis. Photo-identification is potentially the most revealing method of analysis. All adult Humpbacks have distinct, individual markings and/or scarring on their tails and sides that change little over time. Just as police compile mug shots for criminals, several groups of researchers are compiling a photographic register of as many Humpbacks travelling along the coast as possible. Re-sightings can then be recorded to provide information on movement for individual animals.

The method is evolving quickly in response to advances in technology. During a 1991 world conference on Humpbacks, hosted by the Queensland Museum in Brisbane, US scientists demonstrated the development of a new computer-based system for the management of large photo-identification catalogues. It uses images stored on a laser video to rapidly sort and retrieve photographs on the basis of a simple code for the patterns on the underside of a whale's

flukes. Patterns on the dorsal fin or other pigmentation help confirm matches. Thus a whale photographed in Antarctica in 1989 could theoretically be compared to a photograph taken in the Whitsundays in 1993 and identified as the same individual.

There are several groups pushing ahead with photo-identification in Australia. Among these are the Marine Research Lab in Western Australia, which is working primarily from commercial whale-watching vessels off Perth, while on the east coast, researchers with the Pacific Whale Foundation and the Queensland National Parks and Wildlife Service are cataloguing fluke photographs. If and when these photographs are entered into the archival matching system and are combined with radio or satellite tracking, Humpback research in Australia will be transformed. Long-term management will be able to incorporate specific groups, perhaps even individuals, rather than random populations. In addition,

Taking time out to enjoy the view? Humpbacks often pop their head vertically out of the water and take a good look around.



AUSTRALIAN PICTURE LIBRARY / JOHN CARNEMOLLA



Whale-watching is becoming quite a commercial industry and there are fears that without proper management this popular tourist pastime could threaten the species' recovery.

tion, biopsy sampling and DNA analysis will provide further information on individual whales, such as sex, paternity and relatedness, that is at present hard to get. Together these tools will help in the management and conservation of Humpbacks (and other cetaceans), with one of the most pressing and controversial areas being that of whale-watching.

WHALE-WATCHING IS A BUDDING commercial industry perceived by many environmentalists to be a looming threat to Humpbacks in the immediate future. According to Paul Hodda, of the Australian Whale Conservation Society, whale-watching has the potential to impact negatively on the recovery of Australia's Humpback population, which is still dangerously depleted. For this reason, appropriate legislation needs to be implemented and enforced to ensure that the potential for harassment is minimised. Provided commercial boats observe these regulations, and the regulations are constantly reviewed, then whale-watching in Australia should have minimal impact on Humpbacks. The current regulations in Queensland state that boats cannot approach a whale any closer than 100 metres. When more than three boats are present, each additional boat can only approach up to 300 metres. Spotter planes are also restricted to a 300-metre limit.

Gordon Anderson, from the Marine Conservation Unit of ANCA, believes that the best way of controlling whale-watching is by incorporating it as part of a complete draft management plan for Humpbacks in Australian waters. It is important, he says, to plan ahead for the time when Humpbacks are once again abundant, moving in their thousands, rather than hundreds, on their annual migration paths. Thanks to committed Government action, Australia is now equipped with the legislative tools (Whale Protection Act 1980 and the Endangered Species Protection Act 1992) required to develop such a recovery plan and to provide the necessary protective regime for Humpback survival.

Other prominent whale researchers, like Dr Paul Forestell of the Pacific Whale

Foundation, also agree in principle with Anderson. Forestell was one of several people who helped to establish regulations for the multi-million-dollar whale-watching industry in Hawaii. He is now working at Fraser Island to establish similar regulations in Australia. Whale-watching, he says, not only has the potential to become a major source of funding for whale research (if managed properly) but can also act as a platform of opportunity for educating the public about important environmental issues. To state it simply, whale-watching cuts straight to the heart—across time, space, culture and economy.

What emerges from the controversy is a single, clear message. Whales have become, and will continue to be, powerful icons representing everything that is mysterious and unique about the oceans. If this interest can be translated into a similar concern for the welfare and fate of all oceans, then animals like the Humpback will be given a fighting chance for survival. ■

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Alex Bortoli is a freelance writer currently based in the Whitsunday region. He holds a B.Sc. (Hons) from the Australian National University and has previously worked as a researcher for CSIRO, a full-time science writer in the Caribbean, and as a consultant writer for various research organisations overseas.

Each year Humpback Whales make a spectacular journey from the cold waters of the Antarctic to the tropical shallows of the Great Barrier Reef to breed and give birth. The whales generally leave their Antarctic feeding grounds in April and hug the shoreline until they reach the northern end of Fraser Island and the sheltered waters of the reef a few weeks later. There they disperse widely through their breeding grounds. Small numbers of Humpbacks commence their southern migration in late July but the majority leave the reef between mid-August and mid-October. By November–December most Humpbacks have left the east coast of Australia for their Antarctic feeding grounds. The entire round trip is an incredible 5,000 kilometres. Here are some whale 'hot-spots' that occur along the east coast.

Airlie Beach, Whitsundays

A spectacular island sanctuary in the Great Barrier Reef Marine Park. Tours depart daily from Shute Harbour or Able Point Marina. The whale-watching season runs for about 12 weeks from early July until September. The Whitsundays currently has only two operators and therefore poses little risk of disturbing the whales in their natural habitat. Considered by many to be the premier site to observe Humpbacks in Australia. Contact: Department of Environment and Heritage on (079) 467 022 or the Whale Hotline on (079) 465 111.

Heron Island

A beautiful coral atoll situated off Rockhampton. National Parks ranger Mark Simmons initiated a whale-sighting program here in 1985. Rangers work from a launch less than half the size of an adult Humpback. Contact: Queensland National Parks and Wildlife Service, PO Box 1362, Rockhampton 4700, (079) 276 511.

Hervey Bay

An officially designated whale sanctuary and the centre for whale-watching in Queensland. The bay is located between Urangan and the northern half of Fraser Island, the world's largest sand island. Some 200–400 whales come in and out of the bay between August and October. The first arrivals seen in August and early September are the immature subadults. Later in

WHALE-WATCHING HOTSPOTS

September the mature males arrive followed by the lactating mothers and their calves. Currently there are 21 charter services operating out of the area to view the whales. Contact: Whale Watch Tourist Centre, Urangan Harbour (071) 253 287 or (071) 253 290, Central Booking Office (071) 241 1300, Hervey Bay Information Centre, 6 Queens Road, Scarness 4655, (071) 252 594.

Bundaberg

Whale-watching trips depart from Burnett Heads (20 minutes drive from Bundaberg) and cruise south to Platypus Bay. Bundaberg is 368 kilometres north of Brisbane and is serviced by daily flights.

Moreton Island

Moreton Island, 25 kilometres from Brisbane, forms the north-eastern gateway to Moreton Bay and a sheltered waterway system stretching south to the Gold Coast. It is a sand island, and almost entirely national park. Roads are unsealed and 4WD vehicles are necessary. Most whales can be seen on their northward migration in June and July and on their southward migration in September and October. The Tangalooma Resort, established in 1951, is on the site of the former Tangalooma Whaling Station. One vehicular passenger ferry leaves daily from Pinkenba, about 12 kilometres north-east of Brisbane centre. Flights and ferry bookings can be made by phoning Tangalooma Resort (07) 268 6333. Tourist and transport information permits: The Ranger, QNPWS Tangalooma Resort, Moreton Island 4025, (075) 482 710.

Stradbroke Island

Just below Moreton Island and directly off Brisbane, whales can be seen at Point Lookout and at nearby Whale Rock. Since 1980 the University of Queensland has conducted systematic counts of Humpbacks off Stradbroke Island. It is also the centre of research for the Pacific Whale Foundation. Stradbroke Island can be reached in conventional vehicles by vehicular ferries that depart from Cleveland (30 kilometres south of Brisbane). Ferries depart every day. Contact: Queensland National Parks and Wildlife Service, Brisbane (07) 227 4111.

Byron Bay

Australia's most easterly point and a former site of one of Australia's largest whaling stations. The best periods for seeing Humpbacks at Byron Bay are June–July for the northward migration and September–October for the southward. They can be seen from the beach, cavorting and playing, with a good set of binoculars. The Australian Whale Conservation Society conducts land-based whale-watches from Cape Byron. Contact: Australian Whale Conservation Society (07) 398 2928.

Korogoro Point, Hat Head National Park

474 kilometres north of Sydney. Whales can be spotted from the headland. Contact: NSW National Parks and Wildlife Service (065) 835 518.

Sydney

Weekend whale-watching tours depart from Rose Bay. They begin in June as the whales slowly make their way north. For the southward migration, tours finish in late October. Bookings are essential. Operators use hydrophones in the water to listen for whale song. Contact: National Parks and Wildlife Service (02) 585 6444, ORRCA (Organisation for the Rescue and Research of Cetaceans in Australia) (02) 992 606, Greenpeace (02) 211 0500.

Sydney Harbour National Park

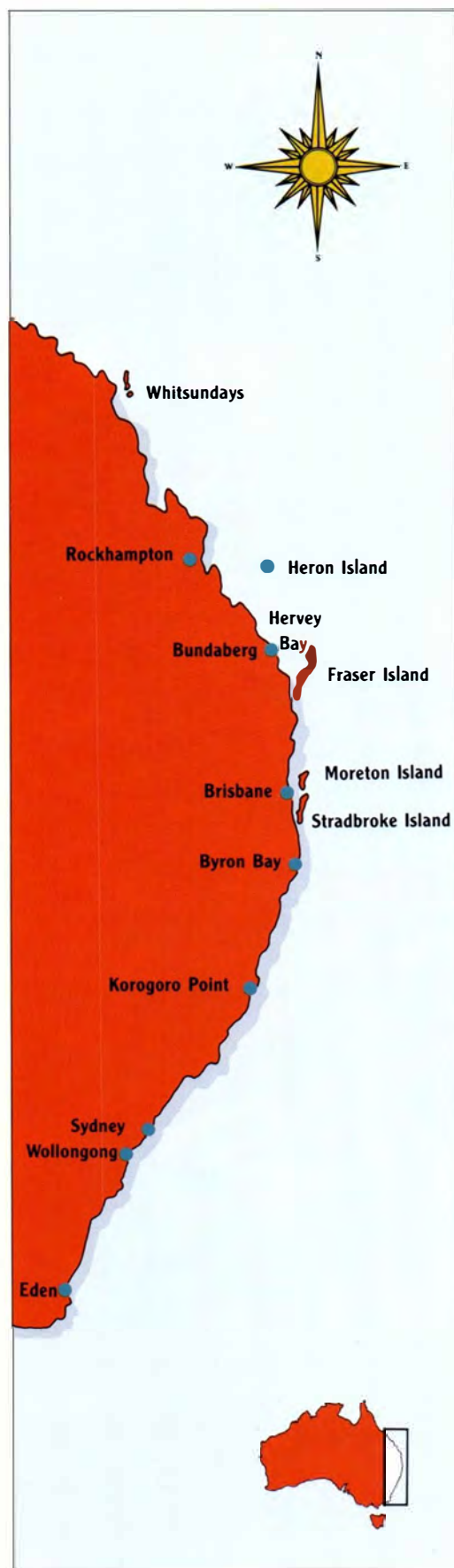
Whales can sometimes be seen with binoculars from The Gap at Watson's Bay, the Gap Bluff and North Head Lookout. Best months for land-based whale-watching are June–July and again in October.

Wollongong

Whale-watching tours depart from Wollongong Boat Harbour every day in June and July as the Humpbacks journey north. Tours start again in late September running through to early November when the whales travel south.

Eden

A small coastal town 486 kilometres south of Sydney and the former site of the Davidson Whaling Station in Twofold Bay. The area is now a historic site. Whales can be seen in June–July and in October. Whale-watching tours are available from Eden boat harbour. Contact: Eden District National Parks and Wildlife Service (064) 961 434.





A field party crossing the boulder-strewn, windswept surface of the Meyer Desert in the Dominion Range.



*Controversy rages
in scientific circles over
the discovery of exquisitely
preserved fossil leaves only 500 kilometres
from the South Pole.*

COLD WAR OVER WARM ICE

THE DISCOVERY OF EXQUISITELY PRESERVED fossil leaves in a mountainous rocky desert in Antarctica—only 500 kilometres from the South Pole—is a startling find. The fact that the leaves are from woody shrubs that grew no more than three million years ago is even more startling, for these fossils record a relatively warm climate in Antarctica at a time when conventional wisdom would have the great southern continent deeply refrigerated, buried by ice and devoid of flora.

Controversy rages in scientific circles over the discovery. That the leaves record a much warmer climate in Antarctica's past is readily accepted. What is not is the geological age assigned to the leaves. Was such a climatic scenario possible only three million years ago? Could there have been a major Antarctic and presumably worldwide warming at that time? Furthermore, will the forthcoming greenhouse warming of the Earth, so widely predicted today, be comparable to that Antarctic warming? And, if so, will the greenhouse warming (see Greenhouse Box) bring about environmental changes to Antarctica and to our whole planet similar to those envisioned to have happened three million years ago?

BY BARRIE McKELVEY

Before attempting to answer these questions let's consider the setting of present-day Antarctica. The remote ice-shrouded continent is about twice the size of Australia. About 97 per cent of it is covered by a vast featureless icesheet, which in places is more than 4,000 metres thick. The icesheet makes Antarctica the coldest and windiest place on Earth. In 1983 the Russian research base at Vostok recorded a winter temperature of -89.6°C. The cutting Antarctic winds are forever blowing because dense cold air cooled by the icesheet flows under gravity out towards the coasts of the continent.

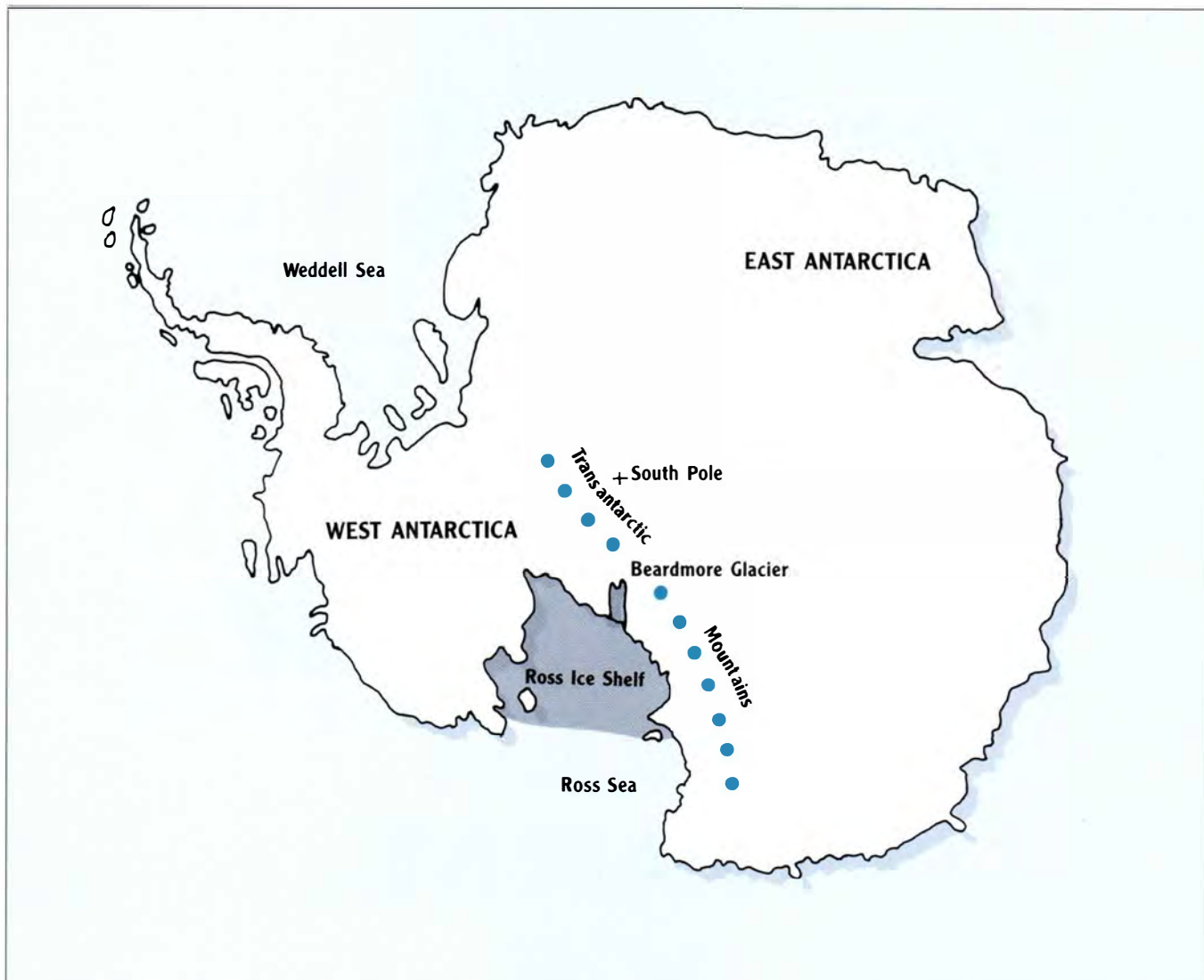
A 3,000-kilometre-long mountain chain traverses the continent and effectively divides it into the larger East Antarctica (to the west) and smaller West Antarctica (to the east). Known as the Transantarctic Mountains, they are up to 4,000

metres high and continue to rise up through the icesheet, at a rate of several hundred metres per million years. Remarkably, a few small areas within the Transantarctic Mountains and some of the other coastal ranges are ice-free. They are cold, arid, mountainous deserts ('oases') with valley floors mantled by glacial sediments, sand-dunes and saline lakes. For a few weeks in summer, vigorous rivers and streams of glacial melt-water may run.

To the casual observer sailing around or flying over the continent, the impression of the icesheet is one of silent unchanging permanence. But is this really the case? Much international research is currently being undertaken to determine just when and how the icesheet formed. Most importantly, has it had a stable history, changing little in extent and volume since it first formed? Alternatively, has the icesheet been dynamic, waxing and waning through time across the surface of the continent it now imprisons?

This question is of great importance to the understanding of the workings of Earth's climate, for the icesheet as we know it today exerts a major three-way control over our present environment. First, the icesheet (together with its

An abundance of delicately preserved fossil *Nothofagus* leaves recovered from the Meyer Desert points to a much warmer climate in Antarctica's relatively recent past.



surrounding girdle of sea ice in the Southern Ocean) reflects back into space much of the incoming solar energy, and so in this way influences Earth's 'heat budget'. The Earth would absorb more solar energy and become a warmer place if the icesheet was absent. Second, dense cold melt-water, derived from the floating edges of iceshelves and from the icebergs broken off from the shelves, travels far northwards along the ocean floors of the world, affecting deep-ocean circulation, and so indirectly the Earth's climate. And third, should the icesheet melt, the water so released (about 27 million cubic kilometres) would cause sea-level worldwide to rise about 65 metres with disastrous consequences to coastal civilisations. For these three reasons then it is important to understand the past history of the Antarctic icesheet. Is that history a dynamic one, capable of causing considerable climatic variations over time, or is it one of stability with little modifying effect upon our environment?

RESearchers seeking to decipher the history of the Antarctic icesheet rely mainly on two sources of data. One is the icesheet's sedimentary record, that is the rock debris scraped by the ice from the landscape over which it is flow-

GREENHOUSE

The Earth's atmosphere is a protective blanket around our planet, a blanket that acts much like the simple garden greenhouse. Without this blanket or 'atmospheric greenhouse' much of the Sun's radiation that reaches and warms the Earth would be lost by reflection back out into space. Temperatures would vary wildly between day and night. The atmosphere—or rather those natural greenhouse gases it contains, such as carbon dioxide, methane etc.—quite simply make our Earth habitable by limiting this heat loss. They allow the solar radiation to reach the Earth and then limit the amount of heat that can escape by reflection. However, should the concentration of these vital gases increase in the atmosphere, then the blanketing 'greenhouse' would allow less heat to escape and a global warming would result.

ing. This sediment is eventually dumped either at the edge of the icesheet on the continental shelf, or on the sea-floor from icebergs as they drift north across the Southern Ocean.

The glacial sediment accumulating on the continental shelf is a particularly valuable source of data because it contains fossils of tiny marine plankton, such as microscopic plants (diatoms) and the pinhead-sized shells of single-celled animals (foraminifers). These microfossils allow researchers to determine the ages of the various layers of strata of glacial sediment and, in this way, to trace the presence of the icesheet back through time. Furthermore, by comparing the thickness of the various layers, researchers can estimate the amounts of glacial erosion through time, which is in part a measure of the size and volume of the icesheet over the ages.

The other source of Antarctica's glacial history data is a sophisticated chemical one, and one that is more indirect in as far as the data are obtained from the ocean floor often far from the continent itself. It relies on the fact that the microscopic shells have a precise isotopic composition (the ratio of two naturally occurring forms of oxygen, ^{16}O : ^{18}O) and this is related in part to the past seawater temperature and, more importantly, to the past volume of the icesheet (see box on How Oxygen Talks). Thus the isotopic 'signature' of microfossils of different ages provides a record of comparative climatic conditions

through time.

The data so far obtained from both sources are exciting but, unfortunately, contradictory in parts. However some basic facts about the history of Antarctica's icesheet are now well established. The oldest glacial sediments, recovered by drilling the continental shelf at several locations around Antarctica, are all about 38 million years old. Of course this date only indicates the time when the expanding icesheet reached the coast and started dumping glacial sediment onto the continental shelf. (We still do not know for how long previous to 38 million years the ice was advancing across the Antarctic landscape.) This ice is thought to have been temperate or 'relatively warm', and a setting similar to parts of Alaska today, with glaciers flowing coastwards down through forested lowlands, is envisaged.

The isotopic signatures of microfossil shells gathered from drill holes in the floors of the Atlantic and Pacific Oceans indicate a major increase in volume of the Antarctic icesheet about 14 million years ago. With this expansion, the Antarctic climate became colder, the refrigeration being much more intense. The isotopic data further suggest that, until only about 20,000 years ago, the icesheet stayed much the same size (somewhat bigger than today's) and the climate remained very cold.

Much of the glacial deposits are today buried far beneath the ice surface. Only in the ice-free oases can such deposits be looked for.

The historical record from glacial deposits is rather more fragmentary. Much of the marine glacial sediment originally laid down on the continental shelf has since been eroded and removed by later phases of the icesheet scraping across the sea-floor. And, much of the glacial deposits laid down on land are today buried far beneath the ice surface and so are inaccessible. Only in the ice-free oases can such deposits be looked for. In the remarkable 'dry valleys' of Southern Victoria Land in the Transantarctic Mountains, thick Pleistocene (1.6 million years to 10,000 years old) and Pliocene (about three million years old) strata have been drilled, but the earlier on-land record is still elusive.

FOR OVER A DECADE NOW, A STEADY stream of startling and new sedimentary data has come from the Transantarctic Mountains. There, since the late 1960s, geologists have known of the existence of scattered pockets of glacial sediments occurring, somewhat enigmatically, well above glacier levels, high on the flanks and even along the crest of the mountain chain. All these alpine deposits are collectively referred to by geologists as the Sirius Group, the name being derived from Mount Sirius, an isolated peak

The author's camp site (foreground) is dwarfed by the Quartermain Mountains. These are just part of the 3,000-kilometre-long Transantarctic Mountain Chain that divides Antarctica in two.



BARRIE MCKELVEY

in the Transantarctic Mountains where these deposits were first observed.

What startled Antarctic geologists was when, in the early 1980s, microscopic marine fossils (again diatoms and foraminifers) were discovered in samples of the Sirius Group by palaeontologists from Ohio State University. Palaeontologists David Harwood and Peter Webb initially estimated the fossils to be about 40 million years old. However Harwood, a fossil diatom specialist, astounded his colleagues by recognising in addition some delicately preserved and much younger diatoms that existed in the Earth's oceans only between 3.1 and 2.5 million years ago, during the Pliocene. As the prevailing stabilist view of the Antarctic icesheet held that the continent had been deeply refrigerated and mantled almost completely by ice since 14 million years ago, then where could these relatively young microfossils have come from and, above all, how did they get into the Sirius Group deposits?

Professors Harwood and Webb and their colleagues (including myself) proposed that the Pliocene microfossils record a previously unsuspected period of more temperate climate in Antarctica around three million years ago. The icesheet receded and large areas of the continent, perhaps as much as two thirds of it, were flooded by rising seas in which the diatoms lived. Then, as the temperate climate waned, the much reduced icesheet started to expand again out

BARRIE MCKELVEY



HOW OXYGEN TALKS

Oxygen occurs naturally as a fairly constant mixture of two stable atomic forms, or isotopes. These isotopes are oxygen 16 (^{16}O) and the slightly heavier oxygen 18 (^{18}O). When individual oxygen atoms combine with two hydrogen atoms to form water molecules, the molecules containing ^{18}O are about ten per cent heavier than those containing ^{16}O . The important consequence of this is that, when evaporation of ocean water occurs, both types of molecules are involved but the lighter water molecules containing ^{16}O are more readily evaporated. The relative proportion of ^{18}O in sea water therefore increases. Just how much so is in part controlled by the seawater temperature. When the evaporated water condenses and returns to the ocean, either directly as rain or via rivers, the original relative proportions of the two oxygen isotopes in sea water are restored.

However, during a period of worldwide cooling much of the evaporated water, relatively rich in

^{18}O , falls on continental interiors and polar regions as snow and becomes impounded there in icesheets and glaciers. It cannot flow back into the world's oceans via rivers. For this reason, then, the amount of increase in the proportion of ^{18}O in the oceans is a measure of the volume of ice at that time on Earth.

So how can this technique be used to identify and measure the seawater temperatures and ice volumes occurring on Earth millions of years ago? The answer lies in microfossil shells, composed of the mineral calcite. Calcite also contains oxygen. This has been extracted from the seawater in which the animal was living and becomes incorporated into the calcite shell. The relative proportion of ^{16}O and ^{18}O in the shell is the same as that of the ancient seawater. In this way fossil shells millions of years old faithfully record, via their isotopic composition, the seawater temperature and the volume of ice present on Earth at that time.

towards the continent's edge. It 'bulldozed' its way across the floors of the shallow seas, picked up the marine microfossils and dumped them, together with glacial sediment, onto the flanks of the Transantarctic Mountains.

Critics who favour the concept of a stable icesheet since 14 million years ago, however, have suggested either the microfossils came from elsewhere and were carried into the Transantarctic Mountains by wind, or else they were misidentified and are actually much older, dating from a time when ice cover was incomplete. A period of climatic warming at a time when other evidence suggests Antarctica to have been completely covered by ice remains unacceptable to many workers.

AND SO CONTROVERSY CONTINUED, AND was further fuelled by more unexpected field data. The location was the Meyer Desert, a small windswept rocky desert near the head of the Beardmore Glacier. Once fully submerged beneath the icesheet, the area is now an ice-free desert because it is slowly rising, along with the rest of the Transantarctic Mountains, up through the icesheet. As a result the Meyer Desert is now above the level of the surrounding glaciers and its icy mantle has been evaporated away by the ever-present Antarctic winds.

An irregular blanket of Sirius Group



Wright Valley is part of the remarkable 5,000-square-kilometre McMurdo Oasis of Southern Victoria Land. In Antarctica an 'oasis' refers to an ice-free area in a continent otherwise thickly shrouded by ice.

other words that it is older fossil material derived by erosion from other glacial sediments over 14 million years old. Other workers wonder whether the wood fragments could have been driftwood, washed up onto the shores of an ancestral Beardmore Glacier fiord, having drifted there from lower, more temperate latitudes.

But on Christmas Eve 1990 the major breakthrough came. Many delicately preserved large fossil leaves of *Nothofagus* were found in the same deposits as the wood fragments. The abundance of the leaves and their delicate preservation clearly show them to have been entombed in sediment and fossilised close (perhaps within a few tens of metres) to where they originally grew.

And when were these shrubs growing, and when did this period of relative warmth in Antarctica cease? The leaves themselves, although they demonstrate the warming, do not give the age of it. *Nothofagus* is too long-ranging through geological time to be a useful fossil for dating. The end of the warmer climate can only be approximated from the age of the reworked marine microfossils within the Sirius Group. We know these fossils

sediments is widespread over much of the Meyer Desert. Here in the austral summer of 1985–1986 'woody' fossil twigs and small branches of the Southern Beech (*Nothofagus* sp.) were discovered. The particular distribution of these wood fragments (always near the top of sediment layers) strongly suggested they had been fossilised close to where they originally grew. In other words the *Nothofagus* shrubs appear to have been growing on the surface of Sirius Group sediment adjacent to the glacier (the ancestral Beardmore Glacier) that had originally deposited it (the sediment) about three million years ago. *Nothofagus* is today growing in a similar setting in partially glaciated Tierra del Fuego. Should this have been so in the Meyer Desert, then the case for a much more temperate Antarctic climate, certainly at the time of deposition of the Sirius Group, would be established. Estimates of the seasonal summer temperatures based on the growth rates of living *Nothofagus*, and taking into account its known freezing limits (to survive in winter), suggest temperatures as much as 15–20°C warmer than today. Such a climatic setting would mean a much smaller icesheet at the time of deposition of the Sirius Group.

However, scepticism about the wood also continues. Some scientists who favour the stabilist icesheet theory maintain the wood is actually reworked, in



Stands of *Nothofagus pumilio* display their autumn tones in Los Glaciares National Park, Argentina. Could similar stands of *Nothofagus* have been present in Antarctica only three million years ago?

were originally living at some time between 3.1 and 2.5 million years ago (in the Pliocene) in the shallow seas that had flooded onto Antarctica during the warming. Then, as the climate cooled again, the microfossils were bulldozed by the expanding icesheet and dumped with the Sirius Group sediments onto the Transantarctic Mountains. The *Nothofagus* shrubs, growing on a landscape of glacial deposits adjacent to the expanding icesheet, were possibly the last survivors of Antarctica's land flora, to be extinguished by the increasingly intense refrigeration accompanying the start of the Pleistocene Ice Age about two million years ago. We can only assume the *Nothofagus* flora had managed to survive (possibly in isolated refugia) the previous, but perhaps less intense, cooling that started about 14 million years ago.

For a world now facing a major greenhouse event, it is vital we understand this prehistoric Antarctic warming. Was the Pliocene warming an earlier greenhouse event and, if so, how did it come about? Could it have been due to a build-up of volcanically produced carbon dioxide? Alternatively, was it due to an increase in the amount of solar radiation reaching the Earth, due to changes in the geometry of Earth's orbit around the sun? No-one knows yet. However we do know that globally the climate for much of the Pliocene was only a few degrees warmer than that of today. Is there then the prospect of the icesheet shrinking again in response to climatic warming, this time caused by a build-up of industrial or anthropogenic carbon dioxide, with at the very least a calamitous global rise in sea-level? ■

Suggested Reading

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Dr Barrie McKelvey is a Senior Lecturer in the Department of Geology and Geophysics at the University of New England, Armidale, New South Wales. He has spent 13 field seasons in Antarctica carrying out geological research. In 1986 he was awarded the Polar Medal by the Queen.



Rain intensifies the colour of a snow gum's bark and trunk in Baw Baw National Park.

P H O T O A R T





Shells clustered at the high-tide line, Croajingolong National Park.

WILD PLACES OF VICTORIA

BY PAUL SINCLAIR

For the photographer, Victoria provides a range of landscapes: deserts, rainforest, mountains and coasts are all contained within this relatively small State.

Each of these areas has its own unique colours, textures and patterns. When these elements are enhanced by favourable light and tightly composed in the camera's viewfinder, a strong visual statement can be produced.

Natural landscape can create a sense of wonder and be a powerful source of inspiration. These photographs are an attempt to capture a personal response to the land and perhaps evoke a similar response in the viewer.

The making of images is not an attempt to explain or analyse the landscape but, in an aesthetic form, a means of conveying a sense of the land's mystery.

Provided the images are successful in achieving this aim, they may also serve as a reminder of what stands to be lost if other short-sighted values compromise the land's integrity.

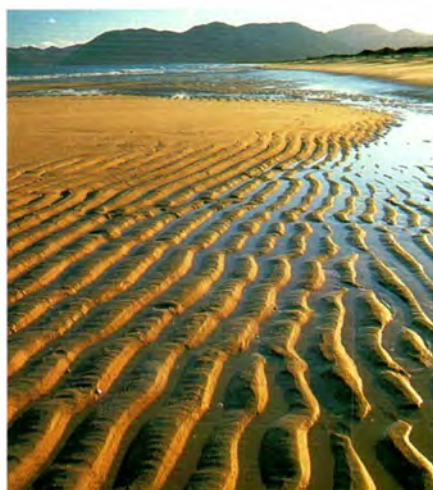


In Mt Buffalo National Park, light briefly falls on a granite outcrop after a storm.



A waterfall deep in the Otway Ranges.





Patterns are left in the sand as the tide goes out in Wilsons Promontory National Park.



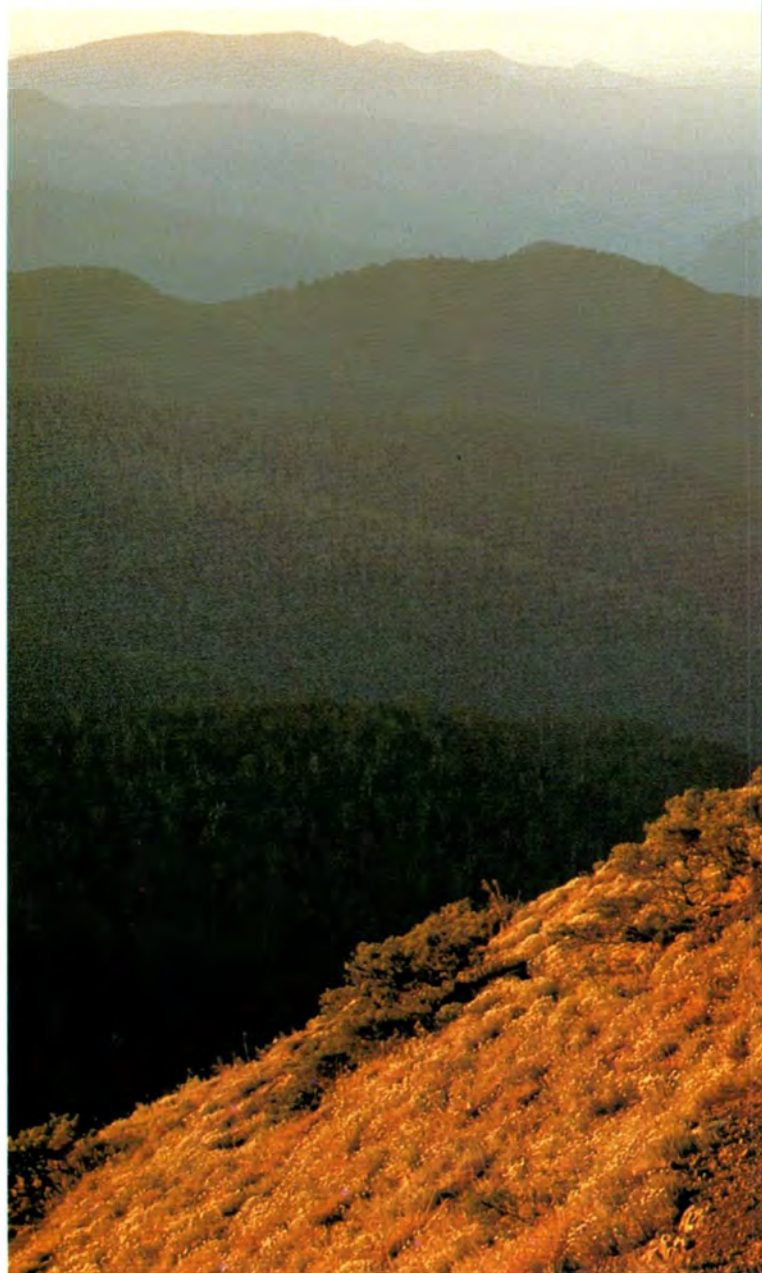
Trees silhouetted in the day's last light at Murray-Sunset National Park.

WILD PLACES OF VICTORIA

WILD PLACES OF VICTORIA



Tree ferns on the side of a steep gorge in Errinundra National Park.



The summit in Alpine National Park glows in the first light of dawn.

P H O T O A R T





The Toorong River weaves its way through moss-clad rocks.

As a palaeontologist, nothing excites me more than the spectacular possibilities of beneficial genetic engineering.

LAZARUS LIZARDS AND UNDEAD DINOS

BY MICHAEL ARCHER

KIDS DEVOTED TO SATURDAY morning cartoons know the three-letter word beginning with 'm' that often precedes 'scientist'. Even at their best, if not depicted as total loonies, cartoon scientists are absent-minded bunglers whose naive experiments seem inevitably to go terribly wrong. The moral appears to be that tinkering with technology is a really big no-no. Mistrust of science and the motives of scientists run deep in the public mind. It is a rare thing indeed for a blockbuster movie to be based on the premise that technological innovation is a *good* thing!

What promises to be one of the decade's most spectacular science fiction films, "Jurassic Park", was in fact written in 1991 by Michael Crichton as a warning to the world about what he considers to be the uncontrolled technology of genetic engineering. In his story, awesome *Velociraptor* (or should it be *Deinonychus*?) and *Tyrannosaurus* dinosaurs, reconstructed as tourist attractions, run amuck, gobbling humans like skinless franks at a wiener roast. In a recent interview he warns of the day when some uncontrolled biotechnician releases a *really* bad bug, one that might, for example, suck the chlorophyll out of all Earth's plants.

Perhaps. But as a palaeontologist who weaves together understanding of the past and present, absolutely *nothing* excites me more than the spectacular possibilities of beneficial genetic engineering. The mind boggles at the vistas opening up for repairing genetic damage, reversing extinction and surviving environmental catastrophes. No longer the victim or consequence of unpredictable change, we may soon be its clever agent, modifying ourselves and our environment to the unlimited benefit of both.



This termite was trapped in Dominican amber approximately 25 to 30 million years ago.

A team of researchers at the American Museum of Natural History recently succeeded in sequencing DNA from a similar specimen.

And, in contrast to Crichton, I don't feel paranoid about the risks. All life forms through time have desperately tried, through aggressive *natural* genetic engineering, to bite, claw and elbow their way to the top of the pile. What has always stopped individual beasts from obliterating the competition is the same thing that would stop an escapee designer beast—the natural checks and balances in all ecosystems. If one creature becomes overly common, it soon finds itself shifted upward on the list of most edible items held by another predator. Even the seemingly invincible Martians that tucked into Earth in H.G. Wells' *War of the worlds* (1898) soon wobbled out of the picture with terminal 'purple spots'—victims of Earth's tiniest predators, the ubiquitous viruses and bacteria. It might take a while, but eventually a rogue beast will meet its unmaker.

I am aware that no argument will reassure someone committed to the view that DNA dabbling is ultimately mad, any more than one can persuade a Creationist of the imperfections of the human body. To some, the living world is a perfect

Creation that should not and will not endure meddlers. But to those of us who feel helpless watching a growing river of unique creatures rushed into extinction, urged on by our unwillingness to control our own populations, a technology that could remove the 'forever' from extinction is no less enthralling and at least as justifiable as Christ's raising of Lazarus from the tomb.

Consider the possibilities! We have the ability to recover DNA from dried museum skins, to repair and clone it and soon to insert it via a retrovirus into the genome of the embryo of a close living relative. In Peter Goldsworthy's *Honk if you are Jesus* (1992), these techniques are used to undo the awful extinctions of the Tasmanian Thylacine and the Dodo (as well as to resurrect Christ from DNA in dried blood found on the spikes that bound him to the cross).

Who could *possibly* fail to thrill at the sight of a bright-eyed pair of Thylacines walking, for the first time in more than 50 years, side by side out of the genetics laboratory into the sunshine? And this would be just the beginning! The beautiful Toolache Wallaby, diminutive Crescent Nail-tail Wallaby, unique Pig-footed Bandicoot and even the Tasmanian Aborigines, all victims of European 'misadventure', could be miraculously restored to life.

But why should we limit benevolent manipulations to creatures of the historical past or present? Why not consider the genetic resources found in more ancient parts of the fossil record? For example, it is clear that 15 million years ago at Riversleigh, north-western Queensland, Australia's tropical lowland rainforests hosted a much wider range of mammals than currently exists in this vegetation type, and that their loss probably relates to a habitat contraction during a relatively recent arid phase of the Pleistocene. Given this understanding, if there are vacant niches in these now much larger forests—niches emptied by contingent extinctions unrelated to the fitness of the mammals that once filled them, why not *refill* them with their original inhabitants reconstructed from remnant strands of DNA that almost certainly survive in the impermeable matrix of their bones? What wouldn't we give to see for the first time, alive, the extraordinary 'thingodontans', fruit-eating pilkipildrid possums, gentle browsing zygomaturines, or voracious marsupial lions?

Or dig just a tad deeper, another mere 50 million years, and go for the really 'big one'—redesigner dinosaurs! Is it possible? Unlike most science fiction, the 'leap of faith' necessary to move the reader into the reality of *Jurassic Park* is steadily diminishing. The reality could materialise in one of two basic ways using either modern or fossil DNA.

Consider first the fact that dinosaur DNA is still very much alive—albeit as the DNA of birds, the only group of specialised dinosaurs that survived the

meteoric holocaust of 65 million years ago. The genome of living birds must contain a great deal of the instructions for whipping up closely related dinosaurs like the chicken-sized, carnivorous *Compsognathus*, which bolted its last meal soon after the beginning of the Cretaceous. Epithelium from a chicken's mouth has already been induced to produce curved, sharp teeth of the kind that *Archaeopteryx* sported 140 million years ago, part of its dinosaurian genome (ANH Spring 1986). Exploring techniques for kick-starting other bits of dinosaurian DNA in the genome of the chook might be one of the easiest ways to bring one of these spectacular creatures blinking into the sunshine.

Jurassic Park's dinosaurs, in contrast, were resurrected from the 'fossil' DNA of blood cells found in the stomachs of mosquitoes preserved in amber (fossilised tree sap). Preposterous? Professor George Poinar (University of California at Berkeley) and his colleagues have already extracted small bits of DNA from muscle tissue of insects trapped in 40 million-year-old amber. The DNA has been cloned, sequenced and its similarity to the DNA of related living insects—stingless bees and fungus gnats—established beyond any doubt. In golden chunks of Dominican amber (35–25 million years old—the amber supposedly used in *Jurassic Park* but which is of course much too young to have trapped diners on dinos), 315 families of arthropods plus spores, fungi, a variety of plant families, frogs, lizards, feathers and even mammal fur have been found. On current estimates, at least 50 per cent of well-preserved organisms found in amber will contain viable DNA. Early Cretaceous amber (130 million years old) that oozed from trees against which dinosaurs rubbed their itchy mosquito bites is also known, raising the odds of recovering DNA from the blood meals of parasitic insects or even, perhaps, from minuscule bits of dinosaur rump itself.

Rumours are rife that dino DNA has recently been recovered from fossilised bones which, if true, is yet another way in which these beasts might be kick-started again into spectacular life.

Clearly, it would be most unwise to declare what *won't* be found or even, given the pace at which the technology of genetic engineering is advancing, what *can't* be done with what can be found. The only worry I have is the same as that of the palaeontologist in *Jurassic Park*—that eventually Dial-a-Dino just might put palaeontologists out of business. After all, why would anyone spend years cooped up in a dingy laboratory peering at a fossil bone when the real thing might soon be grinning at you across the dinner table? ■

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.

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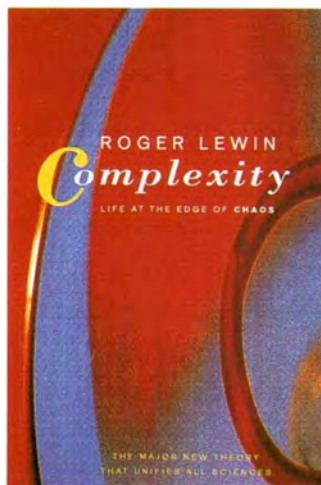
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REVIEWS



Complexity

By Roger Lewin. Allen & Unwin, NSW, 1993, 208pp. Rrp \$39.95.

Review a book titled *Complexity*? You've got to be kidding! I live in a complex world. I yearn for a simpler life. Why on Earth would I want to read about complexity?

To explain this I need to take a short detour back to high school. Many things in everyday life can be predicted quite accurately. If you apply heat to water, its temperature will rise; and the amount that it rises is directly dependent upon how much heat is applied. This is called a linear system because you can describe what will happen in the system using a simple equation that can be shown graphically as a line. It is a system with order. Still with me?

Unfortunately most of nature does not work this way—it is non-linear. I say unfortunately because a characteristic of non-linear systems is they are very difficult to predict. Weather is one example. Economics is another. We know how difficult they are to predict.

Systems such as these are also dynamic in that they change from moment to moment. Thus they are known as non-linear dynamical systems.

Chaos Theory deals with such systems. Order and chaos can be viewed as two extremes. Opposite ends of the spectrum. Complexity also deals with non-linear dynamical systems, but those that have order.

The protagonists of the new science of complexity assert that overall order can arise from the interactions of non-linear dynamical systems. They say this can be seen in the workings of human societies, in development of embryos, in ecosystems—in fact all around us. Bold stuff.

Bold stuff, because what these people claim is contrary to a lot of current thought. Especially in biology. In exploring complexity Lewin gives a good historical perspective of some areas of contentious science and does an excellent job of explaining what it all means. This historical overview is one of the book's strengths.

The science of complexity is a new one, still embryonic in many ways.

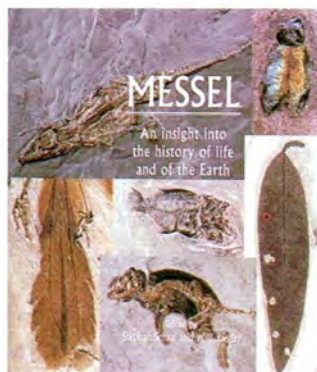
Another of the book's strong points is the insight it provides into the rarefied atmosphere of top scientists and thinkers. Lewin captures the thrill of the intellectual chase. Through his writing we witness the competitiveness and drive of scientists, the ego that pushes them, their fear at being beaten to the finish line, and the fall from grace of those who lose. Fascinating stuff.

If by now you are feeling this book is too intellectual for you, don't. Lewin's style of writing

is easy to read and accessible to most people. Nor is the author dogmatic or didactic. The science of complexity is a new one, still embryonic in many ways. The debate will probably go on for years and Lewin does a good job of introducing the concept to novice readers without pushing any point too hard. He lets the people at the cutting edge do the talking.

So, do I recommend *Complexity*? Yes I do. It's easy to read, fascinating and informative. But be warned—this book may taint your life. You may find yourself looking at the apparent complexity around you with a jaundiced eye, forever seeking the underlying pattern of simplicity promised by the new thinkers. But then is the pursuit of simplicity such a bad thing?

—Greg Gowing
Australian Museum



Messel: An Insight into the History of Life and of the Earth

Ed. by Stephan Schaal and Willi Ziegler. Clarendon Press, Oxford, 1992, 322pp. Rrp \$160.00.

Very rarely in the fossil record are there sites where fossils are preserved in exquisite detail. These 'lagerstätten' (literally 'lode places' or 'mother lodes' in freer translation) are known throughout the geological column and their contribution to our knowledge of life's history is out of all proportion with their frequency. The 500-million-year-old Burgess Shale of British Columbia detailed by Stephen Gould (*Wonderful life*, 1989) is a particularly well known and documented occurrence of this phenomenon. The site at Messel, near Darmstadt in Germany, is one of these 'lagerstätten' fossil localities that in this case preserved the flora and fauna

that lived around a small lake 49 million years ago. Birds' feathers and mammal hair have been found fossilised, an extremely rare occurrence, and even a tadpole has been recovered. Some of the vertebrate animals, such as crocodiles and some mammals, are so well preserved that they are known from complete skeletons and in some cases outlines of soft tissues are present. Little imagination is needed to bring these animals back to life.

This book, which is an English translation of an original German edition, is beautifully produced. The illustrations, whether photograph or line drawing, are all of high quality. Effective use has been made of SEM photomicrographs, X-ray photographs and conventional colour photography, which all combine to reveal the breathtaking beauty of the specimens.

Messel is a collection of well-illustrated papers by 14 authors, all experts in their fields of research, that comprehensively documents life in and around the lake during middle Eocene time. For the layperson the text is not always easy to read, as it is written for the reader with a biological and geological education. Scientific and stratigraphic names are used throughout. Most likely many people will only read the figure captions, which themselves are quite comprehensive.

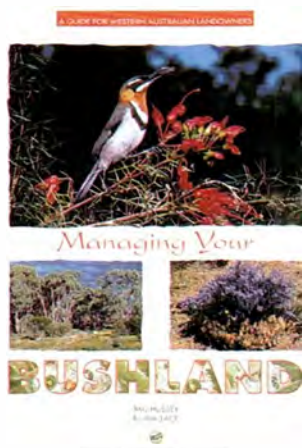
The work opens with an abbreviated history of the site that shows, amongst other things, how close it came to being turned into a municipal garbage dump! We are then led in a logical sequence through the Messel deposit's place in time, the sedimentology and the history of the lake. It is then on to the plant fossils and the vegetation that must have surrounded it. Following this are 18 chapters on the groups of animals that are found as fossils, 11 of them dealing with mammals. The other seven are on the invertebrates, fish, amphibians and reptiles. The last five chapters cover taphonomy, conservation, preparation, and some analysis and interpretation of the deposit and what it can tell us.

A list of all the illustrated specimens with their collection numbers is included. This will be most useful to palaeontologists researching Messel fos-

sils. Also a species index is supplied, although it is actually a name index of all the mentioned and figured flora and fauna with higher categories included as well—a handy addition when using the book as a reference work.

I could not recommend the book for everyone, especially at the price, but if you have a passion for beautiful and amazingly preserved fossils, then maybe you might think it worthwhile to obtain this superb book.

—Robert Jones
Australian Museum



Managing your Bushland: A guide for Western Australian Landowners

By B.M.J. Hussey & K.J. Wallace.
Department of Conservation and Land Management, WA, 1993, 196pp. Rrp \$19.95.

This attractive publication is packed with useful information and case histories on how to preserve or expand native bush on your land. The flora and fauna of Western Australia are unique, but many of the principles and management plans outlined can be used as a basis for conserving bushland remnants in almost any region of Australia. It outlines many of the problems associated with removal or degradation of native plant communities and the problems often encountered with reversing the process.

Chapters covering values of remnant vegetation, planning, information collecting, principles of native flora management, problem plants, principles of native fauna management, problem animals, fire management, regeneration and replanting are all included.

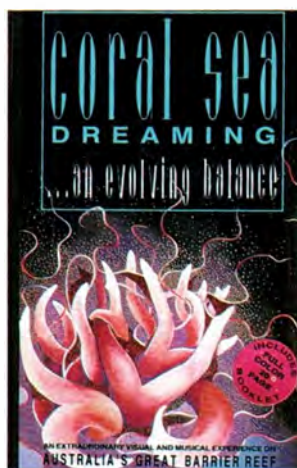
Problems associated with human settlement are also discussed and the legal aspects relating to rare plants, collecting of native plants, and noxious plants and animals are summarised.

The value of remnant vegetation and the reasons for saving and expanding them are outlined. Throughout the book, the importance of planning and collecting information is emphasised. In any regeneration or replanting project there are many points to consider. When growing plant from seed, for example, the seed must be from the local genotype, but how local is local?

The text is clearly and attractively presented, with numerous line drawings, tables, diagrams and colour photographs. It is easily understood, but at the same time thought-provoking as many possible plans are outlined and projects summarised.

For any landowners who genuinely wants to conserve or expand their bushland there is no excuse. If your particular problems are not covered in this book, then many references are listed. It will also be useful for school projects as it indicates how to document any remnant of native bush and how to monitor changes over following years. A very practical guide and well worth having.

—Gwen Harden
Royal Botanic Gardens, Sydney



Coral Sea Dreaming

Produced by Coral Sea Imagery and Natural Symphonies. *Natural Symphonies*, NSW, 1993, 55 min. Rrp \$39.95.

"Coral Sea Dreaming" is a visual masterpiece. The

footage was shot over four years (1989–1992) on the Great Barrier Reef, Coral Sea and Lord Howe Island in waters clear enough to make most scuba divers weep. The video is set to music and contains no dialogue. In the words of the producers, "It represents a new approach to natural history, synthesising scientific and aesthetic knowledge into a musical, artistic expression".

The music beautifully complements the images. It is the work of Adelaide composer Tania Rose and comprises pieces performed on keyboards, strings, and synthesised sound. The video is worth playing for the sound track alone.

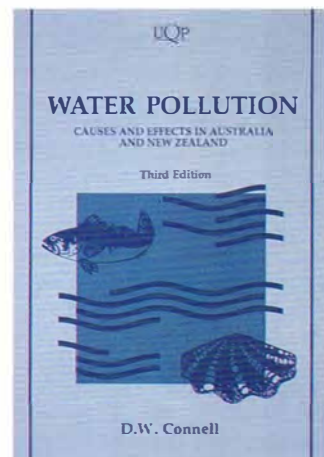
The video starts with magical footage of mass coral spawning at night followed by colourful corals by day. There are aerial views of coral reefs and islands with their associated bird life, and footage of turtles laying eggs and the subsequent hatching. This is followed by several minutes of soft corals, sea fans, crinoids, anemones and their resident anemonefishes. The footage of two Clown Anemonefishes (*Amphiprion percula*) swimming through the tentacles of a beautiful white anemone is the most stunning footage of this type I have ever seen. Just about every type of marine fauna you could imagine is captured in startling colour and clarity; flatworms, Spanish Dancers and nudibranchs, various crustaceans, molluscs and sea cucumbers in amazing reproductive poses. Also featured are cuttlefishes and octopuses, sea snakes, starfishes and scuba divers, whales, worms and wrecks.

It's the footage of the fishes, however, that steals the show. The variety of colour, shape and behaviour is stunning. The video shows many different species such as angelfishes, coral trouts, garden eels, wrasses, basslets, stingrays and sharks to name just a few. Towards the end of the video is a section on fish feeding followed by some graceful footage of manta rays swimming. The video ends with a well-chosen printed message pointing to concern for the coral reefs of the world.

An educative version of "Coral Sea Dreaming" is being released that is time-coded with documentation to allow

identification of every creature seen. Both versions come with a small, colourful booklet. It contains information on coral spawning, biology, ecology and a range of interesting facts about the animals found on coral reefs. Unfortunately, I found Paul Carter and Russell Kelley's pseudo-scientific introductory comments about evolution and reef ecology pretty awful. Despite this small criticism the video is very enjoyable viewing. It superbly lives up to the producers' wish to create a musical artistic expression.

—Mark McGrouther
Australian Museum



Water Pollution: Causes and Effects in Australia and New Zealand

By Des Connell. University of Queensland Press, Qld, 1993, 203pp. \$29.95.

Over the last two or three decades, the study of water and groundwater pollution has evolved into a wide-ranging, specialised, multidisciplinary science. Developing from a purely chemical background, it is now well established that the links between water pollutant chemistry and the impacts of pollution on the aquatic ecology are close and integrated.

Water pollution, the third edition of a well-circulated text originally published in 1974, intends to provide a general overview of the integrated approach to the study of water pollution by describing the chemical and biological impacts of pollution.

The first two chapters give an introduction to the importance of our water resources and the threats to which they are being subjected. This is

followed by a very brief description of aquatic ecology and a description of the three major types of water resources, namely marine, estuarine and inland freshwater.

The next three chapters provide an overview of the fate and behaviour of pollutants in the aquatic environment, the idea of toxicity and a general discussion of aquatic community response to pollution. The remainder of the book consists of specific chapters on the general impacts of animal and vegetable wastes, nutrients, synthetic chemicals, petrochemicals, metals and suspended solids, salt, temperature changes and other catchment activities on water quality and ecology. The book closes with two chapters on pollution control and future needs, which in most regards are far too short for the topics intended.

While it may appear to be an ambitious project to cover such a wide range of issues in such a short text, overall the book is able to maintain its generalist view and yet provide specific examples in each chapter. It is important to note, however, that this book is not a thorough reference text, but rather a valuable general reference for students, libraries and non-specialists in the field of aquatic resource protection. I should add that there are numerous examples of interesting and valuable tables and statistics throughout the text that will ensure the book remains well used and circulated in the water industry.

—Sean Hardiman
Environment Protection
Authority, NSW

Flora of the Kimberley Region

By J.R. Wheeler (ed.), B.L. Ryde, B.L. Koch & A.J.G. Wilson.
Department of Conservation and Land Management, Perth, 1992, 1,327pp. Rrp \$89.95.

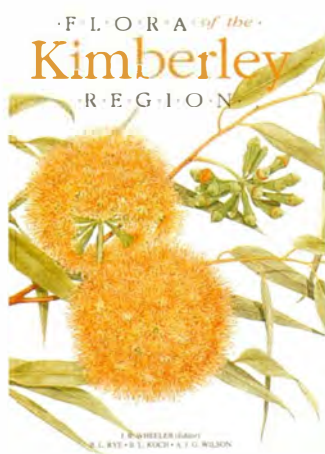
Flora of Victoria Volume 1

Ed. by D.B. Foreman & N.G. Walsh. Inkata Press, Sydney, 1993, 320pp. Rrp \$89.00.

Floras are comprehensive identification guides that key out and describe all the wild plants (including weeds) in a given geographic region. They

are arguably the most important of all botanical books because they provide accurate names for plants, and names are the foundation stones of botanical knowledge.

Although these two floras are very different, they are both excellent in their own way. The *Flora of the Kimberley region* is very significant as it is the first flora to deal with a northern Australian region. Much of Australia's plant diversity is concentrated in the tropics yet, until publication of this volume, there were no comprehensive plant guides to coastal Australia north of Bundaberg. The Kimberley region shares most of its 2,085 plants with the Top End of the Northern Territory, so this book will



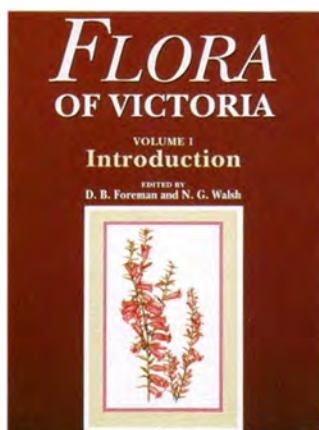
prove invaluable to botanists in both regions.

By breaking a few design rules, the publishers have managed to produce a single-volume flora suitable for field use. It is a hefty 1,327 pages and weighs almost three kilograms. The text averages about 16 words per line, and has the smallest margins I have seen on a book (down to five millimetres on some pages). I only hope the binding is strong enough to handle the weight. This flora is jam-packed with information, and the authors are to be congratulated for taking on so daunting a task—one that opens a remote corner of Australia to botanical scrutiny.

The *Flora of Victoria* is to be a four-volume production, and this first volume is devoted entirely to introductory essays. Included are very detailed chapters on prehistory, fire, Aboriginal plant use, rare plants, exotic plants, botanical explorers, climate, soils and geology. The standard is very high and the bibliographies are

extensive.

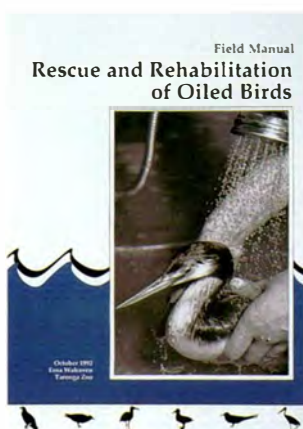
Victoria's remnant bushland suffers from appalling levels of weed invasion and G.W. Carr has written an excellent overview of the weed problem—



listing among the environmental weeds many Australian plants from other States that have become bushland weeds in Victoria. Some cultivated grevilleas are even pollinating local native species, producing vigorous hybrids that are eliminating the original genetic stock. Carr's bibliography runs for eight pages. Another important chapter is Beth Gott's account of Koori (Aboriginal) plant use; it too includes a detailed species list.

Detailed chapters of this kind are not usually found in floras, and this volume deserves a wider readership than the genre usually receives. It would make a good university textbook, although the high price will put this volume, like other recent floras, beyond the reach of many readers.

—Tim Low



Rescue and Rehabilitation of Oiled Birds

By Erna Walraven. Zoological Parks Board of New South Wales, NSW, 1992, 140pp. Available

from Taronga Zoo for \$30.00 plus \$8.00 postage and handling.

Although Australia has been fortunate in thus far avoiding a serious oil spill, events such as the *Exxon Valdez* oil spill demonstrate that the threat of a major environmental disaster is always present, and will probably become increasingly likely. In the event of such an occurrence in Australia there would be no shortage of helping hands. Despite the best of intentions, without a well-defined plan of action, such volunteers can never be used to the best advantage. Unlike the beaching of whales, for which established rescue protocols exist, the reaction to an oil spill in Australian waters could easily turn into a chaotic nightmare. Fortunately the likelihood of this scenario should now be greatly reduced. In this field manual Erna Walraven has addressed the potential problems involved in responding to an oil spill.

The first part of the manual reviews the effects of oil on birds and humans. The following section discusses contingency plans for mounting a rescue operation, outlining the preparations, equipment and personnel necessary for successfully dealing with an oil spill. There is also advice for dealing with the media and assuring proper identification of species.

The rescue and initial treatment of oiled birds is a crucial stage in the recovery operation. The section on emergency procedures deals with such important aspects as handling, treatment, transport and data recording. Much of this section is appropriately directed towards the cleaning and removal of oil from the bird. Other areas, such as handling, stress reduction and transport, are of concern to anyone involved in the rescue and care of native birds. Likewise, the chapter on rehabilitation and release has relevance beyond the specific concern of treating oiled birds. Many of the procedures are applicable to any avian species in need of care, and will be of value to animal carers. A valuable and practical part of the manual is a removable handout for field staff and volunteers that contains the most important information from these sections of the text. It comes in a form that

can be easily photocopied and supplied to each person involved in the rescue operation.

The bulk of the manual is written in easy-to-understand terminology for the layperson involved in the treatment of oiled birds. Birds thus injured, however, do require a veterinarian's attention. The manual caters for these needs with several appendices directed towards the trained veterinarian who may not have extensive experience with birds.

Erna Walraven has produced a timely and valuable guide for coping with a problem that will hopefully never arise. This manual is comprehensive and easy to use. Its value is not limited to addressing oil spills—anyone who is interested in, or may be involved in, the rescue and rehabilitation of Australian birds should have a copy. The author, Taronga Zoo and the sponsors who made publication possible should be congratulated on this production.

—Walter E. Boles
Australian Museum

The Herpetology of the Weipa Region, Cape York Peninsula

By E. Cameron & H.G. Cogger.
Technical Reports of the Australian Museum, 1992, 200pp.
Rrp \$41.00.

Most of us live in the southern parts of the Australian continent and so places such as Cape York Peninsula have a romantic appeal. For naturalists, the feeling of romance is even more enhanced because, in the Cape, the fauna of Australia meets the fauna of New Guinea. For naturalists, this is the closest they will come to having an overseas experience without having to go outside Australia.

Despite all the interest in Cape York, very few books have been written and, of these, the eastern side, with its more up-market rainforests, has usually been the focus. This publication is an exception and thus a welcome addition. Its subject is the frogs and reptiles from the Weipa area in the west of the Cape. It is essentially a report of a survey commissioned from the Australian Museum by the mining company Comalco. But there has been a lot of care taken in its production, and this along with its style takes it beyond a technical scientific report.

The Herpetofauna of the Weipa Region, Cape York Peninsula

E.E. Cameron & H.G. Cogger



Technical Reports of the Australian Museum

The book details the species of all known herpetofauna from the Weipa area. They are described and their distributions, habitats and habits are detailed. As an appendix, a useful key to all the species is presented. All this, plus it is lavishly illustrated with 102 colour photographs.

If you are going to Weipa and you are keen on frogs and reptiles, this is the book to take with you. In fact, it is quite handy for all of the Cape York Peninsula north of Coen except for the rainforests of the east. For the herpetologist, the book has all these advantages as well as being an excellent introduction to the literature on the Cape.

—Glen Ingram
Queensland Museum

Just Published

March

Bunji

By B. Day. Aboriginal Studies Press, ACT. \$24.95.

Return to Palm Island

By B. Rosser. Aboriginal Studies Press, ACT. \$19.95.

May

A Field Guide to Australian Butterflies

By R. Fisher. Surrey Beatty & Sons, NSW. \$TBA.

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By C. Moritz, J. Kikkawa & D. Doley. Surrey Beatty & Sons, NSW. \$93.00.



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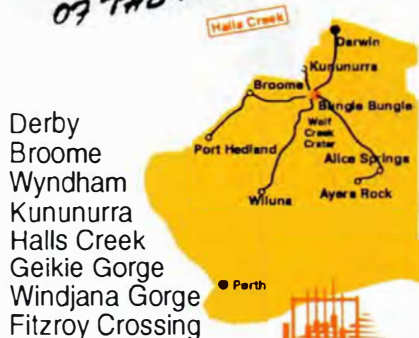
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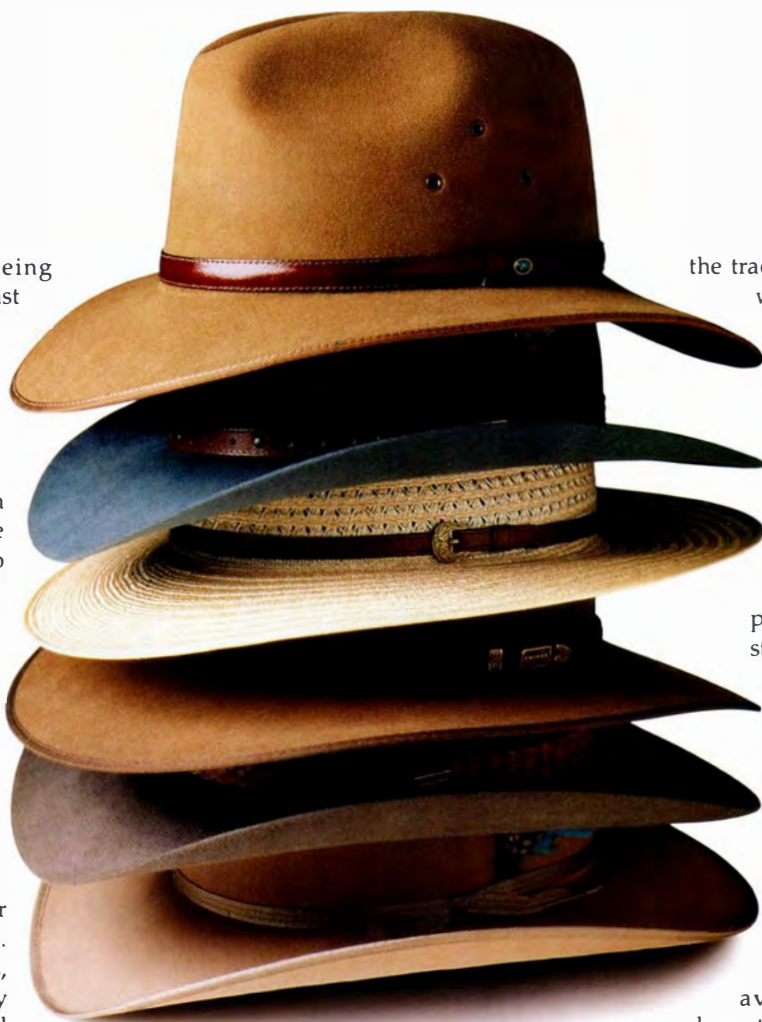
Apart from being sensible protection against our harsh Australian climate, Akubra hats are very fashionable.

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If we had ten pages in this magazine we might just be able to show you our range of hats. That is of course, without including all the different colours and trims.

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In fact, it's nice to know, that the United States, so often recognised for leading the way in many trends, is delighted by the range of styles that we offer. This variety has enabled customers to buy hats that are particularly suited to them, rather than just



ANH SOCIETY PAGE

Get involved! Across Australia there is a network of active societies, large and small, local and national, which exist to further the cause of the subject that you hold dear. Whether your special interest is conservation, birds, science, national parks, bushwalking or a particular group of animals there's a society for you. ANH is pleased to help promote the following societies:

ANIMAL WELFARE

The Marsupial Society of Australia Inc

GPO Box 2462, Adelaide, SA 5001.

Phone: (08) 374 1783

Contact: Bob Cleaver, Vice President

Meetings held third Thursday of each month (except December and January) at Urrbrae Agricultural College, Cross Road, Urrbrae (enter from Cross Road). Visitors welcome.

BIRDS

BOCA, Bird Observers Club of Australia

PO Box 185, Nunawading, Vic 3131. Phone: (03) 877 5342

Contact: Zoe Wilson, Manager

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

NSW Field Ornithologists Club

PO Box C436, 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, weekend campouts, 3-week tour to Kakadu and Alice in May. Beginners welcome.

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.

BUSHWALKING

National Parks Association of NSW

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

Contact: Carol Davies, Office Coordinator

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

CONSERVATION

Australian Bush Heritage Fund

102 Bathurst St, Hobart, Tas 7000.

Phone: (002) 31 5475 or

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Contact: Victoria Templeton, National Coordinator.

National non-profit organisation raising funds to purchase and manage private land of outstanding conservation value. Recently acquired Daintree block. Donations are tax deductible.

Orangutan Fund Australia

PO Box 447, St. Leonards, NSW 2065. Phone: (02) 489 6341

Contact: Jenny Katauskas, Secretary

The OFA and its international affiliates are dedicated to the preservation of the Orangutan and its tropical rainforest habitat through research, conservation and education.

EARTH SCIENCES

The Fossil Club of NSW Inc

3/5 Baker St, Carlingford, NSW 2118. Phone: (02) 871 6112

Contact: Sharon Kellett, Publicity Officer

Anyone interested in fossils welcome. Receive quarterly newsletter, enjoy monthly social and educational evenings, usually with guest speaker and bimonthly field trips around Sydney.

EDUCATION

Antarctic Society of Australia Inc

PO Box 243, Pymble, NSW 2073. Phone: (02) 44 5414

Contact: M.D. Murray, Hon Secretary

A society for anyone interested in the Antarctic and sub-Antarctic. Bimonthly meetings held at Australian Museum. Quarterly newsletter and information brochures for high schools published.

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 bi-monthly magazine, national experiments, competitions and many local events. Over 20,000 members.

Dinosaur Club WA

The Western Australian Museum Dept. of Earth & Planetary Sciences, Francis St, Perth WA 6006. Phone: (09) 328 4411

Contact: Bernie Fisher, Secretary
The club provides news of latest dinosaur discoveries and other prehistoric animals through its twice-yearly magazine *Dinonews*. \$12 year for junior or senior membership.

The Dinosaur Club NSW

Australian Museum, PO Box A285, South Sydney, NSW 2000.

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ENVIRONMENTAL

Australians for an Ecological Sustainable Population

Australian Museum, PO Box A285, Sydney South, NSW 2000.

Phone: (02) 651 1849

Contact: Jill Curnow, President
NSW Branch

AESP aims to promote awareness of the limits in sustainable population size and non-racist policies leading to population stabilisation. Members receive quarterly newsletter. Annual conference held.

Society for Growing Australian Plants (Hunter Region)

8 Lerra Rd, Windella via Maitland, NSW 2320. Phone: (049) 30 7727

Contact: Andrea Sage, Secretary

The Society seeks to promote propagation, cultivation and conservation of plants native to Australia.

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, their own magazine, lectures, seminars, field trips, films, excursions and expeditions.

Friends of the Queensland Museum

c/- Queensland Museum Association, PO Box 3300, South Brisbane, Qld. 4101.

Phone: (07) 840 7555

Contact: Sandra Mann, Executive Officer.

The Waterhouse Club

S.A. 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.

REPTILES

Tasmanian Herpetological Society

c/- Queen Victoria Museum & Art Gallery, Wellington St, Launceston, Tas 7250. Phone: (003) 40 1340

Contact: Dr Rodney Geelan

Society aims to ensure conservation of Herpetofauna (reptiles and amphibians), and to promote public understanding of Tasmanian herpetofauna. Regular meetings, talks, field trips; provide live displays.

Victorian Herpetological Society Inc

16 Suspension St, Ardeer, Vic 3022. Phone: (03) 363 6841 (pm)

Contact: Brian Barnett, President

Publisher of *Monitor*. Distributor of *Herpetofauna* and *Australasian Herpnews*. Meetings held Feb, June, Oct. Many discount goods available to members.

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Q & A

Discerning Palate

Q. *How do creatures know that 'unlikely' foods are edible? I would never have believed, for example, how quickly my Common Bluetongue Lizard (Tiliqua scincoides) found pieces of banana to be deliciously edible!*

—R. Boon
Oatley, NSW

A. Animals can use a variety of senses to detect and select food. At a distance, both sight and smell are important. Sight examines the visual appearance of the item, including features such as shape, surface texture and colour. Smell involves the detection of scent particles, exuded or evaporated from the food, by receptors located in the mucous lining of the nasal cavity.



AUSTRALIAN PICTURE LIBRARY

Many snakes and lizards, including bluetongues, have an additional sense that is akin to smell. By extending the tongue and waving it in the air, scent particles are picked up. These particles are then wiped off inside the mouth and transferred to a vomeronasal organ lying in the roof of the mouth where they are detected by receptor cells.

The relative importance of the different senses in detecting food varies between species. Domestic chickens, for example, show little response to smell, relying predominantly on sight.

When a potential food item is detected and acquired, the sense of taste is used to determine whether it will be swallowed. Taste receptors are mostly located on small rounded papillae on the upper and lateral surfaces of the tongue. Different types of receptor cells respond to different types of particles. In humans, taste sensations are commonly classified into categories such as sweet, salty, bitter and sour, each due to different types of molecules acting on different sets of receptors. However, other animals may not necessarily have the same range or

There is more to a bluetongue lizard's tongue than meets the eye.

types of taste sensations. While your bluetongue found the smell and taste of banana to its liking, a liking for banana is not universal among all animals.

—Glenn Shea
Dept of Veterinary Anatomy
University of Sydney

Stormy Antics

Q. *The larger black ants and the sugar ants of our area gather a large quantity of clover seed into their holes. Before a storm, they carry it all up and pile it around the entrance to the hole. When the rain comes, some of the seed falls over the hole. Is this a method for preventing water entering the hole? Do you know anything about this?*

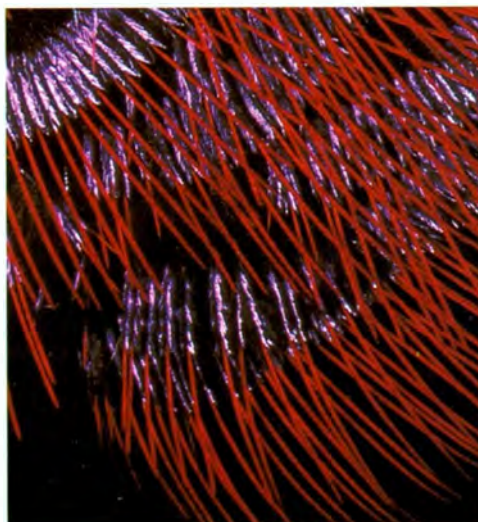
—A. Seddoa
Candelo, NSW

A. The natural history of most ant species is virtually unknown, so I cannot provide you with a definite answer. However, my guess is that the ants are probably reorganising the nest so that, should it become waterlogged in the event of heavy rain, most of the contents have been moved to the surface (or close to it). Many ants do this. One consequence of this behaviour may be a blocked entrance, but I doubt if this is intentional.

—L. Rodgers
Macquarie University, NSW

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. Summer's Pic Teaser was a mosquito pupa.



KATE LOWE / AUSTRALIAN MUSEUM

Mysterious Metamorphosis

Q: I recently found a beautiful bright metallic-silver chrysalis around two centimetres long attached to a grass stem about 20 centimetres off the ground. I kept it to see what moth or butterfly resulted but instead it was eaten out by two fly grubs that then formed pupae themselves. I kept these pupae and the result was two flies. Is this a common occurrence, and what insect made the silver chrysalis in the first place?

—S. Saunders
Whitebridge, NSW

A: The bright silvery pupa or chrysalis was almost certainly that of the Crow or Oleander Butterfly (*Euploea core*), a species common in parts of coastal New South Wales and Queensland. The grubs mentioned are larvae of one of many species of flies of the family Tachinidae that parasitise larvae of moths, beetles and sometimes other insects. Tachinid flies are very

The silvery chrysalis of the Oleander Butterfly.



significant in reducing the numbers of caterpillars and other insects, including many pest species. Sometimes it is quite disappointing, after expecting to raise an attractive butterfly, to find that it has fallen victim to a parasitic fly or wasp. Many people now realise that these latter insects can also be objects of interest and have their own place in the ecology of our planet.

—David K. McAlpine
Australian Museum

JIM FRAZER/MANTIS WILDLIFE

Answers to Quiz in Quips, Quotes & Curios (page 15)

1. Michael Crichton
2. Convention on International Trade in Endangered Species
3. A parliament
4. Six
5. Christmas Island
6. Ros Kelly
7. Honeycomb weathering patterns often found on sandstone
8. Sturt's Desert Pea
9. Riversleigh, Murgon, or Naracoorte Caves
10. North American sequoia trees

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Reactions of disgust to other people's eating habits may be part of a deeply ingrained survival tactic.

FOODS THAT REVOLT: A TALE OF SURVIVAL

BY PETER D. DWYER & MONICA MINNEGAL

W

HY IS IT THAT WE ARE so easily revolted by

other people's dietary habits? A light lunch of raw molluscs, mould-ridden cheese and fermented fruit juice may either delight the taste buds or induce retching—it is all in the mind. You might recoil at the thought of tapeworms; some Papua New Guinean people who eat tapeworms would not contemplate escargot. Even the bravest may falter. Remember Indiana Jones in the "Temple of Doom", confronted by an entree of live baby eels and a soup in which pigs' eyes were floating?

Dietary habits are of abiding interest to anthropologists. They have learned that food may be used to mark the identity of individuals and ethnic groups, or to acknowledge the often-changing status of individuals within groups. The foods people eat, the ways they prepare and share it, and the manifold subtleties of their rules of avoidance serve, on the one hand, to distinguish them from neighbouring people who behave differently and, on the other, as symbols of their own social forms.

There is, however, an important difference between not eating certain kinds of food and being revolted by those foods. Anthropologists have often addressed the first topic, but have seldom considered the second. In the first case people accept that the items they do not eat are indeed food; they know that other people eat those items and are often curious about them. In the second case people are confronted by the edibility of something they cannot accept as food; the behaviour of other people transgresses what had been a secure classification of the world.



The Kubo people of Papua New Guinea make large pies consisting of greens and hundreds of weevil larvae.

It is true, of course, that the usual diet of any society of people must serve nutritional ends. Extinction is the fate of populations that do not satisfy minimal requirements. Because the array of potential foods varies with location, different groups of people must assemble different diets to suit their needs. Dietary differences, then, serve crucial functions. But this knowledge does not explain our responses to those differences. If anything, it makes those responses more puzzling. A different perspective is needed to answer our question.

Within particular environments there is much that can be eaten. There is also a great deal that cannot be eaten or that must first be treated in special ways. Many plants contain distasteful and toxic chemicals. Cycad nuts, for example, can kill. Yet, in parts of Australia, these nuts are an important food to people who know how to leach out the cyanide they contain. Indeed, many staple foods—potatoes, yams and pulses—have been developed from poisonous forebears through centuries of artificial selection. But mistakes still occur. All too often the media report that someone has died or become seriously ill from eating datura, funny mushrooms, fish containing ciguatera or, perhaps, from smoking the dried skin of Cane Toads. The list of potential dangers is long. Fugu eaters of Japan are not the

only people to play Russian roulette at the dinner table. We are all at risk unless we are exceptionally cautious.

In choosing what to eat and what to leave alone there is wisdom in caution. But how may this be acquired? Certainly, there is some truth in the cliché that it is the elders who are wise; the capacity for reflective wisdom increases with advancing years and it is the young who are apt to be foolhardy. Yet, clearly, only those who eat wisely when young will live to join the ranks of respected elders. Cautious eating habits are a necessity. Their acquisition should not be left to a lifetime of chance and experimentation.

The young of many mammalian species acquire a repertoire of safe foods by mimicking the food choices of their mothers. Rats are known to do this. As older, independent individuals these early experiences stand them in good stead. Much the same may be said of people. As children we learn what to eat and what to enjoy. We are taught by example. We grow to understand that certain things qualify as food and the rest does not. Our carers construct a boundary around the legitimate and the safe.

Yet boundaries are both artificial and ambiguous. They may also be tempting to cross. Adventurous young people may not respond well to an endless list of injunctions against eating this, that or the other thing. Nor, in truth, could they memorise the list. Something else is needed that will work with greater force—a 'mind set', easy enough to instil in humans yet, perhaps, unavailable to most other species.

For all animals there is a boundary between things that are eaten and others that are not eaten. People, however, transform this boundary into a contrast between the edible and the inedible. They perceive items in the first category as desirable. Those in the second category cannot be conceived as food; the thought of eating them disgusts. The useful outcome of this contrast between the desired and the disgusting is to safeguard individuals against reckless dietary experimentation. But apparently irrational responses to foods other people eat were not part of the original design. They are an artefact of a world of travel; a world in which we are often privileged to meet the neighbours of our neighbours' neighbours . . . and their neighbours too; to meet people who eat items we never imagined could be food.

Our sense of revulsion at what other people eat, or their distaste for what they see us eating, is, almost literally, inculcated in the cradle. It is an odd addition to a necessary survival kit for living in a chemically dangerous world. ■

Dr Peter Dwyer is a Reader in the Department of Zoology, University of Queensland, and Monica Minnegal is a postgraduate student in the University's Department of Anthropology and Sociology. They study the socio-ecology of Kubo people in lowland Papua New Guinea.

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Cobourg Peninsular, Victoria settlement and Seven Spirit Wilderness in inclusive 7-day feasts of the Top End. By special permission they alone are permitted to visit the offshore islands of World Heritage Shark Bay. To round off the program two classic desert expeditions cross the legendary Simpson, Strzelecki, Sturt's Stony and Great Sandy Deserts. Discovery Ecotours were recently awarded first prize in the prestigious Environmental Tourism category of the 1993 Australian Tourism Awards. This was in recognition of their success in creating unusual and exclusive holidays which combine extraordinary encounters with wildlife and rewarding cultural experiences. All tours are led by qualified science communicators. But they don't just come to look. Discovery Ecotours also funds research into some of the rarest fauna and flora in the world. For more information about their innovative holidays, simply use the tear-out form in front of this page or call (089) 811 100.



1. Competition entry is achieved by returning the fully completed appropriate ANH gift or new subscription coupon or renewal (or copy) together with payment. 2. The competition is open to all Australian residents over the age of 18 years, with the exception of employees of the Australian Museum, Discovery Ecotours, their families, suppliers and associate companies. 3. Entries close on the last mail, Friday 15th April 1994. 4. The winning entry will be drawn at the Australian Museum on 20th April 1994. 5. The winner will be notified by mail and published in The Australian on 23rd April 1994. 6. The prize must be taken as offered and is not redeemable for cash. 7. The prize must be taken 31/8/94 to 9/9/94. 8. The prize of one place on the Discovery Ecotours 1994 Misool tour includes flights Darwin/Sorong and Fakfak/Darwin, Tall Ship charter, on-board food & accommodation, transfers to and from Sorong & Fakfak, accommodation & ship, services of expert leaders, all operating & licensing costs. 9. NSW Chief Secretary's Department No. TC 93/5583 Vic Permit No. 93/3750 issued on 06/12/93 ACT Gaming & Licenses Permit No 93/2102 NT Gaming Control Permit No NT 93/1759.

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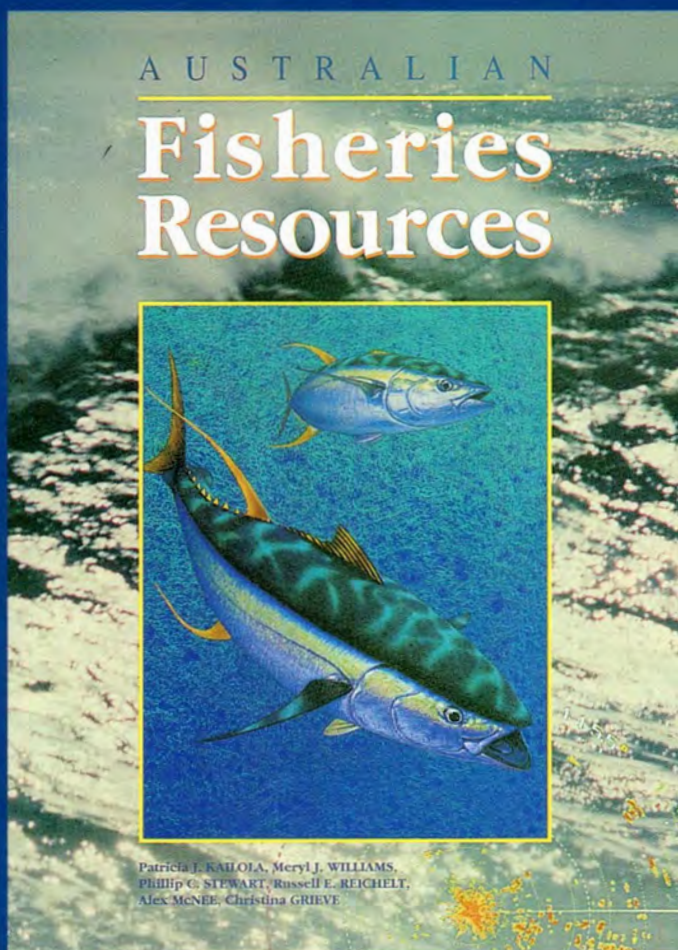
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