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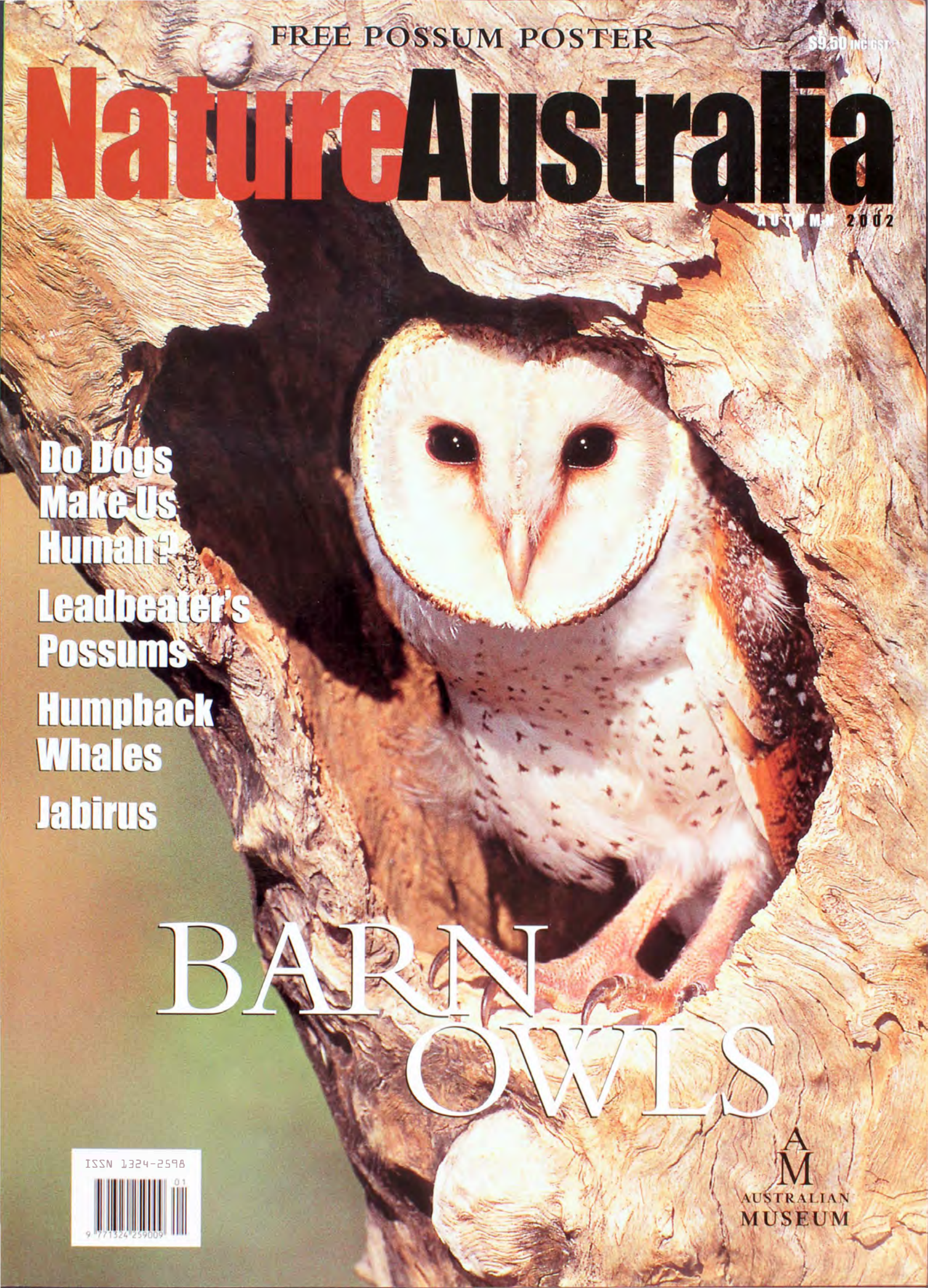

Do Dogs Make Us Human?

Leadbeater's Possums

Humpback Whales

Jabirus

BARN OWLS

ISSN 1324-2598

AM AUSTRALIAN MUSEUM

THE 02 EUREKA PRIZES

STOP PRESS! EUREKA PRIZES LEAP TO ALMOST $180,000

Two new prizes have recently been added to the Australian Museum's **Eureka Prizes**, Australia's premier national science awards. The creation of $10,000 prizes for lateral thinking by students and for Information and Communications Technology (ICT) innovation means there are now an outstanding 18 prizes worth almost $180,000 on offer in 2002.

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FRONT COVER
A Barn Owl (*Tyto alba*) peers out from its roost in a hollow. Photo by Dave Watts/Nature Focus.

up front

Barney, that's the name of my black Labrador, my canine companion. Even after eight years I am still amazed at how easy it is to communicate with him. Most of the time he seems to know exactly what I'm thinking and I often find myself musing that he's not a dog, he's a very hairy person. You might be thinking, well that's not surprising, after all, humans have been selectively breeding dogs for hundreds of years and we've bred them to be in tune with us. Add to this the fact that dogs naturally occur in highly social packs and it's not so unusual that Barney is in tune with my family—his social pack. And yes, this is all true, but it may not be the whole story.

TED SCHIFFMAN/PETER ARNOLD INC/APL

Anthropologists Paul Taçon and Colin Pardoe have been thinking about the human–dog relationship from the point of view of the effects on human evolution rather than dog evolution. What they have proposed suggests that the ongoing interaction between dogs and humans has not only been instrumental in turning the Grey Wolf into modern-day dogs but it has been instrumental in creating modern-day humans from our ancestors. Were dogs domesticated over 100,000 years ago and in the process did they also domesticate us? Did our ancestors' relationships with dogs give them the competitive edge over Neanderthals? Did we learn to mark our territory, undertake big-game pack hunting and live in large, extended family groups from our dogs? Read the article on page 52 and judge for yourself. I know it made me take a long hard look at the much-loved Labrador lying under my desk.

Black-necked Storks are not particularly well-known Australian birds. This is unusual because most people have heard of storks and it's hard to miss a large, mainly black-and-white bird that stands well over a metre tall and has a beak like a sword. Perhaps people are not familiar with them because they now mostly occur in the wetlands of the Northern Territory. But this was not always the case. Today we might be amazed at the idea of a large stork flying around Sydney but for people in the 1920s it would have been a wonderfully common sight. Eric Dorfman has taken on the tricky task of trying to understand why these birds have gone from the Sydney region.

Leadbeater's Possum lives nowhere else on Earth but Victoria. In Victoria this possum can only be found in a tiny 60 x 80–square-kilometre area of the Central Highlands, within one of the most spectacular forests on Earth—the Mountain Ash forests. These forests also contain the tallest flowering plants on the planet. And what is our response to all of this? We systematically cut it and burn what's left to the ground, putting Leadbeater's Possum on the well-trodden path to extinction. Perhaps it's time we changed our response.

Also in this issue we explore the mysteries of Humpback Whale song, attempt to discover what's killing off the beautiful Giant Barred Frog and meet an insect that came back from the dead—the Lord Howe Island Giant Stick Insect.

— JENNIFER SAUNDERS

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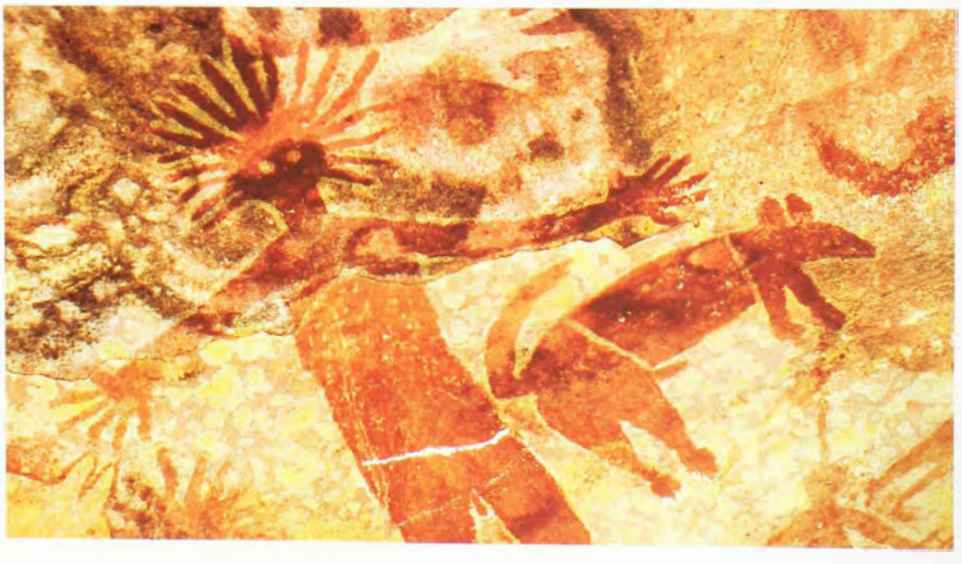


COLUMNS

letters

Do All Fish-eaters Smell?

After enjoying to the full (almost to the point of rolling around on the ground from mirth) Steve Van Dyck's Backyard Naturalist article on the Water-rat (*Nature Aust.* Winter 2001), I was left with one minor source of puzzlement: the author's implication that this rodent's "pungent natural odour" (eclipsed only by a rotting polecat carcass) is due to its being a primarily fish- and game-eater. Is this indeed a natural cause-and-effect? Are all fish- and game-eaters olfactorily offensive? I would be interested to know the connection.

—Anne Drover
Wollstonecraft, NSW

What I wrote was a bit of a non sequitur *really. Drawing the conclusion that eating fish makes you reek was probably a bit rich, although if you have dined on muttonbirds, or smelt a penguin rookery, the memory of Peck's Paste past its use-by-date might be evoked. I know whale breath is pretty pongy, but I'm not sure how Eskimos measure up under the sniff test. Caged Water-rats stink partly because their four walls concentrate their fishy droppings and table scraps. But their own smell comes from living in a fishy place. Laying down a smell trail in an environment that might get tidally inundated twice a day calls for a brew more tacky than freeway lane paint. They produce this gagging, musky glug in glands beside the anus, and slap it around the landscape like a liquid bar code. The real bummer about this sort of trail blazing is that some of the dots and dashes they daub around inevitably land in their own lap. The build-up of a Water-rat's aroma might speak volumes to another Water-rat, but to a human it simply reads as* eau-de-polecat.

—Steve Van Dyck
Queensland Museum

Exploring Molluscs

I take offence at Barbara Brownlow's Letter (*Nature Aust.* Winter 2001), in which she likens my research on molluscs to the process of extracting bile from Asiatic Black Bears. In fact, I (like many other Australians) have signed a petition calling for the halt of this inhumane practice, which involves keeping bears alive in small cages whilst their bile ducts are tapped. My research, by comparison, is carried out on invertebrate organisms, which have no central nervous system, after they have been humanely sacrificed by placing them in a freezer.

There is a big difference between the words "explore" and "exploit", and I deliberately chose the word "explore" because I am a research scientist with a strong interest in conservation. Through my bioprospecting activities I have been able to contribute to the conservation of intertidal ecosystems by identifying breeding habitats used by molluscs and hotspots of molluscan diversity. It should be noted that it is often difficult to get funding for direct biodiversity-related research in Australia, so there are advantages in using the banner of potential human applications.

With respect to the Shell Cove boat harbour, Barbara Brownlow and others may be interested to know that, as a result of my research, Bass Point (Shellharbour) has now been selected as an appropriate site for a new marine reserve by New South Wales Fisheries. Bass Point is a "priceless" marine environment because it supports an unusually high diversity of species and provides important breeding habitat. If the need for protecting this ecosystem cannot be appreciated for these values alone, it becomes necessary to appeal to people in any way that will be effective, including "for the sake of humans". I

BARRY & BERT WELLS/NATURE FOCUS

Water-rats have a pungent odour, not so much because of what they eat, but rather because of where they live.

care about the protection of species and ecosystems, so if sacrificing a few individuals (in an environmentally sustainable and humane manner) can further our ultimate goal of conservation and community education, is this really such a bad thing?

—Kirsten Benkendorff
University of Wollongong

Evolutionary Theory

Your magazine has been of much interest in opening to me the many natural wonders of our own country. The work involved is much appreciated. The continued emphasis on evolution is, I take it, a given in your scientific world and I can accept that this is so, albeit with some boredom as to its repetition.

The article "The Killer Rat-kangaroo's Tooth" (*Nature Aust.* Winter 2001) has an unfortunate conclusion quite uncalled for, even if the tenor of the article is overlooked. No allowance is made for your wide readership, which probably includes some who still know that the evolutionary theory is just that. It seems to me to be a bad lapse of editorial oversight that Stephen Wroe was not counselled about such antagonism. Surely this is not a useful way to impart scientific research findings.

I also puzzle over the statement "…this is pretty strange. A single organ has been used for two completely different roles…". I thought that the natural world was replete with multiple-use features—most creatures, including myself!

—Jack Austin
Cowes, Vic.

Mr Austin displays a lamentable lack of strength in his convictions. He concedes that the acceptance of evolution as fact underpins most Nature Australia *contributions, but takes exception to my article, evidently because it actively denies Creation theories. In short, it is not that I flaunt subscription to evolutionary theory, but that I argue against 'design' by a god. However, to accept evolution is to deny Creationism, whether overtly stated or not. Austin, it seems, would prefer me not to call a spade a spade; he would prefer that scientists were routinely censored—that they embedded their conclusions between the lines. Although it is Austin's right to disagree with evolutionary theory, if he has an argument against it, then he should put it on the table, not call for the silencing of those who disagree with him.*

As to Austin's second concern, I do not claim that Ekaltadeta's *second premolar (P2) is unique in being "multi-use", but in being "used for two completely different roles in the course of the individual's life". There is a difference and I'll explain it more fully. The P2 of this strange kangaroo has a distinct and single use in the juvenile, that is, as a shearing blade. With maturity, this tooth is repositioned to perform a completely different function as a buttress. It is this obligate change of function through the course of the animal's life that defines* Ekaltadeta *as unique. Of course there are many organs that are multi-use, but at no point is this true of the P2 of* Ekaltadeta. *Structural change redeploys the tooth in a completely new role and constrains it to only this new role.*

—Steve Wroe
University of Sydney

Magazine Rap

I am, for the first time in my life, renewing a magazine subscription for more than a single year, and I do so with confidence. I enjoy a number of popular scientific magazines, primarily but not exclusively from the USA, and I consider myself to be a fussy reader. Among my long-loved subscriptions is your American counterpart *Natural History*, published by the American Museum of Natural History.

I compare *Nature Australia* and *Natural History* and conclude that *Nature Australia* must have excellent management and staff. The reality is that quality often relates to revenue, and revenue relates to scale. Much as we might wish we could read *Nature Australia* every month and not just quarterly, I conclude that it reflects your conscious choice to go with quality rather than quantity given the smaller population base you serve domestically. Every issue of *Nature Australia* is a treat, with good writing about interesting subjects, and wonderful photographs. Keep up the good work!

—Eric Anderson
Rhode Island, USA

Is There a Pure State of Nature?

In his article "The Pure State of Nature" (*Nature Aust.* Spring 2001), David Horton cautions us about reading too much into the scanty and subjective evidence about the extent that Australians had modified their environment prior to European settlement. He then uses this evidence to argue strongly that James Cook and Ludwig Leichhardt would have seen the same Australia even if Aborigines had never set foot on this land. Perhaps we will never know what they would have seen, but does it really matter?

To Horton it does, because if Aborigines did drastically modify the vegetation with fire, and wipe out the megafauna, this would legitimise destructive practices such as land clearing; modification of an already human-modified environment isn't as bad as upsetting "the pure state of nature". But organisms have been modifying their own environments for billions of years, frequently in ways that are deleterious for themselves and for other organisms. Oxygen, for example, was a rare and toxic gas before the evolution of photosynthetic organisms. Can we really argue that there is a "way it was meant to be" which we must discover and then return to? Or must we instead decide the way we want it to be? If the latter is true, there is still every reason for us to choose the same world that Horton hopes for, and that the first Australians had when Cook stepped onto their shore—a diverse one.

—Michael Kearney
University of Sydney

***Nature Australia* requests letters 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 this issue will receive a copy of *The Story of Peking Man*. The winner this issue is Michael Kearney.**

nature strips

COMPILED BY GEORGINA HICKEY

RICHARD FULLAGAR, KARINA HOLDEN, MICHAEL LEE, KAREN McGHEE, MICHAEL McLEAN, RACHEL SULLIVAN AND ABBIE THOMAS ARE REGULAR CONTRIBUTORS TO **NATURE STRIPS**.

Antarctic Meltdown

Global warming is already turning up the heat on Antarctica: air temperatures are rising, ice is melting and the physical environment on the frozen continent is changing.

Krill (*Euphausia superba*), which underpin most Antarctic food chains, are believed to be suffering too and it's speculated that the biomass of these small shrimp-like crustaceans has been declining in the Southern Ocean for the past decade due to decreasing ice cover. The broader ramifications of this have now been investigated by Keith Reid and John Croxall of the British Antarctic Survey in Cambridge.

The researchers analysed population and reproductive data on four krill-eating predators—Antarctic Fur Seals (*Arctocephalus gazella*), Gentoo Penguins (*Pygoscelis papua*), Macaroni Penguins (*Eudyptes chrysolophus*) and Black-browed Albatrosses (*Thalassarche melanophrys*)—collected from South Georgia, north-east of the Antarctic Peninsula, during surveys from 1980 to 2000.

They found that, although study populations of the four species were either stable or increased slightly during the 1980s, they all declined during the 1990s. Macaroni Penguins and Black-browed Albatrosses suffered the worst declines, their numbers falling by about 50 per cent.

The four species have different physiologies and ecologies but share two significant features. They breed at South Georgia and rely on krill as their principal source of food.

Diet-sampling studies on the four species revealed that, at the same time they were in decline, the population structure of krill in the South Georgia region was also undergoing significant change. Most importantly, the proportion of krill in the largest size range was falling.

When all things were considered, it appeared that the likely cause of the decline in predators was directly related to declining krill availability.

—K.McG.

JEAN-PAUL FERRERO/AUSCAPE

Macaroni Penguin numbers have fallen dramatically in the last decade.

Show-offs and Pay-offs

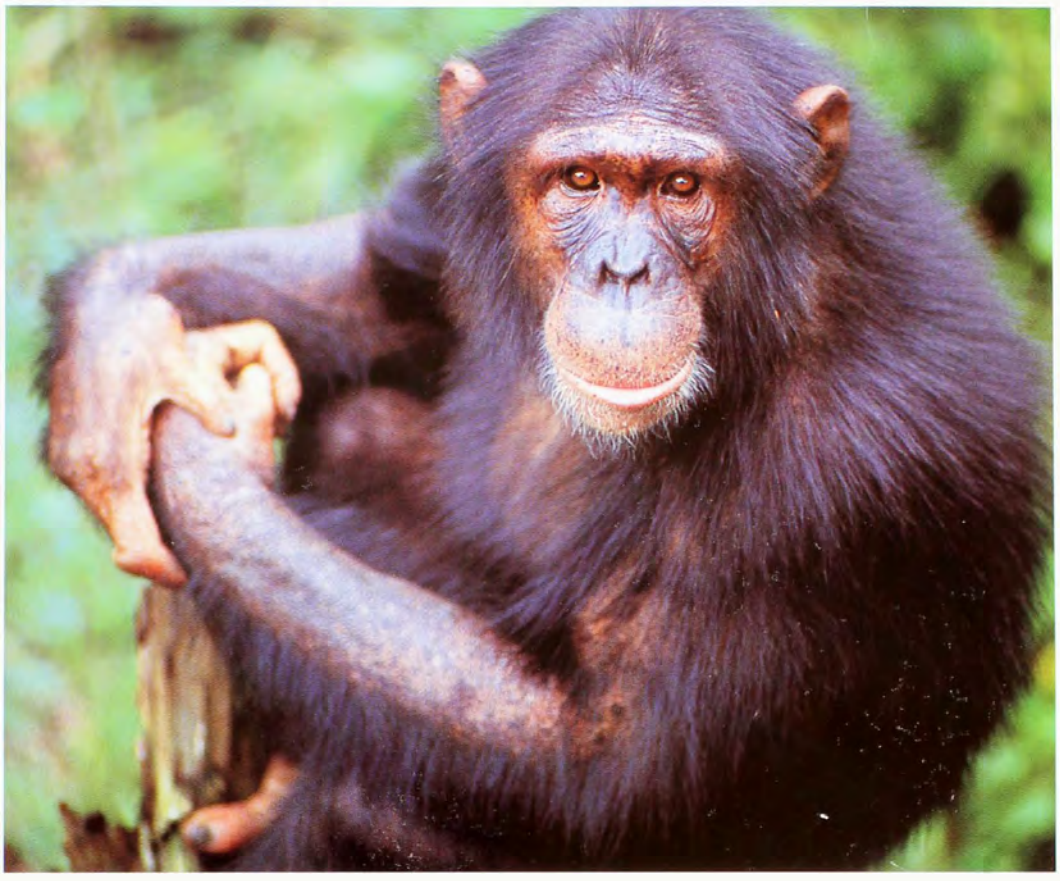
We all know humans can behave irrationally. Some behaviour has no apparent evolutionary advantage at all, and the 'Darwin Awards' commemorate the remains of foolish individuals who have contributed to the improvement of our gene pool by removing themselves from it (*www.darwinawards.com*). However, other apparently irrational behaviour may have a hidden evolutionary agenda. For example, individual hunters may choose to collect food the hard way (with relatively low returns), or they may acquire food and give it all away. How can evolutionary models explain such seemingly wasteful practices?

A team of anthropologists led by Rebecca Bird (University of Utah) believes that hunting itself may provide an honest signal (one that can't be faked) of skill or other fitness-related quality. The evolutionary pay-off is that many people get to assess the signaller's (in this case, hunter's) credentials as a mate, ally or competitor.

Bird and colleagues studied foraging practices of the Meriam—Indigenous owners of Mer and the other Murray Islands in the Torres Strait. They found that spearfishing provides much less food (in terms of nutrition) than the hunters could catch had they collected other available seafood like shellfish (the target food of most women). While dietary variety may play a role, the researchers showed that these hunters rarely share their catch, and therefore few people actually benefit from task specialisation. However, hunting success clearly signals individual prowess and skill. Anyone can collect shellfish and no-one (not even a good collector) stands out, but everyone remembers the best spearfisherman swaggering up the beach with his catch in hand.

Turtle-hunting provides another example. Although nesting Green Turtles (*Chelonia mydas*) are easily collected on the beaches of Mer from October to April, turtles must be hunted in the open sea at other times of the year. Invariably the purpose of these turtle hunts is to provide fresh meat for public feasts. Unlike spearfishing, turtle-hunting (and collecting) produces a lot of meat. But while a turtle-collector keeps a proportion of the meat for his own family's consumption, the turtle-hunter keeps none for himself and has no say in how it is distributed. How could this help the hunter? As Bird and colleagues explain, news of the hunt spreads quickly. The successful turtle-hunter is immortalised in local legend and thus shows off his qualities as a potential mate or ally to the rest of the community.

—R.F.



FERRERO-LABAT/AUSCAPE

What was the driving force in the evolution of three-colour vision in Chimpanzees?

Seeing Red

For most mammals the world appears rather dull and gloomy. The vibrant colours we see in nature are often lost on the animals that live there. Yet at some stage in evolutionary history, primates stepped out of that washed-out world and started seeing in technicolour. Scientists believe the evolutionary force that made primates finally see red was hunger.

Trichromatic or three-colour vision allows us not only to distinguish blue from yellow but also red from green. This is thought to be important for primates foraging for fruit high in the canopy. Yet recent studies by biologists from the University of Hong Kong suggest that leaf colour, rather than fruit colour, was probably the driving force in the evolution of trichromatic vision.

Nathaniel Dominy and Peter Lucas studied the eating habits of Chimpanzees (*Pan troglodytes*), Black-and-white Colobus (*Colobus guereza*), Red Colobus (*Piliocolobus badius*) and Red-tailed Monkeys (*Cercopithecus ascanius*) in Kibale National Park, Uganda. From the analyses of colour, chemical content and toughness of the primates' chosen foods, the researchers were able to determine how colour

GEOFF SPANNER/AUSCAPE

How does a Black Bear maintain muscle strength after months of hibernation?

influences diet.

By seeing red, these primates have the advantage of being able to select tender young leaves, which are rich in protein and provide a critical food resource when fruits are scarce. To a colour-blind species, a young red leaf might appear dark and mature, thus tough and unpalatable. Interestingly, over half of Africa's tropical plants have young leaves coloured red, and all primates on this continent have trichromatic vision. However, in the tropics of South America, less than a third of young leaves are red, and only one genus of New World primates, the howler monkeys (*Alouatta*), has evolved (independently, the authors say) to see in full colour.

—K.H.

Bear Facts on Hibernation

Does a wild bear defecate in the woods? Not in winter it doesn't. Nor does it eat, urinate or move outside the safety of its den. Yet, despite 'bearly' moving during the five to seven months of hibernation each year, Black Bears (*Ursus americanus*) retain most of their muscle tissue and strength. Bedridden humans, by contrast, would hardly be able to move a muscle. So how do bears manage it?

Henry Harlow (University of Wyoming) and colleagues radio-tracked Black Bears to their dens at the start and end of winter, cautiously jabbed them with anaesthetic and hauled them out. Muscle biopsies were taken, then the sleeping bears were fitted with a brace to stabilise the hind leg and the nerves stimulated causing the foot to kick against a metal plate. When the forces of impact were measured, the team found that the strength of the bears' kicks decreased by only 23 per cent. Similarly confined humans would lose 90 per cent of their strength.

The team suspects that the bears' shivering (isometric muscle contractions), along with their known ability to recycle nitrogen from the urine to synthesise new amino acids and proteins, keeps the animals strong during hibernation. Presumably this allows them to maintain their fighting condition should a predator disturb their rest.

—R.S.

The Advantage of Dull Neighbours

Being drab and dull is usually a disadvantage for male songbirds in monogamous society. They are picked on by rival males, passed over by the females, and relegated to the worst-quality habitats. Yet in the small North American Lazuli Bunting (*Passerina amoena*), the dullest males share choice territories with the brightest males. Males with mediocre plumage are aggressively chased away by the brightly coloured males, yet strangely the drab males

are tolerated. This curious neighbourhood arrangement has been examined by biologists in the US seeking to understand how dowdy birds have made it to the top of bunting society.

Erick Greene (University of Montana) and colleagues observed a population of Lazuli Buntings near Missoula, where both bright and dull males shared high-quality territories. Their observations revealed that the arrangement is one of unusual collaboration between the males. The researchers suspect the pay-off for the colourful male is promiscuity. Because of his irresistible looks, he is likely to attract the attention of females that have paired with his dull-looking neighbours and so gain extra-pair matings. Moreover, he can be sure of his own partner's fidelity, as the next-door neighbours are far too drab to tempt his female away.

The advantage for the dull male is one of belonging to a good neighbourhood. By this fortune he has been able to secure a mate and increase his chances of paternity.

Apart from the cheating partner, the manipulative neighbour and the illegitimate offspring, he's got it made! Well, it might not seem the most equitable form of cooperation, but he's still doing better than the average male.

—K.H.

COURTESY JOSÉ LUIS SANZ

Fossilised dino vomit?

Cretaceous Chunder

Just in case you ever wondered, it seems that dinosaurs suffered from indigestion too: researchers have uncovered what may be the first known example of fossilised dino vomit.

The team, led by José Sanz from Universidad Autónoma de Madrid, discovered the 115-million-year-old lump while digging at Las Hoyas in central Spain. It contains the jumbled remains of four juvenile birds from three different species surrounded by feathers. During the Cretaceous Period, Las Hoyas was a calm lake —an ideal deposition environment that resulted in an unusually large number of isolated, complete and perfectly preserved skeletons.

It is unlikely that such a mish-mash of bones and feathers from individuals of different species would have occurred through natural geological processes.

The researchers ruled out the possibility that the blob is fossilised dino poo. Compared with other known coprolites, the degree of destruction of the bones and amount of surface pitting is consistent with being immersed in stomach acids but not with having passed right through the alimentary canal.

Positively identifying the responsible predator, however, is tricky. The Las Hoyas site has yielded an amazing array of vertebrate fossils including fishes, birds, small dinosaurs, crocodiles, lizards, pterosaurs (flying reptiles) and early mammals. Fish and mammals were excluded from the list of suspects because they regurgitate large, loose masses of bones, as were the crocodiles, which would probably have regurgitated more completely digested bones, and as were lizards and birds, which were about the same size as the offending lump.

The researchers ruled out the possibility that the blob is fossilised dino poo.

The most likely predator was either a small dinosaur or pterosaur, which probably raided the nests of the different bird species, dined heartily off their occupants, and then spat out the indigestible remains.

—R.S.

Moose for Dessert?

Large carnivores such as wolves and bears are the focus of intense conservation efforts. In several countries, their recent local extinctions have been reversed by intensive reintroduction programs. However, such translocations might tamper with, rather than aid, the target species (see "Putting the Move on Nature", *Nature Aust.* Summer 2000–2001). As well, the impact of such reintroductions on prey species has rarely been assessed.

Joel Berger (Wildlife Conservation Society) and colleagues have recently examined the latter aspect. They first compared the behaviour of Moose (*Alces alces*) in areas with and without Brown Bears (*Ursus arctos*) and Grey Wolves (*Canis lupus*). Moose living alongside predators reacted much more strongly to danger signs such as wolf calls and bear odours. In places where introduced predators are expanding their range, Moose suffer double the natural predation rate along the encroaching 'predator front', but normal rates behind it. As predicted, Moose outside the predator front were predator-naive but Moose immediately behind the front, despite having coexisted with bears and wolves for only a

ERWIN & PEGGY BAUER/AUSCAPE

Moose are quick to relearn their anti-predatory behaviours to wolves and bears.

JAN TAYLOR

An Australian dung beetle, *Onthophagus ferox*. Extravagant horns come at a price.

generation, were already predator-savvy. Thus, the anti-predator behaviours are relearnt remarkably quickly.

These results raise both concerns and optimism. They suggest that, although such predator reintroductions can devastate prey populations in the short term, if the initial prey population is large enough to absorb the onslaught, recovery of prey can be swift and effective.

The researchers also suggested that similar rapid adaptive learning might have occurred in the Pleistocene megafauna, thus "tempering" the effects of any human overhunting. However, this extrapolation might not be justified. The naive prey populations in the study (Moose) had coevolved with their natural predators (bears and wolves) for at least tens of thousands of years, and had only been isolated from these predators for a geological instant (a century or less). These populations thus already possessed all the anatomical and behavioural traits for resisting predation, but had momentarily lost the ability to use them. In contrast, the Pleistocene megafauna of the Americas and Australasia, for example, had never encountered a human in their entire evolutionary history, and never evolved any appropriate defences. Without the behavioural and anatomical traits in their armoury to fall back on, these animals would have had to evolve entirely novel defensive repertoires in response to this new predator—a slow process that may have meant sustained mortality rates for lengthy periods...and eventual extinction.

—M.L.

Horny Beetles

Dung beetles sport horns that reach gigantic proportions and grow in extraordinary forms. Horns sprout from the front, back or middle of the head, or from the thorax. Despite this diversity, beetle horns all function the same way. Males use them to block the burrow entrance to keep rivals out and to safeguard their mate. Larger horns therefore have an obvious reproductive benefit, but why are horns so variable in their shape and location? A recent study by Douglas Emlen from the University of Montana suggests that functional costs influence horn design.

Emlen's study of *Onthophagus* dung beetles has shown that possessing extravagant horns comes at a price. Wherever horns grow, they stunt the development of nearby organs. Species with horns at the front of the head have small antennae and hence an impaired sense of smell (olfaction). Those with horns at the back of the head have smaller eyes with reduced vision. And beetles with horns on the thorax have smaller wings with diminished flight capabilities.

Each trade-off reveals the functional association between ecology and horn design. Most dung beetles need to see, smell and fly, yet the importance of these factors varies with the beetle's environment. For instance, nocturnal dung beetles need large eyes for seeing in low light, so the costs of producing horns at the back of the head (near the eyes) should be higher in nocturnal beetles than diurnal ones. Indeed, Emlen found that horns were significantly more likely to be located away from the back of the head in nocturnal dung beetles. Likewise, beetles inhabiting areas where dung is sparsely distributed rely on flight and well-developed olfactory senses. Emlen suspects that horns in these species will likely be found at the base of the head, so as not to impair the wings or antennae.

Emlen's study has shown that, while ornaments and weapons may have developed from the benefits of sexual selection, their diversity is driven by the cost constraints of ecology.

—K.H.

FRITZ POLKING, AUSCAPE

An African Rock Python (*Python sebae*) swallows an Impala (*Aepyceros melampus*) whole. How do pythons cope with their feast-or-famine lifestyle?

Cicada Clocks

Cicadas can't tell time, of course, but some have extraordinarily precise capabilities for monitoring the passage of years. In at least three North American species, for example, virtually all adults in a given area will emerge and mature within days of each other after spending almost exactly 17 years under ground. As a result, thousands, even millions, of rhythmically droning adult cicadas can suddenly appear in a location where they haven't been seen for years.

How these so-called 'periodical' cicadas (all members of the genus *Magicicada*) keep track of the years has long been one of nature's great mysteries. Now researchers led by Richard Karban (University of California at Davis) have found an important part of the puzzle.

While under ground, juvenile cicadas (nymphs) feed on tree-root sap and barely move during their long pre-adult lives. They dwell too deeply to be influenced by usual seasonal guides such as changing day lengths and air-temperature fluctuations. Instead, Karban and his colleagues have found that periodical cicadas probably take their cues from the plants upon which they live.

The researchers transferred 15-year-old nymphs into roots of peach trees of a variety that could be made to flower twice a year, instead of just once. They accelerated the rate of seasonal change experienced in one group of trees so that, physiologically speaking, they passed through two years in one. The nymphs on these trees took only one year to develop into adults, reaching maturity prematurely after just 16 years of life. Nymphs transferred to trees left to experience seasonal changes naturally maintained the normal 17-year cycle.

The work suggests that annual changes in nutrients and other sap components associated with flowering keep the insects informed about the number of seasons they pass through.

—K.McG.

Snake Guts and Bladders

Many of us know the painful feeling of indigestion after indulging in too much food. But pity the poor python that just swallowed a goat! Life is either feast or famine for pythons, so to prevent an upset stomach their guts have to be incredibly flexible to cope with the changes. The small intestine may increase by as much as three times once a snake has gorged itself. Zoologists Matthias Starck and Kathleen Beese from Friedrich-Schiller University in Germany have recently studied the cell structure of the python gut to find out how these snakes battle the bulge.

Because pythons shut down their digestive systems between meals, scientists have always assumed that stored energy reserves are used to switch on the digestive process and expand the gut. But if this was the case, a python that's been fasting for a long time may not have the energy to digest its next meal and you'd expect to see a lot more

Microscopic traces left on this 1.5-million-year-old handaxe from Tanzania suggest it was used to shape wooden implements, perhaps even spears.

COURTESY J. SERRALLONGA

dead pythons with full bellies.

Starck and Beese looked at the intestine of the Burmese Python (*Python molurus bivittatus*) and discovered that it could swell without exerting any energy in producing new cells. The lining of the gut (the epithelium) is highly flexible and coiled, which allows the distension of the organ. By rearranging the cells of the epithelium into a single layer and expanding these cells under hydraulic pressure, the snake expands its stomach to feeding size. In this way, the python's gut is similar to a bladder, stretching and shrinking in size. Only after nutrients have been absorbed does the snake produce new cells, which can then replace those lost or damaged during digestion. And the bulging belly is simply deflated after the meal has been digested.

—K.H.

Ancient Woodworkers

Traces of *Acacia* wood have been found on some of the oldest known (1.5-million-year-old) handaxes, from Peninj in Tanzania, suggesting that they were used for woodworking. Why is this important? Other research has already highlighted social explanations that link manufacture of these tools with mate selection and evolutionary success (see "Sex Axe", *Nature Aust.* Spring 2000). But it is also important to know how these tools were actually used, so that we can test proposals about the role of meat and hunting in early human diets.

Handaxes are distinctive, two-sided stone tools made by our human ancestors (*Homo* sp.) and they

KATHIE ATKINSON

What's the quickest way to wake a sleeping King Penguin?

remained the tool of choice for over a million years. Previous work had shown that some of the later handaxes (about 500,000 years old from the UK) had wear patterns typical of butchering, but the new research by Manuel Dominguez-Rodrigo (Universidad Complutense de Madrid, Spain) and colleagues has revealed the presence of a particular type of phytolith (plant microfossil) that is common in woody tissue and indistinguishable from those belonging to *Acacia*. Coupled with the fact that the handaxes were heavily worn, the researchers suggest that these tools were used to chop hard wood or shape wooden implements, which have since disappeared from the archaeological record.

Although there is also some evidence of possible woodworking in older (1.7–2.0-million year-old), simpler-style tools from South Africa, Dominguez-Rodrigo and colleagues conclude that, certainly by 1.5 million years ago, our human ancestors were using their stone tools to make wooden tools, perhaps even spears, and therefore (contrary to current views) at least had the means to hunt down their prey (rather than just scavenge). We do not know for sure, however, whether they actually did hunt, or how important meat was in early human diets.

—R.F.

Penguins' Ticklish Toes

King Penguins (*Aptenodytes patagonica*) breed in dense colonies and so sleeping birds are frequently bumped by passers-by—some individuals as often as once every three minutes. French researchers wondered how these birds are able to remain asleep in their crowded rookeries, yet wake up in an instant if their egg or chick is threatened.

Gérard Dewasmes and Frederic Telliez (Université de Picardie J. Verne) snuck up on snoozing penguins nesting on Possession Island in the Crozet Archipelago. They carefully placed weights of increasing size on the birds' feet, and on their upper backs, until they opened their eyes, indicating they were awake. Penguins that had weights placed on their backs woke after about 800 grams had been applied—about one-fifteenth of their total body weight. But penguins that had weights put on their feet needed only about 40 grams

to wake up. In other words, penguins' feet were much more sensitive to changes in pressure than were their backs.

The researchers suggest this different sensitivity allows the penguins to protect their eggs and chicks. Penguins keep their egg on their feet, and this is also where the chick remains for most of its early life. If an egg rolls off, or a chick is dragged away by a predator, the sleeping parent will know about it quickly. But if the penguin is jostled around the shoulders by another adult as it wanders through the crowd, the bird is likely to sleep on, undisturbed.

So, if you want to wake a penguin, don't waste time tapping it on the back. Tickle its toes instead.

—A.T.

How do expecting mothers avoid producing all females... and possible extinction?

Soft- or Hard-boiled?

Incubating eggs is difficult at the best of times, but it's especially tricky if the sex of the children depends on the temperature of the nest.

That's the problem faced by sea turtles, which bury their eggs on sandy beaches and leave them to incubate in the warm sand. For the Green Turtle (*Chelonia mydas*), less than 26°C and all hatchlings are male, over 29°C and they're all female. So in the warm tropical sands of the turtle rookeries, how do expecting mothers avoid producing all females...and possible extinction?

David Booth and Katherine Astill from the University of Queensland recorded temperatures in Green Turtle nests on Heron Island using temperature data-loggers, which they placed at the bottom, middle, side and top of the eggs while they were being laid. Temperatures were recorded every 30 minutes during the two-month incubation period.

The researchers found that small temperature differences between regions of the nests persisted throughout incubation, and that these variations resulted in minor differences in the predicted hatchling sex ratio. On Heron Island, the nests that are most likely to produce the greatest number of males are either deep, or constructed early in the nesting season when sand temperatures are relatively cool. However, even in the warmest nest they monitored, there were a few eggs at the bottom of the nest cool enough to produce males.

Regional differences within the nest, the researchers suggest, act like little refuges for members of the minority sex and could provide a precautionary mechanism to ensure both males and females are produced. A warm and

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

The temperature of the nest determines the sex of Green Turtle offspring.

comforting thought for any turtle worrying over whether or not to soft- or hard-boil her eggs.

—M.McL.

Pass the Tapeworms

The evolutionary history of tapeworms provides an unexpected indicator of early human diet and behaviour. The curious life cycle of these gutless parasites generally involves two hosts—an intermediate host (typically a herbivore) and a definitive or final-stage host (typically a carnivore). Humans are the definitive host for three species of *Taenia* tapeworms, one of which was recorded to have reached 23 metres in length. Ingested eggs develop in cattle (*Bos* spp.) or Pigs (*Sus scrofa*), which pass the larvae on to people who unwittingly consume partially cooked meat and offal. Conventional wisdom had argued that tapeworms initially infected humans when these animals were first domesticated about 10,000 years ago. But new evidence suggests a much earlier association.

Based on DNA analysis, Eric Hoberg (United States Department of Agriculture) and colleagues estimate that two of the human tapeworm species (*Taenia saginata* and *T. asiatica*) diverged from each other between 780,000 and 1.71 million years ago. These tapeworms were likely to have been parasites of early human ancestors at that time, which was well prior to the emergence of modern *Homo sapiens*, and long before the domestication of animals.

Anatomical comparisons of 35 tapeworm species, combined with studies on their host associations and geographic ranges, indicate there were two independent host shifts from African carnivores such as lions and hyenas to hominids. Hoberg and colleagues suggest African antelopes, as intermediate hosts, first passed on tapeworms to scavenging human ancestors at a time when habitat disruption was causing a switch to a more omnivorous diet, with its lashings of uncooked meat. The timing of this event may coincide with the earliest evidence for meat consumption by African hominids—2.5 million years ago (see "What's Cooking?", *Nature Aust.* Autumn 2000).

So, rather than cattle and Pigs passing their tapeworms on to us, it appears that we passed our tapeworms onto them. Keep this in mind if you are ever unlucky enough to get a tapeworm

Did Pigs pass tapeworms on to humans, or was it the other way around?

from eating underdone beef or pork—we've only got ourselves to blame!

—R.F.

Plant Stroke

Do plants have feelings? New evidence suggests that some plants are much more sensitive to our presence than we realise.

James Cahill (now at the University of Alberta, Canada) and colleagues stroked six different plant species from root to tip, once a week for eight weeks, and compared them with control groups given no attention. To see if touching had any effect, in particular on the plants' susceptibility to insect attack, they measured the leaf area of each plant at the start and end of the experiment. If being visited

had no impact, there should be no difference in leaf loss between control and stroked plants. But amazingly, they found that one of the six species, *Potentilla* sp., flourished from the attention. Plants that had been stroked had significantly more leaves at the end of the study period than the unstroked controls, which had lost up to half their leaves to marauding insects. By contrast, another species, *Apocynum* sp., fared less well, with insects causing much more damage to stroked plants than their unstroked controls. The other four species showed no change.

Why would a gentle stroke once a week affect a plant? One possibility is that touching the plant changes it in some way to make it more or less tasty for insects. Previous research has shown that leaves can respond to touch by changing their shape, their physiology, or even by switching on genes. Or, it may be that making regular contact with a plant changes its immediate environment. For example, trampling the neighbours might give a particular species an advantage if availability of light is limiting its growth, or it might harm it by exposing it to more predators.

Ultimately, the researchers warn, it may be impossible to carry out field experiments on some plants without inadvertently affecting the results.

—A.T.

Some cataclysmic event had destroyed almost every living thing on the planet.

Mother of Mass Extinctions

About 251 million years ago, something happened that wiped out 90 per cent of all marine animals and plants, 70 per cent of land vertebrates and paved the way for the dinosaurs. In less than a million years—the twinkling of a geological eye—some cataclysmic event had destroyed almost every living thing on the planet, marking the end of the Permian Period and the beginning of the Triassic. Researchers now have evidence that the culprit was an asteroid, similar to the one that wiped out the dinosaurs 65 million years ago at the end of the Cretaceous.

At three Permian–Triassic (P–T) sites in Japan, China and Hungary, Luann Becker (University of Washington) and colleagues found buckyballs—tiny spheres of carbon molecules—also known as fullerenes. These fullerenes act like balloons, trapping within them noble (chemically inactive) gases. When analysed, the trapped gases turned out to be certain isotopes of helium and argon—very rare on Earth but quite common in meteorites. Indeed, the

JEAN MICHEL LABAT/AUSCAPE

European Eels spend 10–15 years in freshwater rivers before migrating to the Sargasso Sea for a frenetic sex session.

abundance of helium-3 in the fullerenes was 50 times higher than in the sediments immediately above and below the samples, indicating a sudden and dramatic new source for the gas.

But one more smoking gun is needed to support the asteroid claim. Shocked quartz, found in abundance in late Cretaceous sediments, is a sure indicator of rocks that have been subject to massive and sudden heat and trauma. So far, though, only relatively small amounts of shocked quartz have been found from the P–T sediments—not enough to convince the skeptics.

—A.T.

The Truth about Eel Orgies

Late each winter, adult European Eels (*Anguilla anguilla*) emerge from freshwater habitats throughout Europe and northern Africa to make a remarkable return to their birthplace, the Sargasso Sea, where they mate and die. Larval offspring then float in coastal currents for two years, change into young eels and swim up rivers where they spend 10–15 years before migrating back to the salty Sargasso. There the life cycle is completed by what's long been considered an event of random and indiscriminate sexual frenzy known as 'panmixia'.

Past genetic studies have supported the panmixia theory, indicating all European Eels belong to one large population regardless of the location of their freshwater home. Now, however, researchers have analysed the genetic makeup of European Eels using DNA technology more sensitive than anything before, and found the panmixia idea doesn't hold water.

Thierry Wirth and Louis Bernatchez from Canada's Université Laval studied seven repetitive genetic sequences known as 'microsatellites' from the DNA of 611 different eels migrating from 13 locations within catchments feeding the North Atlantic Ocean, and Baltic and Mediterranean Seas. They identified genetic patterns that revealed eels from different locations were slightly yet significantly different. Moreover, the differences increased the more geographically distant the populations were from each other.

This means the Sargasso sex frenzy probably isn't as random as previously thought. Instead, the genetic data suggest eels from each location mate mainly with individuals from their own freshwater homes.

Timing, say the researchers, could be the key. Each migrating group may arrive at the spawning ground at a different time so that eels from one location have a better chance of mating with their own than with individuals from another location. The findings also imply that, somehow, each young eel must return to the specific freshwater home of its parents.

—K.McG.

Happiest Birthdays

Apart from affording idle pleasure to those who like to read their daily horoscopes, does it really matter which month you were born in? Yes, according to a recent study: whether you live in the northern or southern hemisphere, or even if you emigrate to the other side of the world, if you were born in autumn, then you can expect to live longer after 50 than your spring-born friends.

Gabriele Doblhammer and James Vaupel from the Max Planck Institute for Demographic Research in Germany compared the life spans of people born in Austria and Denmark with those of people born in Australia as well as British immigrants to Australia.

The study, which examined the birth and death records of over a million people who died between 1968 and 1996, found that life-span patterns of British immigrants to Australia are very similar to those born in Austria and Denmark: those born in the northern hemisphere between October and December generally outlived those born between April and June. In Australia, the pattern shifts by six months, with those being born in the second quarter of the year outlasting those born in the fourth quarter by an average of 128 days.

The researchers found no support for the theories that seasonal variations, socioeconomic factors or selective survival in the first year of life affected life expectancy after 50 years. Instead, it appears to depend on conditions in the womb (or in early infancy) that may affect susceptibility to diseases, such as heart disease and stroke, in later life. Doblhammer and Vaupel, however, say that you don't need to start putting your affairs in order if you were born in spring. This is because medical advances and year-round availability of good food have closed the gap for those born after the beginning of the 20th century, and the differences between life expectancy by birth season have decreased significantly.

—R.S.

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QUICK QUIZ

1. *What type of birds are referred to as 'muttonbirds'?*
2. *Name the island that is the Tammar Wallaby's major stronghold.*
3. *What does an anemometer measure?*
4. *What do Giant Pandas normally eat?*
5. *Which chemical element is represented by the letter K?*
6. *What type of animal was* Wonambi*?*
7. *What is 'sugarbag'?*
8. *Name the artificial lake that was formed from the damming of the Molonglo River in 1964.*
9. *What type of rock do you associate with a 'karst' landscape?*
10. *What, exactly, are nits?*

(Answers on page 83)

Fowl play

The Barn Owl is one of the finest examples of a precision nocturnal hunting machine on wings.

DAVE WATTS/NATURE FOCUS

A Barn Owl's huge, heart-shaped facial mask directs the faintest sound in and back to its large ears, hidden among feathers behind its eyes.

EVERYONE KNOWS THAT COOKED chickens haven't always come in red-and-white cardboard boxes. But a few generations ago, the chook was so highly esteemed that the only appearance it ever made on the dinner table was at Christmas time, to be flanked by cashew nuts and musky raisins that tasted like mouthfuls of sweetened aquarium gravel. For that one day of the year, the sizzling fowl and its bellyful of indigestible stuffing stole the yuletide show.

This meant that the day before the feast, young ankle-biters got to play with the chook's severed legs, which even in those days were considered too uncouth to be cooked up on the bird.

Chook feet were a lot of fun if left hiding inside someone's slippers or in the cornflakes packet. But for as long as they stayed fresh you could pull on the dangling white tendons that hung out over the 'knee', and have those four toes flicking and flexing with the digital commitment of a 12-year-old pianist hooked on *Für Elise*. In time the feet would seize up, but they could then be passed down the line for the Dog to chew up and recycle.

I've never forgotten the shock when I tried repeating the trick with a Barn Owl leg. This was found dangling from the first owl I'd ever handled, a hopelessly flattened creature killed by a car on the main road through Tenterfield. On seeing the exposed tendons I couldn't resist giving the cords a sharp tug to see if the feet moved like a Christmas chook's. The effect was as breathtaking as it was instantaneous. Its four limp toes suddenly jerked with life and purpose, and they sprung into action as if onto their last escaping rodent. The quartet of gaff hooks swung in from all directions, converging in such a piercing clutch that my heart (and other bits) bled for all the hapless rats doomed to end life in such a pickle.

Here were bionic grappling irons programmed for the snatch and grab. No expense had been spared in their design, even down to the warm feathery leggings and the bristly spines that protected the toes against bites from enraged, snared rats.

The Barn Owl (*Tyto alba*), found throughout Australia (and in most other countries of the world), is one of the finest examples of a precision nocturnal hunting machine on wings. But its semi-human facial features have both endeared and endangered it through the centuries. The Greeks and Romans looked on the owl as the essence of profundity and it was sacred to Minerva, the goddess of wisdom, the arts and war. Eminent 19th-century

BY STEVE VAN DYCK

entomologist Walter Froggatt, however, painted a more discomforting picture of it where, among country folk in England, the Barn Owl was looked upon as an evil creature that peered through the window of sick-rooms, and its sudden call at the dead of night warned one of coming death. "In some places they also believe that if one discovers a resting owl, he can, by walking slowly round it, cause it to twist its head off, as it keeps turning its head to watch the intruder."

While the twist never really comes to a big final crunch, the owl does have an uncanny ability to rotate its head. Some can manage a turn of up to 270 degrees. One reason for this lies in the physiology of the owl's eyes which, although relatively large and equipped with big conical retinas and lens-like corneas, are practically immobile in their sockets. So the owl must turn its head when following an object visually.

HERE WERE BIONIC

grappling irons programmed for the snatch and grab.

Contrary to popular belief, the Barn Owl cannot see in total, pitch-black darkness. So to save itself from starvation when the moon is new, it plays the hunting game by ear. Its huge, heart-shaped facial mask directs the faintest sound in and back to its large ears, hidden among feathers behind its eyes. The openings of the sensitive ears are arranged in a cock-eyed fashion on the bird's head so that the precise location of an incoming sound can be determined by the process of triangulation, the same process used by Dogs when cocking their heads to determine the origin of a sound. So in complete darkness a Barn Owl is capable of locating, striking and catching a mouse using only its remarkable sense of hearing.

As if these features alone didn't qualify the Barn Owl as the original mean-machine, its feathers have downy edges to eliminate all the whirring, telltale sounds usually associated with flight in other birds, and the owl's body weight is so low compared to its wing area that it can cruise with the minimum of effort and the minimum of flapping. In a Barn Owl, looks are deceiving. Only after handling one can you believe that this bird really is nothing much more than just skinny legs, head and wings all generously covered in a fluff-ball of stealth-bomber padding. Remove the wrapping and what's left looks more like a giant frog.

The efficiency of Barn Owls in keeping rats and mice in check has long encouraged European builders to incorporate owl roosts into the tops of barns and roofs. Here in Australia, Barn Owls must remain content with dead tree hollows to shelter and nest in. Unfortunately, however, traditional 'tidy' agricultural practice has tended to discourage them from the very rodent-infested places where they are needed most. In sugarcane-growing Ingham, northern Queensland, a recent attempt has been made to counter this tradition, with farmers installing owl roosts and nest boxes throughout their cane fields. Perhaps the idea should be trialled further afield than just on farms.

In the meantime, consider sparing that big dead gum tree in the backyard; it may be sheltering Nature's most calculating, self-setting rat-trap.

Barn Owl

Tyto alba

Classification
Family Tytonidae (barn or masked owls), 10–17 species distributed worldwide (5 species in Aust.).

Identification
Magpie size. Classic owl appearance, with 'monkey' face, slender body and long thin legs. Face and legs white, belly and under wings white flecked with dark brown. Back, rich tapestry of light grey and orange flecked with dark brown and white. Strongly hooked white beak. Length 32 cm. When flying, appears ghostly white. Call, a screech "scee-air", does not 'hoot'.

Distribution and Habitat
Cosmopolitan except for Antarctica. Open woodlands, deserts, farmlands, swamps and heaths, throughout Australia.

Food
Mostly small mammals but will also eat frogs, reptiles, small birds and insects. Average 3 prey items per 24-hr period. Abundance may fluctuate wildly with prey availability (e.g. during mouse/rat plagues).

Reproduction
Breeds any time of year. Home range up to 500 ha, but reduces with increased food availability. Lays 3–6 dull, white, oval eggs (4 cm long) inside tree hollows, but also in well shafts, caves, buildings, burrows and crevices under rocks. No nest built. Incubation 30 days (by female only). Male feeds female during incubation and brooding. Young leave nest at about 50 days old. In good times pairs may raise 3 broods in 18 months. Young sexually mature at 10 months.

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DR STEVE VAN DYCK IS A SENIOR CURATOR OF VERTEBRATES AT THE QUEENSLAND MUSEUM WHERE HE HAS WORKED SINCE 1975.

Lord Howe Island Giant Stick Insect

The Lord Howe Island phasmid had not been seen alive for about 80 years, and the species was presumed extinct.

ISOLATED IN THE SOUTH PACIFIC, 780 kilometres north-east of Sydney, lies the tropical paradise of Lord Howe Island. Until its discovery in 1788, this remote, coral-ringed, volcanic outcrop had been quietly eroding undisturbed for 6.5 million years—long enough for this speck of land to develop a suite of unique plants and animals.

One such species is the Lord Howe Island Giant Stick Insect or Phasmid (*Dryococelus australis*). Known locally as the Land Lobster and with a body over 12 centimetres long and 1.5 centimetres wide, the phasmid is one of the heavyweights of the arthropod world. These giant flightless insects once dominated the nocturnal forests of Lord Howe Island. Resting during the day in hollow logs and tree cavities, they emerged after dark to feed amongst the forest canopy. The locals found their constant rustling on the tin roofs a perpetual source of annoyance at night and, at a time when women regularly wore long dresses, a visit to the 'outhouse' around dusk meant brushing away these giant insects, which instinctively climbed anything in their path.

PHOTOS: NICHOLAS CARLILE

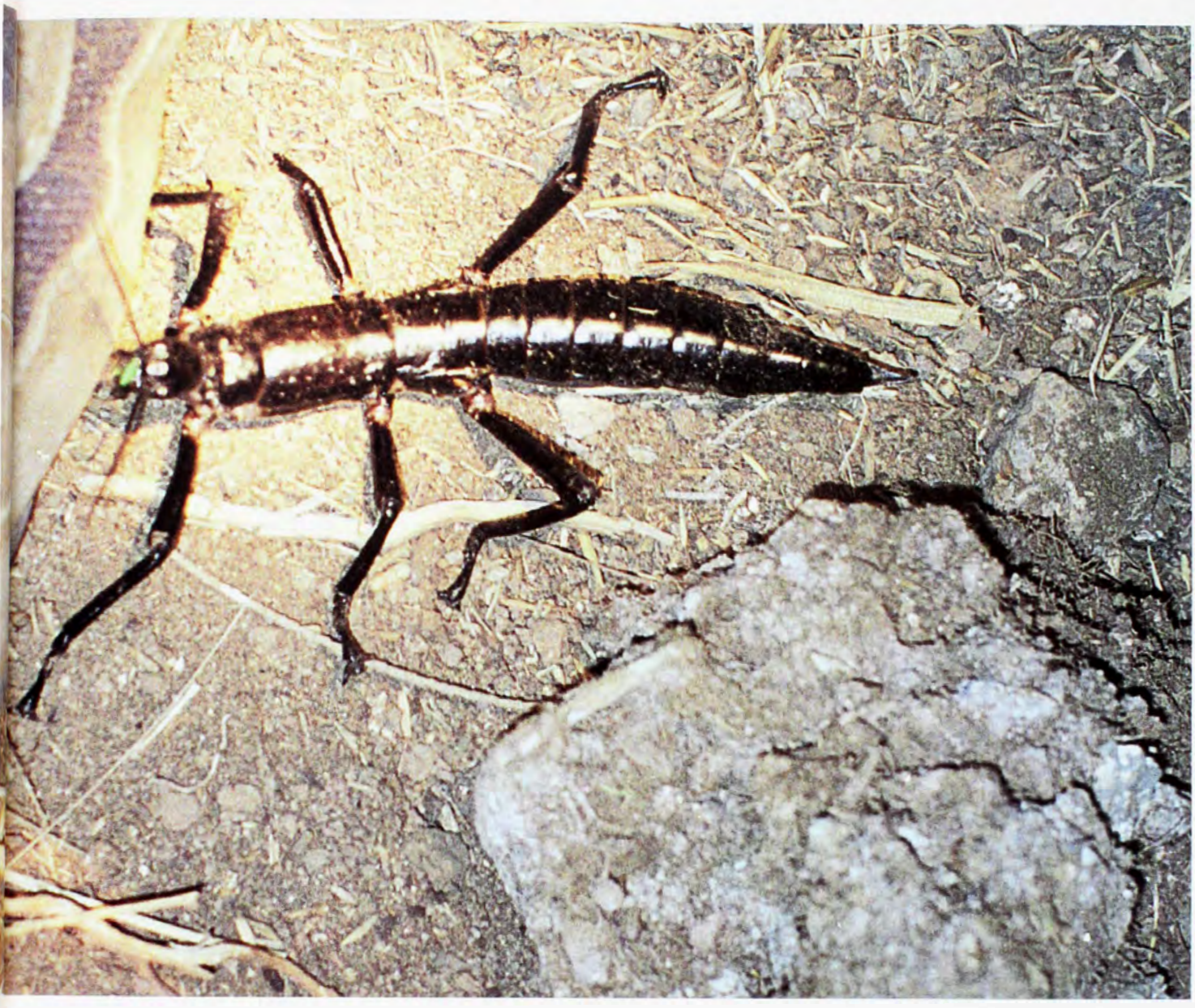
Once common and widespread across the island, the phasmid disappeared soon after Black Rats (*Rattus rattus*) found their way ashore from a grounded ship in 1918. The Lord Howe Island phasmid had not been seen alive for about 80 years, and the species was presumed extinct.

Twenty-three kilometres to the south-east of Lord Howe Island is a second volcanic plug, doing somewhat less well in the erosion stakes. Balls Pyramid is only 1,100 metres long, but rises abruptly to a four-metre-wide summit, 551 metres above the ocean. This spectacular sea stack, the tallest in the world, is home to innumerable breeding seabirds. In the 1960s, rock-climbers found some remains of the 'extinct' phasmid high up on Balls Pyramid. Precisely how a few specimens came to be here—a rock spire void of forest—had, until recently, never been resolved. Many scientists and climbers had tried to find live specimens on the Pyramid but none was successful. The phasmid remained a tantalising enigma for the best part of half a century.

Intent on solving this mystery, we pulled together a team of five skilled professionals to make an assault on the Pyramid. Besides us, the team included an entomologist, a phasmid expert and a local island ranger.

Part of the challenge in searching for the phasmid on Balls Pyramid was the obvious logistical difficulties. Sea conditions surrounding the Pyramid can change rapidly and without warning. With landings involving jumping from a boat onto a steep rock shelf, anything but calm seas invites mishap.

BY DAVID PRIDDEL & NICHOLAS CARLILE



These difficulties aside, we managed to get ashore and within two days of intensive searching had located a small colony of the phasmids (comprising just three individuals) living on a single *Melaleuca* shrub. Water seeping from nearby rocks had enabled other vegetation to build up around the shrub, providing the phasmids with moist refuges in which to survive the scorching daytime temperatures.

All individuals seen during the survey (and all dead specimens collected in the 1960s) were female. Remarkably, like a number of other arthropods, phasmids can reproduce without males. This process, known as parthenogenesis, results in the unfertilised eggs all hatching as females—clones of the parent. The introduction of a male will see both male and females hatch from the fertilised eggs, but there is a distinct possibility that we may now be dealing with an all-female species.

A VISIT TO *the 'outhouse' around dusk meant brushing away these giant insects.*

With just a handful of individuals alive, the Lord Howe Island phasmid is probably the rarest insect on Earth. The good news is that a plan for its recovery is taking shape. Two individuals will be removed from the Pyramid to become the founders of two separate captive colonies. Animals from these colonies may one day be reintroduced back onto Lord Howe Island, but only after the rats have been removed. Perhaps then these majestic giant insects can regain their place as nocturnal heavyweights in the tropical forests of this remote island paradise.

DR DAVID PRIDDEL AND NICHOLAS CARLILE HAVE COLLABORATED ON PROJECTS DEALING WITH ISLAND ECOLOGY AND SEABIRD RESEARCH WHILE WORKING FOR THE NEW SOUTH WALES NATIONAL PARKS AND WILDLIFE SERVICE.

The art of naming

I can't imagine anyone ever spying a lizard and crying out "Look! A Greater Robust Fine-lined Slider!"

PHOTO: TIM LOW

Peters' Frog is also known as the 'Bumpy Rocketfrog', a much more evocative name. Peters was the scientist who named this northern species in 1867.

BY TIM LOW

NAMES MATTER. THEY SHAPE our conceptions of the plants and animals around us. 'Ivory Silky Oak' suggests something very different from 'Monkey Nut', although both are the same plant (*Hicksbeachia pinnatifolia*). 'Willie Wagtail' (*Rhipidura leucophrys*) is much friendlier than 'Black-and-white Fantail'—an old name for the same bird.

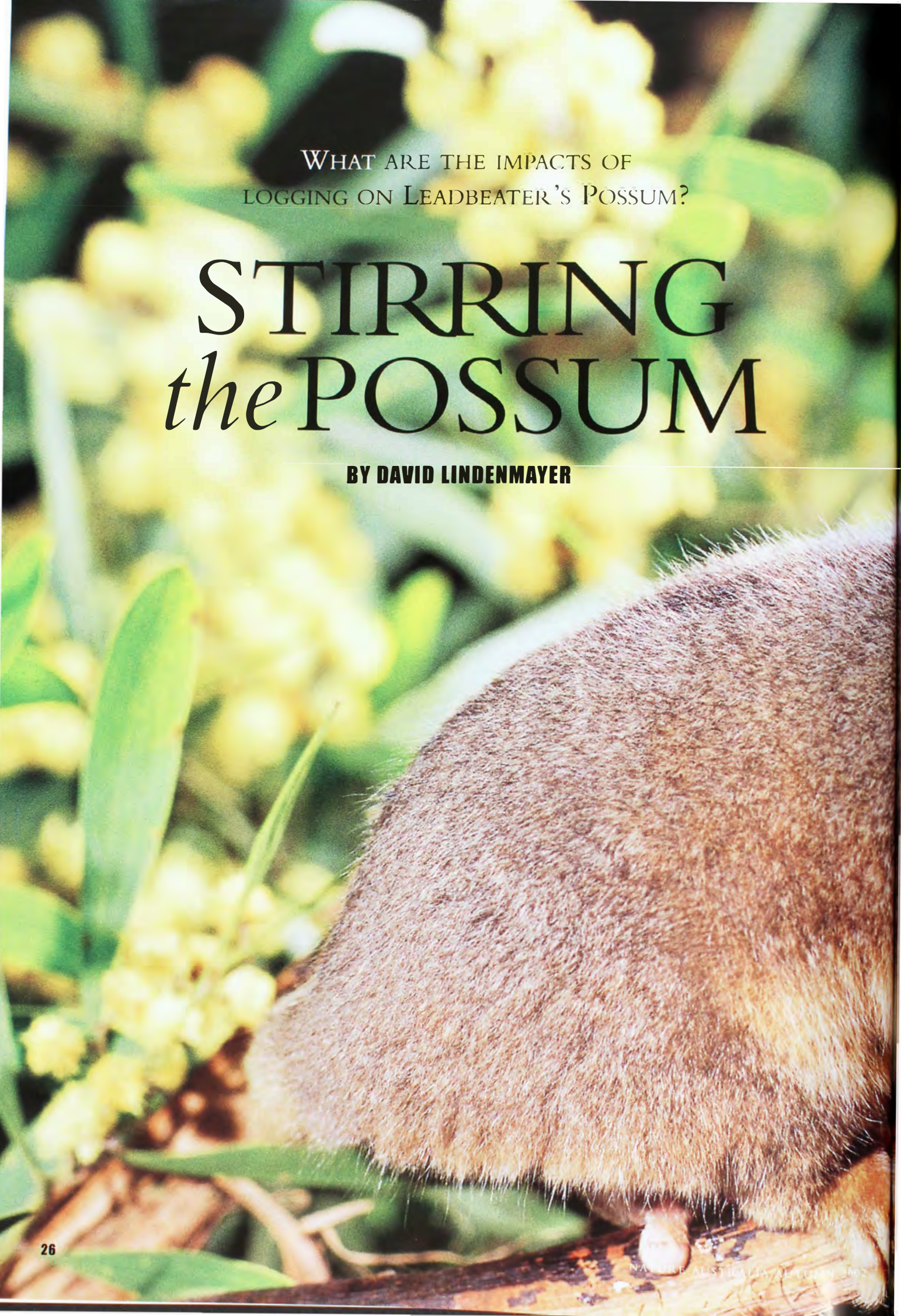
Scientific names are the *lingua franca* of biology, but common names are important too—as the language of most Australians. Biologists acknowledge their worth. But some animals and plants have been lumbered with such appalling common names that serious efforts are sometimes made to replace them.

'False Water-rat' makes no sense at all. It's the unfortunate name for a rare and interesting animal (*Xeromys myoides*). Some years ago Steve Van Dyck from the Queensland Museum proposed 'Mangrove Mouse' as a substitute, but he's withdrawn this idea, partly because *Xeromys* doesn't always use mangroves, but also because the bad name musters sympathy. As Steve said: "The False Water-rat has had as much attention for having a bad common name as anything else. It's a talking point."

The Common Noddy (*Anous stolidus*) also gets by with a poor name. 'Noddy' means 'simpleton', but fortunately the word is archaic and most people don't think of stupidity when they see these birds. Ornithology, by the way, is the one discipline where English names often prevail. The common names recommended by Birds Australia (formerly the Royal Australasian Ornithologists Union) have wide currency in scientific publications. Most ornithologists think in English when they see their subjects of study, unlike botanists and entomologists.

Among plants, 'New Zealand Spinach' (*Tetragonia tetragonoides*) has posed problems for the emerging bush-tucker industry. The plant is native to Australia as well as New Zealand but, because it was discovered by Joseph Banks on the wrong side of the Tasman, it obtained a name that is unusable on Australian bush-tucker menus. An old name, 'Warrigal Greens', has been resurrected. Another plant name that has lost favour, for obvious reasons, is 'blackboy'. These plants (*Xanthorrhoea* species) are now called 'grasstrees'.

Naturalists sometimes grumble about common names bearing the names of people. While I'm sure no-one begrudges John Gould for naming a beautiful finch after his wife (the Gouldian Finch, *Erythrura gouldiae*), there do seem to be too many common names celebrating forgotten scientists. 'Peters' Frog' (*Litoria inermis*) and 'Lesueur's Frog' (*Litoria lesueuri*) come to mind. These names convey no information about the frogs. In Queensland they were done away with some years ago when three biologists, Glen Ingram, Rick Nattrass and Greg Czechura, compiled a suggested list of Queensland frog names. Their alternatives, 'Bumpy Rocketfrog' and 'Stony-creek Frog', are



What are the impacts of logging on Leadbeater's Possum?

STIRRING *the* POSSUM

BY DAVID LINDENMAYER

The claws and foot pads of Leadbeater's Possum help the animals as they move acrobatically through the forest, sometimes leaping distances of up to one metre.

ESTHER BEATON

LEADBEATER'S POSSUM IS A small but feisty animal. Weighing just a quarter of a standard tub of margarine, it nonetheless packs a powerful political punch. And this is because its home in the Central Highlands of Victoria is in the heart of logging country. My colleagues and I have been studying the endangered Leadbeater's Possum and the majestic Mountain Ash forests it inhabits for almost 20 years. We have revealed many fascinating insights into the biology and ecology of the species. But most importantly, we've shown that the survival of Leadbeater's Possum hinges on our ability to develop ecologically sustainable logging practices.

THE HISTORY OF LEADBEATER'S Possum (*Gymnobelideus leadbeateri*) has been a checkered one since European settlement. The species was first described from a handful of specimens collected in 1867 from dense tea-tree thickets around the Bass River east of Melbourne. By the early 1900s, given that no additional animals were seen and that the area had been extensively cleared, Leadbeater's Possum was thought to be extinct. The 'extinct' status remained until 1961 when Leadbeater's Possum was 'rediscovered' near Marysville in the Central Highlands of Victoria. It was found in Alpine Ash (*Eucalyptus delegatensis*) and Mountain Ash (*E. regnans*) forests, in an area well to the north of former records and in an environment that contrasted markedly with the one where it had first been described.

Most of the 400-plus records of Leadbeater's Possum since its rediscovery 40 years ago have come from stands of Mountain Ash, Alpine Ash and Shining Gum (*E. nitens*) in the Central Highlands region. These are some of the most spectacular forests in the world. Mature Mountain Ash trees can exceed 100 metres in height and three metres in diameter, making them the tallest flowering plants on the planet. They are slightly shorter than coniferous California Redwoods (*Sequoiadendron giganteum*), but grow up to four times more quickly and reach their top height within 300 years. Young Mountain Ash trees can grow more than a metre in a year. It is

This magnificent stand of 90-metre-tall old-growth Mountain Ash forest is ideal habitat for Leadbeater's Possum. It contains a number of large trees with hollows and a healthy wattle understorey for foraging.

ESTHER BEATON

ESTHER BEATON

Like many sap-feeding arboreal marsupials, Leadbeater's Possum has a distinctive stripe of black fur on the back and head. Resembling flowing sap from a tree, it may serve to camouflage animals when they are feeding.

perhaps ironic that, while most Melbournians know who plays full-forward for Essendon or Carlton in the Australian Football League, many remain unaware that some of the nation's most beautiful forests are less than two hours' drive from the MCG!

The distribution of Leadbeater's Possum is highly limited. The entire range is confined to an area of just 60 x 80 square kilometres of the Central Highlands, making it the only species of mammal restricted to the State of Victoria. Not surprisingly then, Leadbeater's Possum is one of the State's faunal emblems (the other, the Helmeted Honeyeater *Lichenostomus melanops cassidix*, is also endangered).

Large tracts of forest within the Central Highlands of Victoria are dominated by tree species other than Mountain Ash, Alpine Ash or Shining Gum and most such forests are unsuitable for Leadbeater's Possum. Populations of Leadbeater's Possums have been found in subalpine forests and woodlands of Snow Gum (*Eucalyptus pauciflora*) and in an isolated stand of swamp forest dominated by Mountain Swamp Gum (*E. camphora*), but there have been few records from other forest types. Even within the ash forests, only certain stands of trees seem to be favoured. Detailed field surveys we have conducted since 1983 have shown that Leadbeater's Possum is most likely to be found in patches of ash forest supporting numerous large eucalypt trees with hollows and a dense understorey of Silver Wattle (*Acacia dealbata*), Mountain Hickory Wattle (*A. obliquinervia*) or Forest Wattle (*A. frigescens*). Prior to European settlement these sorts of stands would have occurred more extensively throughout the landscape, particularly as fire refugia on south-facing slopes and deep protected valleys where wildfires would have burnt less intensively than in the rest of the landscape.

The dense wattle understorey is an important food source for Leadbeater's Possum. Animals eat the sap that exudes from small cuts they make by gnawing on the trunks of the trees. Wattle sap flows from these wounds but it is quickly exhausted by hungry

ESTHER BEATON

Climbing ladders is a necessary part of the nest-box study for Leadbeater's Possum and other hollow-using species. The study, which has been underway for over three years, has had depressing results, with just a handful of the boxes being occupied.

ESTHER BEATON

Capturing Leadbeater's possum is far from easy. Here Ross Meggs is checking a trap set over ten metres above the ground.

possums, so animals chew the bark on several different trees within their one-to-three-hectare territories to maintain a number of sap sites. Other species of arboreal marsupials eat sap produced by wattles or eucalypts in ash forests. These include the Sugar Glider (*Petaurus breviceps*) and the Yellow-bellied Glider (*Petaurus australis*). Like all these sap-feeding species, Leadbeater's Possum has a distinct stripe of black fur on its back. It is thought that this fur-colouring resembles a strip of sap on a tree trunk and helps camouflage animals while they are feeding, thereby reducing the chances of being taken by an owl.

Trees with hollows are the other key part of the habitat requirements of Leadbeater's Possum. Colonies of up to 12 animals spend as much as 75 per cent of their time living in tree

cavities, which they line with finely shredded and woven strips of bark. Here they sleep, huddle (to keep warm and reduce energy expenditure), rest (between bouts of feeding in the surrounding forest) and groom (to rid themselves of ticks, fleas and mites). The nest sites used by colonies of Leadbeater's Possum can sometimes be recognised by the marks that animals leave on the outside of a tree. The trees they nest in often have very smooth trunks and, in order to get a proper purchase on them, allowing them easy access to their nests, Leadbeater's Possums use their sharp teeth to gnaw at narrow cracks or fissures in the trunk. They then line their nests with finely shredded and woven strips of bark.

Not all hollow trees are suitable nest sites for Leadbeater's Possum. The species chooses only very large-diameter trees that are often in an advanced stage of decay. These trees can be 200–400 years old. We don't know why Leadbeater's Possum selects these types of nest trees. Perhaps the mass of decaying wood inside generates heat (much like a suburban compost heap) and helps the animals survive the cold, wet winters characteristic of the Victorian ash forests.

THEY LINE THEIR NESTS *with finely shredded and woven strips of bark.*

Because hollow trees are such an important part of the lives of Leadbeater's Possums, we wanted to learn more about how they use them. With the help of a nine-metre ladder and climbing equipment, we placed traps high above the forest floor. We then fitted the captured animals with tiny radio-collars and tracked them over several months to their daytime nest sites in huge Mountain Ash trees. The results were a real surprise. Colonies of Leadbeater's Possum do not maintain just one nest site in a single hollow tree. Rather, six or more trees may be occupied, with animals swapping regularly between different nest sites on successive days. The reasons for such 'den-swapping' behaviour are not known, but perhaps it prevents predators such as owls learning the location of active nest sites. It also might help reduce burdens of parasites in the fur, although these are more likely to be transported to many nest trees as a result of den-swapping behaviour. Alternatively, different trees may have different thermal properties or ecological roles. For example, because of the rotting compost within some trees, they may be particularly favoured at certain times of

ESTHER BEATON

Leadbeater's Possum is a feisty animal to handle. This individual is about to be sedated so that a radio-collar can be fitted.

PHOTOS ESTHER BEATON

Understanding how animals use nesting sites in large trees is critical. Here radio-collared Leadbeater's Possums are being tracked to their daytime nest trees.

the year such as during periods of heavy snow. Den-swapping is not limited to Leadbeater's Possum and appears to be common in most, if not all, species of Australian arboreal marsupials. Individuals of another species that shares forest habitats with Leadbeater's Possum, the much larger (four-kilogram) Mountain Brushtail Possum (*Trichosurus caninus*), use more than 25 different nest trees.

Standard forms of field survey such as spotlighting are ineffective for Leadbeater's Possum because Mountain Ash forest is so tall and the understorey extremely dense. To count individual possums, we therefore had to use a specialised field-survey method called 'stagwatching', in which observers sit quietly under all the large hollow trees for 30 minutes before dusk until 60 minutes after. (The term 'stagwatching' seems to derive from the dead, white Mountain Ash trees that tower above the canopy of shorter, living stems—reminiscent of the antlers of a male deer.) The possums' den-swapping behaviour makes it essential to simultaneously stagwatch all the trees in a one- to three-hectare site. Many people are required for this, and in one night of field counting we had 54 volunteers helping us. Since surveying began in 1983, nearly 4,000 volunteers have assisted us in our project. We count not only Leadbeater's Possums but also other arboreal marsupials, small mammals and forest birds. This is part of a long-term study on population trends in gliders and possums and their response to disturbances such as logging and wildfires. Our work constitutes one of the longest-running forest research studies in Australia.

BOTH THE WAY

the forest is cut and the current rate of harvesting have major negative impacts on Leadbeater's Possum.

VICTORIAN ASH FORESTS ARE NOT only important for Leadbeater's Possum and other animals, but they are also the basis for major forest industries. More than 80 per cent of ash trees logged in the region are used for paper manufacturing. What are the impacts of logging on Leadbeater's Possum?

Unfortunately, our detailed studies have shown that both the way the forest is cut and the current rate of harvesting have major negative impacts on populations of Leadbeater's Possum—and probably also the other 40 species of vertebrates that depend on

A heart-shaped face, lack of gliding membranes, and club-shaped tail help distinguish Leadbeater's Possum from the closely related Sugar Glider.

ESTHER BEATON

Leadbeater's Possum is one of the most active species of arboreal marsupials. This is a rare still moment for the animal, before it dashes off into the dense Mountain Ash forest.

Leadbeater's Possum

Gymnobelideus leadbeateri

Classification
Family Petauridae (petaurid possums and gliders).

Identification
Head–body length approx. 15–17 cm, weight 120–160 g. Club-shaped tail same length as body. Pelt grey to grey-brown with pronounced black dorsal stripe. Capable of making highly athletic leaps of up to 1 m.

Distribution and Habitat
Population centred in the montane ash forests of the Central Highlands, Vic., with some extra-limital populations in Snow Gum (*Eucalyptus pauciflora*) forest and lowland swamp forest at Yellingbo Nature Conservation Reserve south of Healesville. Areas most likely to support Leadbeater's Possum characterised by numerous hollow-bearing trees and high-density wattle understorey.

Diet
Sap from wattle trees, insects (especially large flightless tree crickets), spiders, honeydew (a sugar-rich solution produced by sap-sucking insects).

Reproduction
Breeds year round, with peaks in autumn and spring. Max. litter size 2, with females typically producing about 3 young in good (wet) years.

Status
Endangered. Threatened by effects of forestry operations and wildfires.

hollows in these forests. Ash forests are logged using the clear-felling method. This involves removing all the living trees on a 40–120-hectare site. Debris left after harvesting, such as lateral branches, the crowns of trees and discarded bark, is then burned in a high-intensity fire. This creates a bed of ash, which promotes the regeneration and growth of a new stand of trees. The planned interval or rotation time between successive clear-felling operations on a given logged site is 50–80 years.

Although clear-felling is a highly efficient and successful way to harvest and regrow Mountain Ash and Alpine Ash forest, it creates an array of problems for animals like Leadbeater's Possum. Most importantly it precludes the development on those coupes of 200–400-year-old, hollow-bearing trees, which are essential for the survival of Leadbeater's Possum. Logging

Clear-felling operations in Mountain Ash forests can have major negative impacts on the habitat of a wide range of hollow-using species, including Leadbeater's Possum.

also tends to be focused on the flatter, more productive parts of the landscape—areas that also provide optimum habitat for Leadbeater's Possum.

On a more positive note, a large reserve—the Yarra Ranges National Park—has been set aside in the middle of the Central Highlands of Victoria and it supports some significant areas of habitat for Leadbeater's Possum. However, populations in the reserve are vulnerable to the effects of wildfires. Therefore, conservation efforts are also needed in the 80 per cent of the species' distribution that occurs in the surrounding forests used to produce paper and timber. There, prescriptions have been introduced to reserve optimal current and long-term habitat for Leadbeater's Possum, and to prevent the felling of trees greater than 100 years old within the possum's range. Half of these forests have been excluded from timber harvesting. Our research in the past ten years has demonstrated that logging and Leadbeater's Possum *could* be compatible—but *only* if harvesting is conducted in a much more ecologically sensitive way.

Despite numerous government inquiries into the Victorian timber industry and trials of alternative logging methods, 95 per cent of Mountain Ash and Alpine Ash that are logged are clear-felled. However, the ecological bottom line is clear. For the long-term persistence of Leadbeater's Possum, clear-felling operations must be replaced with more sophisticated cutting methods—methods that ensure a substantial number of large trees with hollows are retained on logged sites and survive through many harvesting rotations. For this, patches of living trees and their associated understorey must be carefully protected from cutting (and the subsequent high-intensity burn) within at least 30–50 per cent of all logging coupes. In addition, the rate of cutting in Mountain Ash forests needs to be slowed by as much as 25 per cent. Without such changes I believe it will not be possible to make a transition to ecologically sustainable forestry in Victoria. This transition needs to be made soon or there is a real risk that wild populations of the State's 'formerly extinct' faunal emblem will be lost permanently and with them a fascinating and important part of Australia's natural heritage.

FURTHER READING

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DAVID LINDENMAYER IS A SENIOR RESEARCH FELLOW AT THE CENTRE FOR RESOURCE AND ENVIRONMENTAL STUDIES, AND AN ASSOCIATE PROFESSOR AT THE DEPARTMENT OF GEOGRAPHY, AT THE AUSTRALIAN NATIONAL UNIVERSITY IN CANBERRA. HE HAS WORKED IN THE VICTORIAN MOUNTAIN ASH FORESTS FOR ALMOST TWO DECADES, WITH COLLEAGUES FROM UNIVERSITIES AND THE VICTORIAN GOVERNMENT. DAVID RUNS TEN-DAY FIELD RESEARCH CAMPS IN THE CENTRAL HIGHLANDS OF VICTORIA STUDYING LEADBEATER'S POSSUM AND OTHER NATIVE MAMMALS AS WELL AS FOREST BIRDS. VOLUNTEERS INTERESTED IN JOINING THESE CAMPS SHOULD CALL THE EARTHWATCH INSTITUTE IN MELBOURNE ON (03) 9682 6828.

D. PATON/PWF

SINGING GIANTS CHANGE THEIR TUNE

THE SONGS OF HUMPBACK WHALES ARE POSSIBLY ONE OF THE BEST-RECOGNISED SOUNDS FROM THE MARINE WORLD.

BY MICHAEL NOAD

POINT LOOKOUT, NORTH Stradbroke Island, 3 August 1996. Hunched over two small loudspeakers, we listen intently. The speakers gently hiss and pop and suddenly we hear it again—the unmistakable eerie moans, chirps and grunts of Humpback Whale song. Somewhere, many kilometres out to sea, a Humpback is calling and we are eavesdropping, picking it up at our base station via a buoy offshore. We had heard many whales that season, but tonight this was no ordinary Humpback...he was singing the wrong song.

THIS WAS *no ordinary Humpback... he was singing the wrong song.*

The songs of Humpback Whales (*Megaptera novaeangliae*) are possibly one of the best-recognised sounds from the marine world. Their mournful quality has captured the imagination of millions of people since they were first described in the early 1970s. Despite three decades of research, however, these haunting melodies from the big blue still have many secrets.

Humpback Whales are medium-sized baleen whales. Like all baleen whales, they do not have teeth, but rather a series of ragged baleen plates that hang from the upper jaw inside the mouth and form a sieve that they use for straining small prey items out of the water. Humpbacks are migratory, spending their summers feeding in colder waters and their winters breeding and calving in warmer coastal waters. Populations inhabit every ocean of the world.

Australia has two distinct populations of Humpback Whales. Both spend the summer months feeding on krill (small shrimp-like creatures) in the Antarctic, but in autumn and winter they migrate up the east and west coasts to their breeding grounds. Off the west coast they migrate past the Exmouth Gulf with some making it as far as Broome and beyond, while on the east coast they inhabit the waters inside the Great Barrier Reef, many staying in the Whitsunday area but others making it as far as Port Douglas and even the Torres Strait.

This coastal migration, particularly along the east coast, makes Australia an excellent place for studying Humpback Whales during migration. Between Cape Byron in northern New South Wales and Cape Moreton off Brisbane, most of the whales pass within about ten kilometres of the coastal headlands. Point Lookout on North Stradbroke Island, east of Brisbane, is ideal for whale watching, and systematic surveys of the Australian east-coast population, led by Michael Bryden (University of Sydney) and Robert Paterson (Queensland Museum), have been conducted there since the early 1980s. Humpbacks were hunted, both along the east coast and in the Antarctic, to near extinction in the 1950s and early 1960s, and these surveys have been extremely important in documenting their extraordinarily rapid recovery since then.

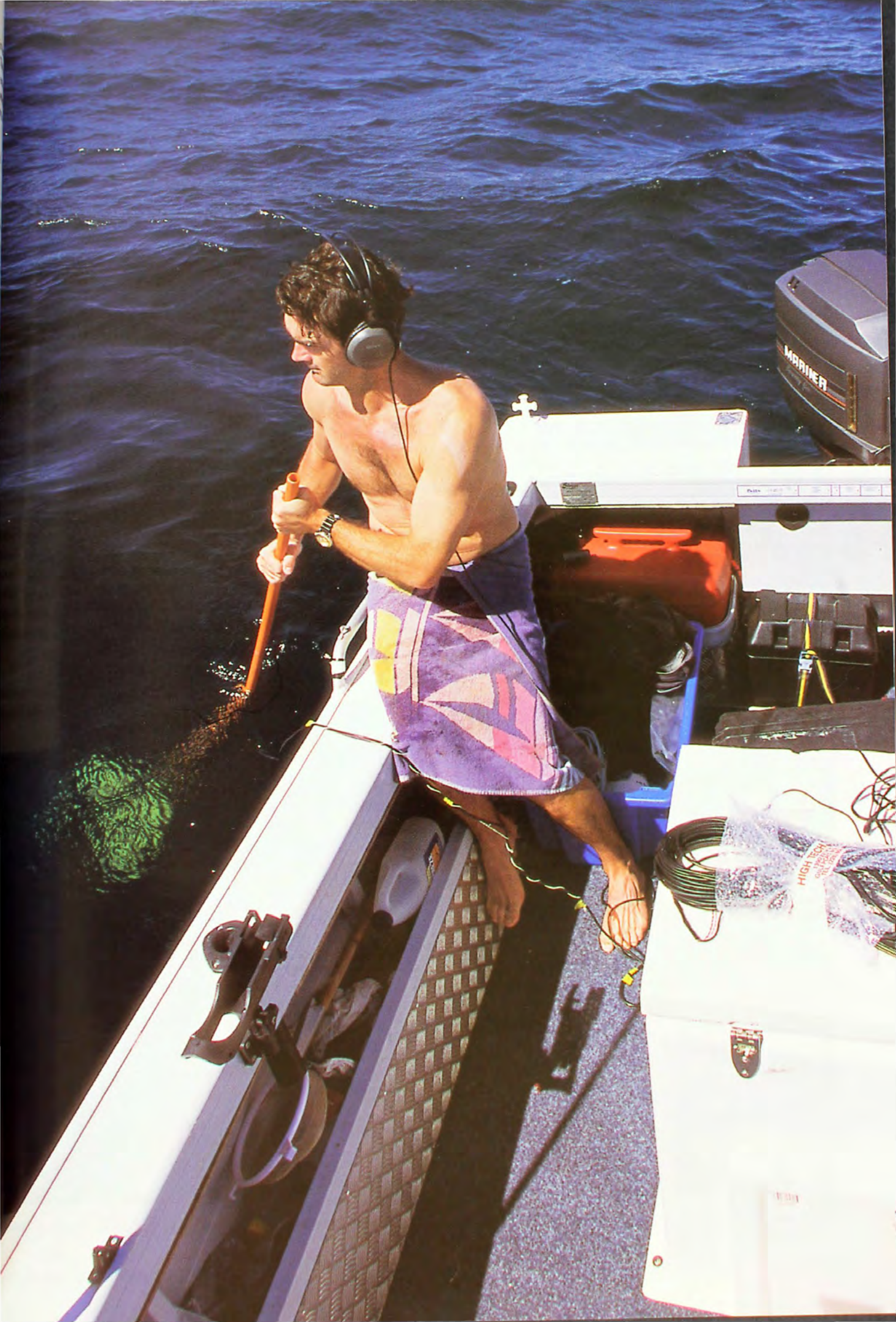
A directional hydrophone is tested for use with Humpback Whale sounds. The hydrophone is rotated under water on the end of a pole. Higher-frequency sounds, like the whistles of dolphins, are more easily located using such devices.

JAYE PAION

ALTHOUGH WE DON'T KNOW exactly when humans first heard

MIKE OSMOND AUSCAPE

A Humpback cow with her growing calf.


MARINER

Humpbacks, records exist of whalers hearing the haunting songs through the hulls of their ships as they lay at anchor on the whaling grounds. The songs were not known to science, however, until the invention of the underwater microphone or hydrophone around World War 2, the earliest recordings being from the 1950s when US naval researchers recorded strange musical sounds off Hawaii that coincided with the yearly appearance of Humpbacks. It was not until the early 1970s though that scientists realised the sounds were not a random cacophony, but were arranged in a structured and orderly way, and that the term 'song' was first used.

Since then we have learnt a great deal about Humpback song. But, in one of those wonderful paradoxes of science, it seems the more we learn, the less we seem to know and the more intriguing the questions become.

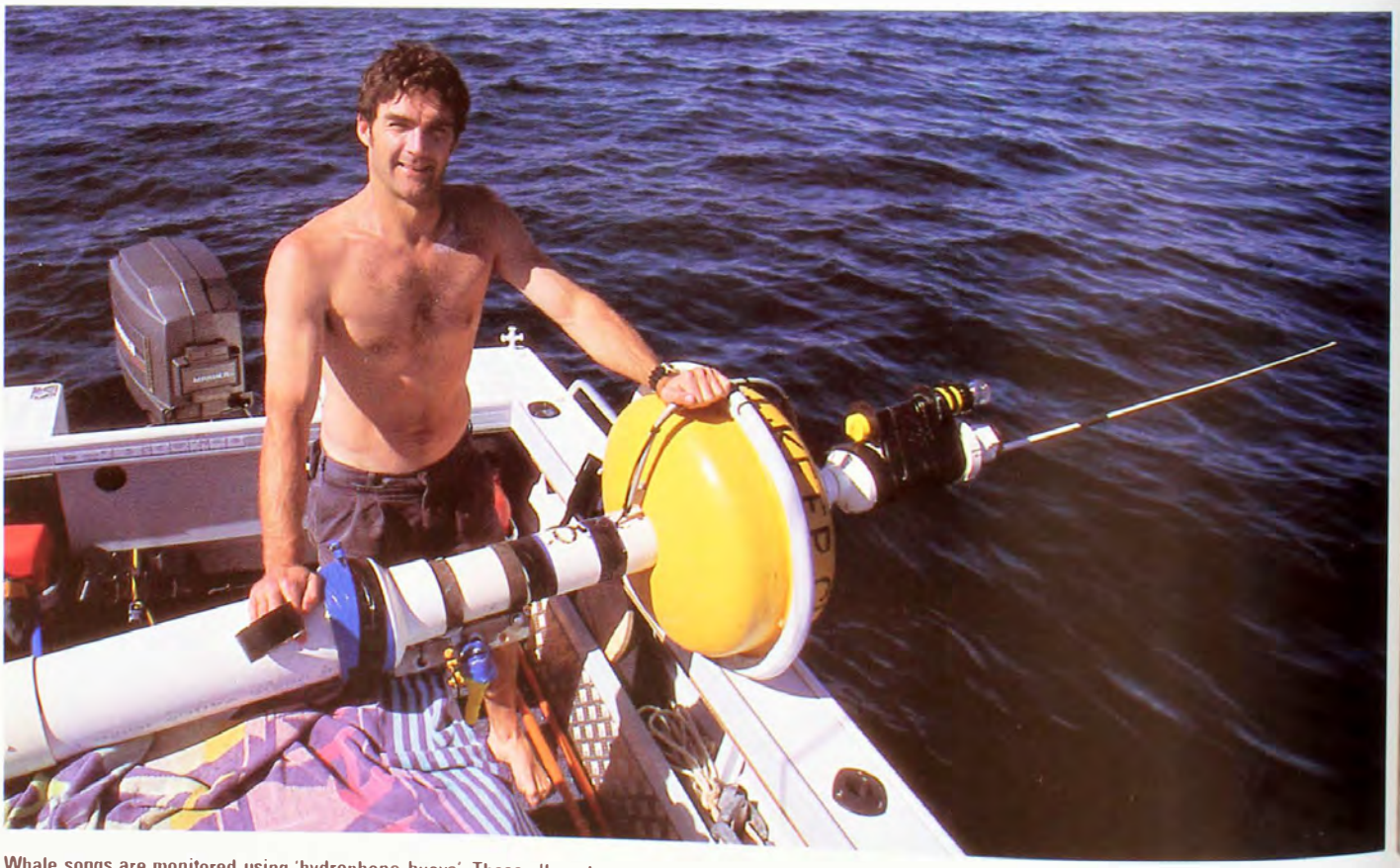
The structure of the song itself is beautifully complex. Individual sounds are arranged into 'phrases' that are repeated many times. Strings of similar phrases comprise a 'theme' and there are several themes per song (themes being analogous to verses of a human song). At the end of a cycle of themes or song, the singer surfaces to 'blow' several times then dives, starting the song again from the beginning. The length of the song varies depending on how many phrases the singer uses in each theme, but most songs last around seven to 15 minutes. A singer, once started, may repeat the same song over and over for many hours without a break.

ONLY MALES SING, *and only during the breeding time of year during migration or on the breeding grounds.*

Only males sing, and only during the breeding time of year during migration or on the breeding grounds. All the males in any given population sing essentially the same song. However, the pattern of the song gradually changes, with all the singers making the same changes so that they still match each other at any given time. Sometimes the song changes little over several years, other times it changes to the point of being unrecognisable within only two or three years. In any case, the rate of song change is far too rapid to be genetically determined and so is considered 'cultural' in the sense that whales learn the ever-changing patterns from each other rather than inherit them.

As a result of this constant song change, populations in different oceans have different and unrelated songs, although populations within the same ocean may share some song material depending on the distances separating them.

We now know a great deal about the characteristics of Humpback song and the way it changes, but fundamental questions about the function of song remain. Why do whales sing and why does song change?



DAVE PATON

Whale songs are monitored using 'hydrophone-buoys'. These allow the sounds picked up by a hydrophone to be relayed back to a shore station in real time. This buoy is having its battery changed by the author off Peregian Beach, Queensland.

EVEN THOUGH I DID NOT KNOW IT at the time, that August night in 1996 was the first of an opportune set of observations that I think helps answer these questions. Doug Cato, from the Defence Science and Technology Organisation (DSTO) in Sydney, has been recording Humpback song at Point Lookout since 1982, creating one of the longest continuous records of song and its changes in the world. Although Doug had obtained his wealth of recordings by sitting in a small open boat with a hydrophone over the side, opportunities for gathering data were restricted by weather, sea conditions and daylight. In 1996, in conjunction with the DSTO, we built buoys that were equipped with hydrophones and radio-transmitters. These could be anchored offshore in all weathers and transmit Humpback song back to a base station 24 hours a day. For the first time we were able to collect enormous amounts of song that we could use to examine song change in detail.

After recording at Point Lookout during the northward migration in 1996, I moved the project to Peregian Beach, just south of Noosa on Queensland's Sunshine Coast. After several weeks of recording normal songs from dozens of whales, another strange singer passed through the area. This time the singer was close to the buoy and the pattern was unmistakably different to the current song pattern. By the end of 1996 I had managed to record 82 singers, two of which were aberrant. At the time I didn't think much about these and just assumed they were the result of biological variability or even pathology (disease).

In 1997 we returned to Peregian Beach during the northward migration and received an enormous surprise. Suddenly about a third of the singers were singing a different song while the others continued to sing a song that was similar to that of the previous year. This was unprecedented. Humpbacks are not supposed to have more than one song in any population at any time. Then I remembered my mystery songs from the previous year and suddenly realised that not only had the two mystery singers been singing the same

Humpback Whale

Megaptera novaeangliae

Classification

Order Cetacea, suborder Mysticete, family Balaenoptera. Only 1 species in genus. Several colour morphs distributed around the world, but no subspecies recognised.

Identification

Medium-sized baleen whale, around 12–14 m in length. Long pectoral flippers up to a third of total body length. Dorsal fin small and often hooked. After blowing at surface, whales roll through water arching their back into characteristic hump, often lifting their flukes clear of water as they sound.

Distribution and Habitat

Populations in all oceans of world. Summers spent feeding in cold, high-latitude waters, and winters migrating thousands of km to tropical and subtropical breeding areas in shallow waters along continental coastlines or around island groups. Australia has 2 populations that migrate up east and west coasts to winter inside lagoon of Great Barrier Reef and off north-west coast of WA.

Breeding

Calves born during winter in warmer waters. Mating never been reliably witnessed but probably occurs in winter since gestation is approx. 11 months and courtship behaviours (including singing) also occur at this time.

Feeding

Only at higher latitudes with no feeding on breeding grounds. In southern hemisphere, majority of diet is krill (particularly *Euphausia superba*). In northern hemisphere diet consists mainly of small schooling fish such as herring and anchovies.

Status

Generally vulnerable. Massive worldwide decline due to whaling between early 1800s and 1960s. Australian populations particularly affected by shore-based whaling along both coasts in 1950s and early 1960s as well as pirate Russian whaling in the Antarctic. Worldwide protection in 1966. Over last 20 years east Aust. population rapidly increased to over 4,000 animals (with original population between 10,000 and 20,000). Most other monitored populations increasing at slower rates, although some (e.g. in NZ) show little evidence of recovery.

mystery song but also that it was the same as the new song now being used by a third of the singing population. As the season progressed and the whales began migrating southwards again, the picture became even more intriguing—the new song gained rapidly in popularity until the old song had disappeared by the end of the season. The extinction of the old song was confirmed in 1998 when we returned and heard only the new song.

This radical change from one song to another, involving the use of two songs in the population at once, raised many questions. At first I assumed that the new song had arisen spontaneously somehow within the population—that we had witnessed a particularly rapid but otherwise 'normal' song change. I decided, however, that good science was thorough science, and obtained some recordings from Kurt and Micheline-Nichole Jenner, based in Fremantle, of the west-coast population's song. I didn't expect to find anything as previous studies have shown no similarities between east- and west-coast songs—a result to be expected as the populations are separated by the Australian continent during the breeding and singing season. As soon as I heard the west-coast tape from 1996, however, I realised that the west-coast song was almost identical to the new east-coast song. So similar were the songs, in fact, that I actually took the tape out to check I had not put one of my own in by mistake!

While we cannot be certain how the west-coast song turned up on the east coast, the most logical route would have been via a small number (probably a few tens) of west-coast males wandering up the east coast. Although the two populations are distinct and usually use different feeding areas in the Southern Ocean, it's possible that some west-coast whales moved farther east than normal while feeding in early 1996. When it came to migration, they headed north and ended up on the 'wrong' side of Australia. Supporting this hypothesis are genetic studies and old whaling data that show there is some low-level mixing of the populations.

What was truly astonishing, though, was that the entire east-coast singing population, rather than ignoring this minority song, should suddenly drop their own song and learn the introduced one. Why would they do this? Does this tell us something fundamental about the function of song?

A FEW YEARS AGO, SAL CERCHIO, from the University of Michigan, suggested that novelty itself, rather than just being a by-product of song change, might in fact drive song change in Humpback Whales. His theory was that, even though males sing complex songs, they all sing the same song and females will hear the same song repeated constantly for months. This results in the females becoming 'habituated' to the songs—so used to them that they stop listening to them. If song is aimed at attracting females, this is a disaster for the males. Males appear to have overcome this problem by evolving a craving for innovation. Males 'want' to be novel enough to stand out from the crowd and grab the attention of the females, but not so novel that they are considered aberrant by the females.

The song change recorded off the east coast of Australia appears to be the first evidence in support of this hypothesis. The whales changed their song to the new one because it was just that—new. But why would they change to such a radical song and risk being ignored by the females when normal song changes are small and gradual? Our hypothesis is that radical novelties may be accepted, provided they are introduced above a certain threshold level. We suggest that song changes normally evolve as a result of each singer making or copying small innovations from other singers, until enough singers (the threshold level) happen to be using the same slightly varied song to make it an acceptable alternative to the old song. Once this new, slightly altered version of the song reaches this threshold level, it is taken up rapidly by other whales. In human terms, an analogy might be fashion—one person dressing in a new way is eccentric, but if a significant number (a threshold) of people all dress in the same new way, it is the start of a trend that is then adopted by others.

A Humpback performs a half-breach

In our case this process may have been 'short-circuited'. A completely novel, well-structured song had suddenly appeared in the east-coast population without having to go through the normal, cautious intermediate steps of song evolution. Presumably the prevalence of west-coast song had exceeded some threshold, and the new song, albeit containing a larger number of apparently spontaneous innovations than normal, would have been adopted instinctively by the east-coast males.

If novelty really is the driving force for song change, it implies that the primary

DAVE PATON

purpose of song is to attract females and so goes some way towards resolving the outstanding question of function of Humpback Whale song. Further research is needed to test some of the predictions arising from this work, for example the attractiveness of novel song to both males and females. And Australia, with its populations of whales being far enough apart to normally have different songs but close enough to have occasional interchange of individuals and song, may prove to be the best place in the world for further study into one of the most beautiful, complex and mysterious natural phenomena known.

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HIS RESEARCH ON HUMPBACK WHALES INCLUDES BEHAVIOURAL STUDIES, ACOUSTIC TRACKING OF SINGERS, AND THE DEVELOPMENT OF ACOUSTIC TECHNIQUES FOR SURVEYING WHALES. HE IS ALSO CURRENTLY WORKING AT THE UNIVERSITY OF QUEENSLAND AS A RESEARCH ASSISTANT. THE AUTHOR WOULD LIKE TO THANK HIS PH.D. SUPERVISORS DOUG CATO AND MICHAEL BRYDEN, AS WELL AS THE MANY VOLUNTEERS WHO HAVE HELPED HIM COLLECT D. AT OVER THE YEARS.

We tried for two months, testing out every bird trap devised by people since the Middle Ages.

STALKING *the* STORK

BY ERIC DORFMAN

When I tell people at my home in Sydney that I work with storks, I am often met with blank looks. After a pause, I usually say "Jabirus?", but this is rarely helpful. A faint flicker of recognition often only comes when I say "You know, the ones that bring the babies".

If you had been born in Sydney in the 18th or 19th century, or even as late as 1930, the name 'Jabiru' would have sparked an instant image of a large bird, perhaps a metre and a half tall, with a sword-like beak wandering around the extensive wetlands that once comprised much of the area. You might even have

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Here's looking at you—the yellow eyes of this Jabiru indicate she is female. Males and juveniles have black eyes.

The nest of Jabirus, a large loosely constructed heap of sticks, is usually located high in a tree, up to 30 metres above ground. Nest sites in New South Wales are becoming scarce, and this could be a major contributing factor to their decline.

factor in the local decline of the species." Jabirus were still being shot along the Clarence River as late as 1930, despite full protection in the State by 1920.

More recently, the species has been relatively free from hunting, yet in 1998 was listed as Endangered in New South Wales. If hunting has stopped, then why has the Jabiru continued to decline? We have some clues.

A LITTLE WHILE AGO, I WAS DRIVING through northern New South Wales, searching for Jabiru nests. At that time, the only maps available for the area dated from 1965. Navigating with these proved impossible, as many of the wetlands had been converted to cane fields, paddocks or housing estates. In fact, much of the area once used by water birds has come under the till for one purpose or another. Without a clear understanding of habitat requirements and movements, the suggestion of what keeps numbers down will remain mere speculation. Even recording sightings is not sufficient for management. Merely looking at the features of sites that Jabirus visit might give a misleading impression of their importance unless there is some additional measure of how much the birds gain from using them.

In order to understand the importance of different types of habitat, I looked at foraging success: the number of fish caught per attempt at a capture (which I termed a 'strike'). Although prey size varies from tiny fish the size of goldfish to metre-long file snakes, measuring hunting success against failure rate should still give us an impression of the richness of the habitat. The idea was that the better a wetland was for birds, the more fish they would catch there. I had orignally planned to compare three sites in New South Wales with three in Kakadu National Park, where the birds are still abundant. In New South Wales, I took my research assistant Adam Lamont (who is actually a descendant of George, the stork-shooter) into the field with me and drove through the area for two weeks, finding only one juvenile, unenthusiastically picking at a dead catfish. Science is a cruel mistress. I then went to Kakadu and met up with colleagues Peter Vesk, now at Macquarie University, and Mariagrazia Bellio, of ERISS.

Rainfall patterns are very different between the Top End and New South Wales. Around Darwin, extremely wet summers alternate with dry winters. During dry periods, water evaporates from the flood plains leaving scrublands dominated by grasses and sparse tree cover. Wetlands and billabongs slowly dry and, as they do, life that needs water concentrates there. In eastern New South Wales, the seasons are much less pronounced, however many coastal wetlands still undergo drying and filling due to intermittent rainfall.

We arrived in the late dry season and found that the birds had concentrated at only two spots in numbers sufficient for statistical analysis. Our tidy experimental design in tatters, we nevertheless

Black-necked Stork

Ephippiorhynchus asiaticus

Classification

Order Ciconiiformes (storks, egrets, herons), family Ciconiidae (storks). Also called Jabiru.

Identification

Australia's only stork and tallest flighted land bird. Adults white with black wing stripe and tail, black bill, crimson legs and feet, iridescent green head and neck. Australasian subspecies (*E. a. australis*) has an iridescent purple crown; Asian subspecies (*E. a. asiaticus*) has a blue crown. Adult females have yellow eyes, those of adult males and juveniles are black. Juveniles up to 2 years old have grey legs and feet, and are brown or mottled as they moult into adult plumage.

Distribution and Habitat

From about Broome, WA, across Top End and down east coast as far as about Newcastle. Population range appears to fluctuate in response to water. Found mostly in seasonal wetlands, including open grass and sedgelands, as well as *Melaleuca* woodlands. Occasionally forages in paddocks. Australasian subspecies also occurs in PNG in unknown numbers. Asian subspecies occurs from India, Sri Lanka and Nepal east to Cambodia, and is extinct, or nearly so, in Thailand, Annam, Cochinchina, Laos and Myanmar.

Diet

Primarily fish, including catfish and eels, and frogs. Also snakes, juvenile crocodiles, hatchling sea turtles, small mammals and birds, including grebes and ducklings.

Breeding

Very poorly known. Nesting usually occurs in tops of trees near fresh water. Adults probably mate for life and share responsibilities in rearing young. Females lay 2–4 white eggs, small for the size of the bird, although usually only 1 juvenile survives to fledging. Seasonality of breeding not yet established.

Status

Australasian subspecies listed as Endangered in NSW and Rare in Qld. Although still common across Top End, continued clearing of wetlands, Cane Toads and other factors present unknown threats. Globally threatened as Near Threatened.

GLEN THRELFO

The young Jabiru (brown) learns to forage with its mother. The first year is the most precarious for the young birds, and low survival during this period is the major hurdle for wildlife managers.

continued undaunted. We videoed many hours of foraging behaviour at Malabanjbanjdju, a temporary wetland that had dried back almost completely, and at Yellow Water, along the banks of the South Alligator River. Back in Sydney, the now-beleaguered Adam steadfastly transcribed individual success rates from the videos onto data sheets ready for analysis. We found that birds at the ephemeral wetland had a significantly higher capture to strike ratio than those along the riverbank. At the former wetland, the shallow water had allowed the birds easy access to fish and was an extremely attractive place to hunt. Larger water bodies are still necessary, however, as they remain wet during drought and feed smaller wetlands. Although we would have been happier with more than two locations, this fits the pattern of many other Australian water birds, including cormorants, herons and the Australian Pelican—that is, a variety of habitats is necessary to maintain healthy populations. Unfortunately, the highly fertile soil at the bottom of both large and temporary wetlands is perfect for cropland and they are regularly planted out.

THE BIRDS *were clever and remained too wary to be caught.*

WE NEXT HAD TO LOOK AT movements. If Jabirus are sedentary, then the destruction of wetlands could leave individuals unable to find new habitat. Conversely, if Jabirus are nomadic, as are many water birds in Australia, then individuals might require a number of functioning wetlands to survive. Either way, it isn't a great situation for these birds: effects are either extreme for a few individuals or pervasive for all. Nevertheless, understanding the scale of the problem is an important key to tackling it.

Because of the potential for long-range movement in this species, we had to use satellite telemetry. We tested out 'dummy' tags for weight and comfort on captive Jabirus generously provided by Taronga Zoo. The tags were light, only 80 grams, and the storks wore them on their backs, attached with a Teflon tape harness, without distress. The next step was to find some wild birds.

Our lack of success at finding Jabirus in New South Wales made us decide to go back to Kakadu for the first specimen. I was accompanied by postgraduate students Errol Nye and Reuben Schmitt, research assistant Bobby Tamayo and a battery of stalwart Earthwatch volunteers. Whereas observing Jabirus had been remarkably easy (once

you knew where to look), catching them proved somewhat more difficult. We tried for two months, testing out every bird trap devised by people since the Middle Ages. Our proudest effort was a clap-net trap, modelled on an ancient Chinese design. This trap was designed to snap shut when released from a distance, after the stork walked in to get the bait fish. But the ancient Chinese evidently hadn't had Jabirus to contend with. The birds were clever and remained too wary to be caught. Fortunately we were at least able to collect valuable habitat and behavioural information on other species of concern in New South Wales, such as Comb-crested Jacanas, Magpie Geese and Wandering Whistling Ducks.

Seven months later, at the beginning of the next dry season, I returned by myself to Darwin and, on advice from naturalist Ian Morris, I used nothing more than a fish and some heavy monofilament line, making a noose to go around the bird's legs. I went to the Territory Wildlife Park and, with the kind assistance of its Chief Veterinarian Derek Speilman and colleagues, chose a bird—an adult male—that was used to taking fish from keepers and caught it in about ten minutes from start to finish. Strike a blow for the KISS principle (Keep it Simple Stupid)! We promptly attached a tag to the bird and released him back into the wild. Our first Jabiru has been named, perhaps perversely, 'Number Two'. We currently have another bird, a juvenile male, housed at the Territory Wildlife Park pending eventual release. You're probably wondering what we'll call him. So am I, frankly.

So far, Number Two has been reasonably sedentary, at least for a large bird. He travels throughout the local area, within a circle of about a six-kilometre radius around his original point of tagging, covering an area of about 120 square kilometres. Although he still likes an occasional handout from the park, he is obviously exploring the surrounding areas for short-term rich patches of fish. These patches, in the far north, will increase in abundance as the dry season progresses, and I expect that Jabirus will have to travel farther to find them. The question we are waiting to answer is whether our tagged bird, and eventually our second one, will fly longer during the rainy season when fish are spread out over the flood plains and more difficult to find, or whether they remain loyal to a single spot.

Slowly, we are building a picture of the Jabiru's natural history. Being an intermittent local resident, the species depends, at least to some degree, on highly variable wetlands for food and reproduction. These wetlands are the type that is being steadily lost to agriculture and coastal development. It is unlikely that the Jabiru is under immediate threat right across Australia, but local threats show no sign of abating. Other factors, such as Cane Toads and power lines, still need to be addressed. We are also about to embark on a study of nesting locations, to discover any additional requirements for breeding.

It may be possible, eventually, to develop a system of reserves in New South Wales that would allow Jabirus to recolonise...although you're unlikely ever to see them wandering along the shores of Bondi Beach on a hot summer's day. Perhaps that's not such a bad thing, considering the ease with which they could make off with your fish and chips, and probably your Pekinese as well. So the next time you're in the mood for a snuggle, remember the majestic Jabiru, Australia's largest flighted land bird and one-time resident in Sydney.

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GLEN THRELFO

Male (right) and female Jabirus probably mate for life, and maintain their pair bond with a variety of courtship displays.

TED SCHIFFMAN-PETER ARNOLD AUSCAPE

Selective breeding by humans has resulted in over 600 different forms of dog known today.

WHETHER TRAVELLING AS PAIRS OR IN PACKS, DOGS AND HUMANS HAVE TRANSFORMED EACH OTHER.

DOGS MAKE US HUMAN

BY PAUL S.C. TAÇON & COLIN PARDOE

IMAGINE A WORLD WITHOUT DOGS. WOULD WE be the same if they were not here? Would human beings have developed in very different ways had our best friends not been by our sides? Recent evidence suggests that domestication of dogs was a two-way street that led to profound changes in the biological and behavioural evolution of both species.

G & D FRITH PHOTO

Once domestication was successful, dogs soon became part of the human family. Their environment changed but also they changed humans in the process. Among other things, the two species became very close companions, as this example from the Southern Highlands of Papua New Guinea illustrates. Humans learned new forms of bonding that likely aided survival.

IT HAS LONG BEEN KNOWN that wolves/dogs were the first animals to be domesticated by humans, but until recently the timing was uncertain. For instance, indisputable domesticated dog remains are yet to be found in archaeological deposits older than 13,500 years. A grave in Israel dated to this time contains the earliest evidence—skeletons of an old woman and a three-to-five-month-old puppy. Other archaeological sites indicate domestic dogs were common from 11,500 to 10,000 years ago, in places as far apart as northern England and south-western USA. This suggests wolves (most likely a subspecies of Grey Wolf, *Canis lupus*) were domesticated in a number of places well over 12,000 years ago but depictions of wolves/dogs are extremely rare in the Upper Palaeolithic rock art of Europe. Furthermore, scenes of hunting with dogs in Asian rock art do not appear until about 5,000–6,000 years ago, and elsewhere, such as southern Africa, rock-art images of dogs and people hunting with dogs are even more recent.

This contrasts with DNA analysis, which suggests domestication occurred much earlier. A team of researchers led by Carles Vilá and Robert Wayne (University of California, Los Angeles) compared mitochondrial DNA from a variety of canids, including 67 dog breeds, five cross-breeds and various wolves, coyotes and jackals, and concluded that dogs split from wolves over 100,000 years ago and possibly as much as 135,000 years ago. They admit that early dogs may not have looked very different from wild wolves but genetic separation by that time had begun. Some fossil evidence has even emerged to support these genetic estimates.

Researchers studying the middle Pleistocene Crayford fossil beds in England have noted that the canid specimens come in two distinct size classes. Danielle Schreve (University College London) believes that, rather than representing the two sexes of the one species, they represent two different

Dogs first appear in the Australian archaeological record about 4,000 years ago, as faunal remains, purposeful burials and rock-art images. In this example, from the Laura region of northern Queensland, a Dingo has been depicted in association with a human figure, emphasising the close relationship between the two species.

PAUL TACON

JEAN-PAUL FERRERO/AUSCAPE

Dogs were likely domesticated for many reasons but they would have been particularly useful when hunting, sniffing out and helping to chase down prey. In places as far afield as Africa, the Americas, Australia and Papua New Guinea dogs continue to be important in big-game and pig hunting. Indeed, the human–dog relationship may have precipitated big-game pack-hunting.

species. The smaller specimens (originally misidentified as the Asiatic Dhole, *Cuon alpinus*) have a relatively short and broad mandible and, according to Schreve, most closely resemble a small wolf. The site is thought to be 190,000–130,000 years old and human artefacts are also present. Is it possible that these fossils represent the earliest domesticates, and that their significance can only be understood against the molecular clock separating dogs from wolves over 100,000 years ago?

The fossils and the genetics support an idea put forward by David Paxton (while at the Australian National University) that wolves and humans first formed a relationship over 100,000 years ago. Paxton conjectured that, since both wolves and humans are social animals with complex communication signals, the two species could have easily picked up on each other's body language tens of thousands of years before other creatures were domesticated. This is supported by John Bradshaw (Anthrozoology Institute, University of Southhampton) who believes wolves chose *us* rather than the other way round. By scavenging around camp edges, the early wolf would have introduced itself. Later, it simply moved in

and made itself at home. Selective breeding by humans then led to the dog as we know it, in its over 600 different forms.

Wolves, and their dog descendants, living in the human camp would have had enormous benefits. For instance, they would have improved sanitation, cleaning up food scraps, human faeces and other potentially poisonous waste. They would have acted as early-warning systems, using their acute hearing to alert humans to the approach of predators, strangers and enemies. And, most significantly, they may have assisted with the hunt, as both companions and partners, sniffing out prey with their renowned sensitive sense of smell. Indeed, Paxton argues that humans soon relied on dogs to do some of our smelling for us. In other words, smelling-nose dogs came first, seeing-eye dogs much later!

All of these results from cohabitation would have greatly improved the chances of survival for early human

COLIN PARDOE

Fossil evidence has recently emerged to support the DNA-backed theory that dogs were domesticated over 100,000 years ago. These jaws, from the Crayford fossil beds in England, are thought to be between 190,000 and 130,000 years old. They all resemble wolf jaws but the smaller specimen is more dog-like. Indeed, the jaws appear to be from two different but related animals—perhaps the first hard evidence that dogs were domesticated as early as the DNA studies suggest.

Grey Wolves (*Canis lupus*). Recent DNA studies suggest dogs were domesticated from wolves over 100,000 years ago.

groups. Colin Groves (Australian National University) speculates this may explain why Neanderthals became extinct and not us. The Neanderthals had no dogs as far as we can tell. Dogs may have given early humans a big competitive advantage. Indeed, if the 135,000-year dates of early dog domestication hold water, then the domestication of dogs may even have been one of the key forces that led to fully (behaviourally) modern humans. It is possible that our immediate ancestors and wolves may have domesticated each other through a strategic alliance that changed both respectively into humans and dogs.

Most studies have concentrated on the effects of human–canine cohabitation on dogs rather than the reverse. But the effects on humans, on their psychology, hunting practices, territoriality and social behaviour, would also have been

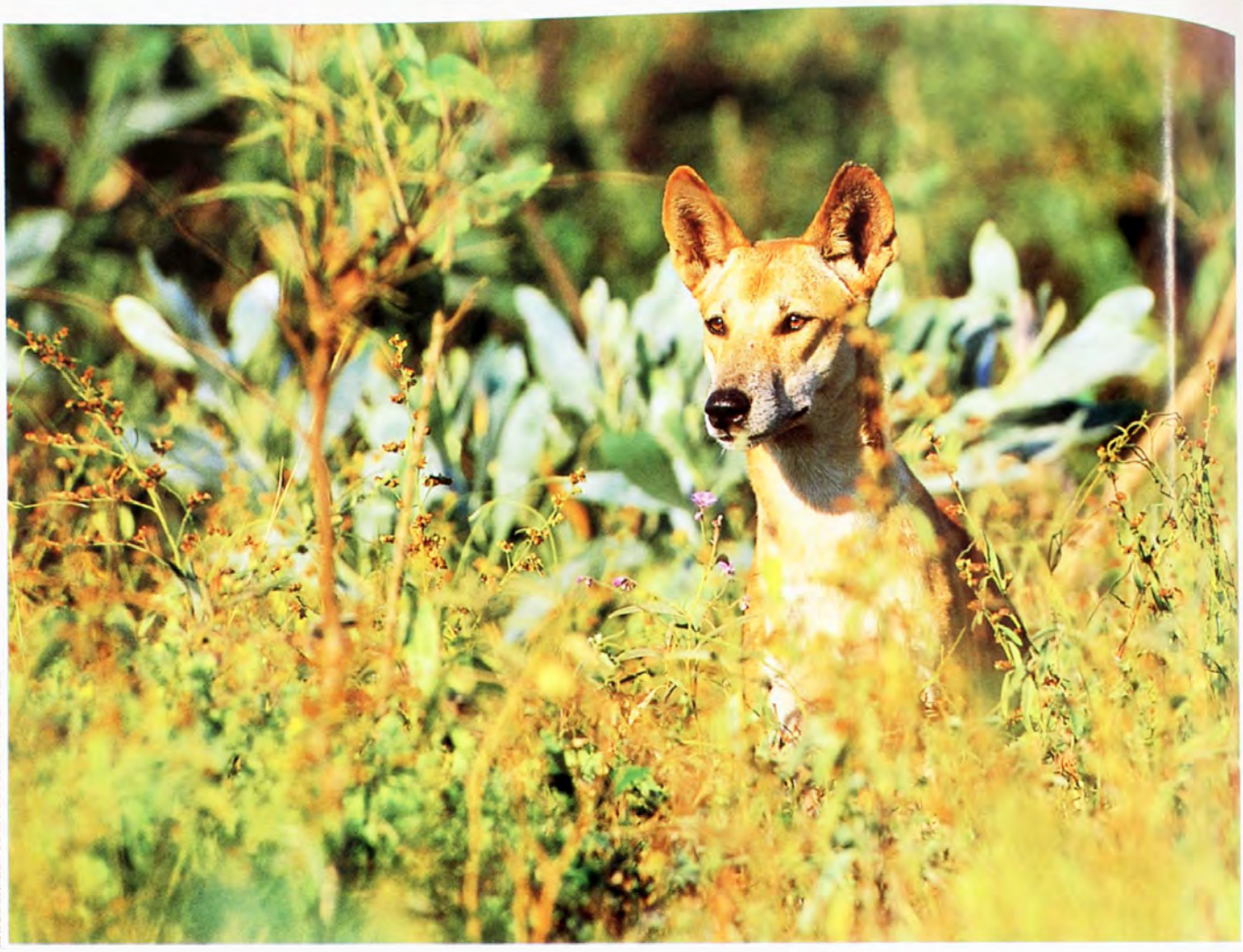
DOMESTICATION OF DOGS

may even have been one of the key forces that led to fully modern humans.

profound. We argue that, not only did the 'natural' environment of dogs change to become that of the human family but also the human environment correspondingly changed. The experience of living with dogs changed forever the nature of human–animal, and even human–human, relationships.

ONE AREA OF CHANGE INVOLVES marking territory. The origins of the territorial marking of landscapes by humans, as well as the origins of image-making and art, are still not well under-

JEAN PAUL FERRERO/AUSCAPE



JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Today there are attempts to save the pure-bred Dingo from possible extinction. The question for many is whether it is 'Australian' enough to bother about. Those in favour of saving the Dingo display an empathy for dogs that may have begun when early humans and the first dogs joined forces over 100,000 years ago.

stood. Although it is clear our immediate ancestors, such as *Homo erectus*, had many abilities in common with *Homo sapiens*, important differences appeared over 100,000 years ago, leading to what some people believe was a 'symbolic explosion' about 50,000 years ago. One of the key changes noted in the archaeological record is a movement toward marking spaces, places, landscapes and territories with enduring signs on rock. Rock marks, such as pecked cupules, hand stencils, hand prints, abraded grooves, finger impressions in once-soft clay and so forth, are an early form of individual mark. Engraved and painted pictures, more reflective of group concerns, became common after about 40,000 years ago. These enduring visual expressions are quite different from the simple sort of markings earlier humans produced.

A defining characteristic of wolves and dogs is their ability to mark territory with urine, signalling to others not only a stake or claim in the area but also a range of personal detail. A groundbreaking study by Canadian author and naturalist Farley Mowat in the 1960s proved how important this territorial marking is for wolves and how it features in their elaborate social systems. Indeed, in order to be properly introduced to and accepted by a wolf pack in Canada's isolated far north, Mowat had to drink vast quantities of water, enabling him to produce enough urine to mark out the boundaries of his territory!

It is the wolf's keen sense of smell that allows territorial marking to be successful in this manner. Many primates also use scent to warn of their presence, along with sound. We do not know what pre-*sapiens* used but we do know that scent-marking would have been unreliable because of a decreased sense of smell in humans, assumed because of a shrinking of both the nose and that part of the brain associated with smell. Some other form of long-lasting mark would have been needed. The production of enduring visual marks would have solved the problem. But how did this behaviour arise? We suggest the behaviour developed after watching wolves, and later dogs, leave urine marks on the land. Of course, visually these marks fade quickly as they dry, the canines relying instead on the lingering smell. But early humans may have taken the visual aspect of marking a step further by producing scratches, stencils, drawings, paintings, engravings and other signs of their presence that would last a long time. Eventually, we believe, this developed into the great diversity of landscape-marking and symbolic-object productions that continues today. For once marking behaviour was established, it could be manipulated to convey an ever-changing array of messages.

Another human trait we believe originated from wolves/dogs is big-game pack-hunting. Hunting large animals in

packs is a distinctive wolf behavioural trait, although at times they do hunt alone and hunting in groups is also characteristic of other species (Chimpanzees are known to collectively hunt smaller creatures such as monkeys). There is no conclusive evidence of big-game hunting among pre-*sapiens* groups. Furthermore, the handaxe, once thought to be an important tool associated with big-game hunting, may have had more symbolic functions related to status, advertising fitness and attracting females (see "Sex Axe", *Nature Aust.* Spring 2000). But big-game hunting is very typical of past and present *Homo sapiens*. Indeed, as a result, many large animal species have been driven to extinction, especially in recent times, although climate change also undoubtedly played a role.

What then was the switch from scavenging and small-game hunting to the pursuit of the world's largest animals? We suggest it had something to do with living in large, socially complex groups, that it involved learning to hunt in packs, and that it required special powers of cooperation and negotiation in complex situations. As these are behaviours characteristic of both wolves/dogs and modern humans, it can be argued that soon after wolves began cohabitation with humans these behaviours were enhanced, developing further in both species as a consequence of living together. Eventually, this led to modern humans and modern dogs hunting their own species and/or each other to death in packs, something there is no evidence of among wild wolves or our immediate ancestors. It also led to territorial expansion and movement into more hostile environments where survival depends on big game.

How did early humans learn to live in large, extended family groups that were cohesive units capable of the long-term defence of territory? This is a question that has long puzzled archaeologists. In the *Illustrated encyclopedia of humankind* (1993), Swedish archaeologist Göran Burenhult explains that the optimal group size for modern traditional societies is about 25. Too big and conflict arises; too small and the population cannot maintain itself. Indeed, most present-day hunter–gatherers live in groups of between 20 and 70. If we compare human groups to other primates, we find Gorilla group sizes range from 3–40-plus individuals and, although they will defend themselves and their group against predators with screeching and other behaviours, they do not defend territory itself. This is true of baboons and macaques as well. However, our closest living relatives, Chimpanzees, do defend territory, sometimes quite violently. They live in communities of 20–80, but they rarely get together all in the one place, living closely in sub-groups of 2–10 individuals instead. Males are known to patrol territorial boundaries, searching for members of the neighbouring community and beating them up badly if they are found. Wolves also actively mark and defend territory, with clearly defined (and scented) ranges. Perhaps early humans not only had their territorial marking behaviour enhanced by living with wolves/dogs but also their readiness to defend territory.

The development of new forms of bonding might also have assisted living in complex, large and varied social groups. One of the keys to recent human survival is the negotiation of complicated situations by forming partnerships. Without 'mates' we would not be able to carry out a large range of complex behaviour important to both individual and group survival. Australian history in particular emphasises the importance of 'mateship' to the country's development, but this form of bonding can be found worldwide. Strong bonds exist between pairs of same-sex wolves, dogs and humans, bonds less fickle than those between other same-sex animal pairs. In most other primates, for instance, mother–infant bonds are strongest, although Chimpanzees do exhibit some strong male–male bonding. But in humans bonding is much more diverse, extending well beyond parent–child,

JEAN-MICHEL LABAT/ALSCAPE

Wolves and dogs have a very keen sense of smell, much greater than humans. Many people believe that we soon became reliant on dogs to do our smelling for us, changing human evolution and aiding human survival in the process. This continues today in many ways, such as specially trained rescue dogs patrolling the French Alps after avalanches.

PAUL TACON

Perhaps prior to 4,000 years ago the Thylacine fulfilled a dog-like role for early Australians. For instance, in rock art thought to be over 10,000 years old, Thylacines are shown in many poses, including interacting with humans. Depictions are particularly prevalent across northern Australia, including this example from western Arnhem Land, which shows a Thylacine carrying a human-made dillybag.

sibling or even sex-partner relationships. And not only does it occur between humans who are culturally very different from each other but also between humans and other living beings. Today the most widespread form of inter-species bonding occurs between humans and dogs. Perhaps the very concept of mates or mateship has ancient origins, extending back beyond the early stages of wolf/dog–human encounters but again being enhanced as the inter-species relationship developed. Later, because of its survival advantage, it became a distinctly human trait, something especially important for dealing with complex situations, such as colonising new areas.

THERE ARE STILL MANY UNRESOLVED issues surrounding the human colonisation of Australia, including the exact timing 40,000 or more years ago (see "A Matter of Time", *Nature Aust.* Spring 2000). One question is whether the first humans to reach Australian shores had dogs with them. Dogs likely assisted the colonisation of new territories by early humans elsewhere, so why not Australia? For instance, in more recent times, dogs undoubtedly assisted with the exploration of and survival in extremely harsh territories. The earliest evidence of domestic dogs in the Greenlandic and Canadian Arctic regions dates to at least 4,200 years ago, associated with the earliest surviving sites of human occupation. And the introduction of the Dingo• in Australia about 4,000 years ago can be correlated to a period of intensification and expansion across not only desert regions but also much of the continent.

Australian Aboriginal people display all of the biological and behavioural features of other humans that may be accounted for by the human–dog relationship. This suggests the major dog-influenced changes in humans took place long before, as there is no evidence that the first humans arrived in Australia with dogs. Indeed, archaeologically dogs are invisible until about 4,000 years ago. Importantly, at that time they entered the archaeological record not simply as faunal remains in deposits, but as purposefully buried individuals. The purposeful burial of dogs can be demonstrated for a large stretch of the Murray River, the Adelaide Plains and the south-eastern coast, from Melbourne to Sydney. In northern Australia some Dingo bones were even rubbed with red ochre, as were those of humans.

If there was an early Australian world without dogs, perhaps the indigenous Thylacine filled the void. Certainly, it is a feature of early northern Australian rock art, with several dozen depictions surviving across the Kimberley and throughout Arnhem Land. One of the more outstanding is of an adult Thylacine nuzzling a pup. More unusual depictions, in the ancient Arnhem Land Dynamic Figure Style, thought to be at least 10,000 years of age, show someone carrying a dog-like animal as if it were alive, a second figure surrounded by a pack of dog-like creatures, and a Thylacine carrying a dillybag.

Unfortunately, early Europeans denigrated both Thylacines and Dingoes soon after arrival in Australia. Both were despised as much as the Indigenous peoples. They were shot, poisoned, fenced in or forced off the land in similar ways. In some northern Australian Dreamtime stories it is the Dingo that makes us human but in Australian English, the term 'dingo' also became a term for a contemptible person, a coward, one who shirks responsibility or evades difficult situations, to betray, to spoil, to ruin. For many early European colonists it was important to not only marginalise Aboriginal people but also their dogs.

Today there are attempts to save the pure-bred Dingo, to class it as an endangered species, recently brought to international attention through the controversial culling of Dingoes on Fraser Island. There are also attempts to bring back the Thylacine. In each case, an empathy many humans and dogs display is being realised, highlighting a long, close relationship and evolutionary voyage. Whether travelling as pairs or in packs, dogs and humans have transformed, and continue to transform, each other. The human–dog partnership set both on a course that would change the world forever. Indeed, it can even be

• *According to CSIRO research scientist Laurie Corbett ("Dingoes: Expatriate Wolves or Native Dogs?", Nature Aust. Summer 1995–96), domestication of an Asian subspecies of Grey Wolf (Canis lupus) led to the evolution of the Dingo (Canis lupus dingo) which was further domesticated to become the domestic dogs as we know them today. As such, the scientific name for domestic dogs should be Canis lupus familiaris not Canis familiaris to reflect this evolutionary pathway.*

argued that the success of our first relationship with another species laid the ground for the eventual domestication of other animals, ultimately leading to a radical transformation of the planet.

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DR PAUL S.C. TAÇON IS A PRINCIPAL RESEARCH SCIENTIST AND HEAD OF THE AUSTRALIAN MUSEUM'S PEOPLE AND PLACE RESEARCH CENTRE. DR COLIN PARDOE IS A CONSULTANT PHYSICAL ANTHROPOLOGIST WHO HAS WORKED WITH MUSEUMS AND INDIGENOUS AUSTRALIANS STUDYING HUMAN REMAINS AND BURIALS.

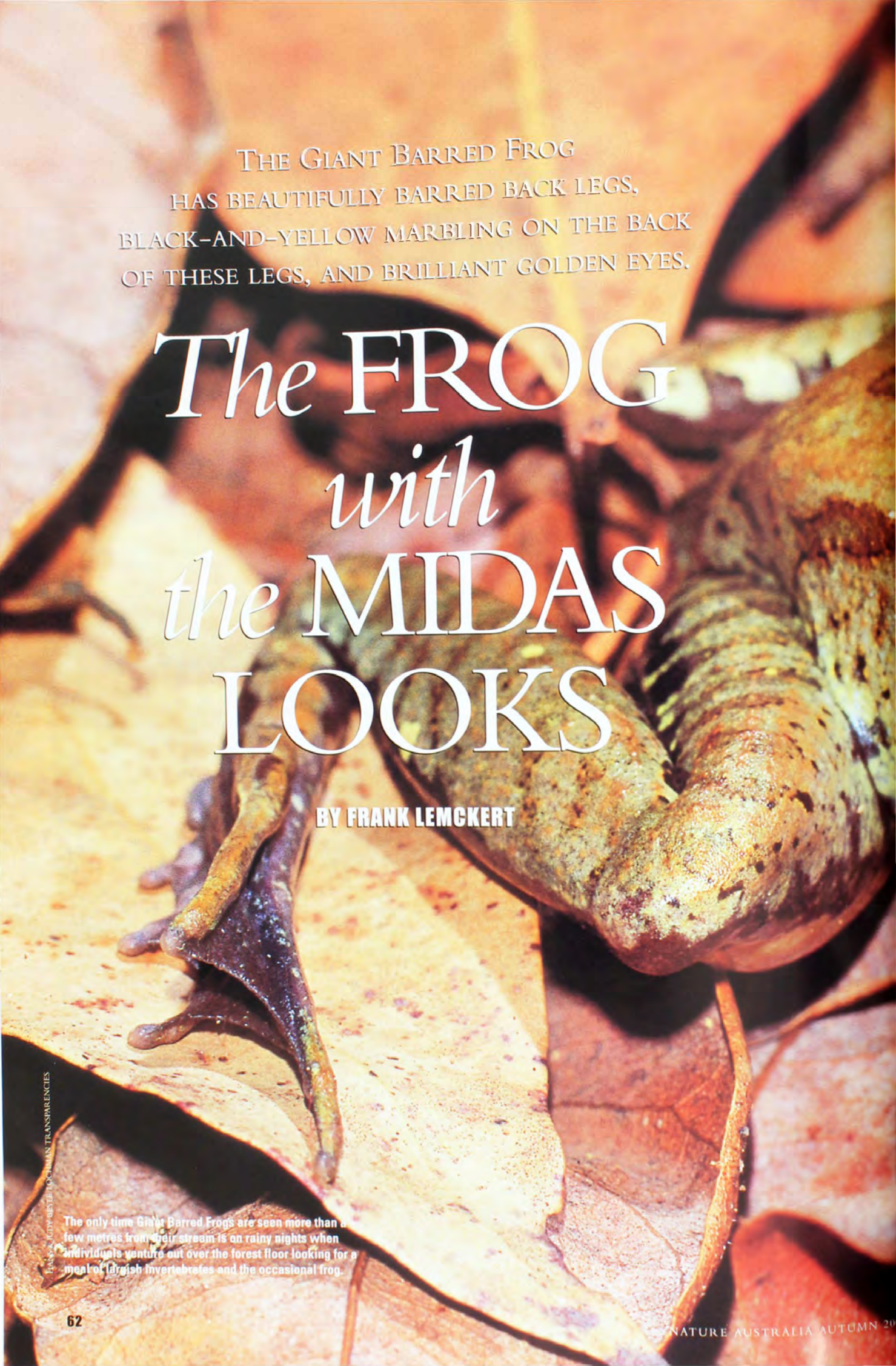
THEY GREATLY ACKNOWLEDGE THE COMPANIONSHIP AND INSPIRATION GIVEN BY BLACKIE, BOOTS, DUFF, NUMBER ONE AND HARRY THE CAT, WHO THOUGHT HE WAS A DOG. THEY ALSO THANK THE AUSTRALIAN MUSEUM FOR SUPPORTING THIS RESEARCH AND THE VERY HUMAN RICHARD FULLAGAR FOR COMMENTS THAT GREATLY IMPROVED THIS ARTICLE.

When Europeans arrived in Australia they denigrated both Thylacines and Dingoes—shooting, poisoning, fencing in or forcing them off land in ways similar to how they treated Australia's Indigenous human population.

THE GIANT BARRED FROG HAS BEAUTIFULLY BARRED BACK LEGS, BLACK-AND-YELLOW MARBLING ON THE BACK OF THESE LEGS, AND BRILLIANT GOLDEN EYES.

The FROG *with the* MIDAS LOOKS

BY FRANK LEMCKERT



The only time Giant Barred Frogs are seen more than a few metres from their stream is on rainy nights when individuals venture out over the forest floor looking for a meal of largish invertebrates and the occasional frog.

One of the most striking frogs leaping through our forests is the Giant Barred Frog (*Mixophyes iteratus*). It is the largest of all Australia's ground frogs (family Myobatrachidae) with females reaching 12 centimetres in length. It has beautifully barred back legs, black-and-yellow marbling on the back of these legs, and brilliant golden eyes. It lives and breeds on very large streams and rivers, which most frogs shun. But the most striking thing about this frog is that at least half of the known populations are now extinct and we are still not certain why.

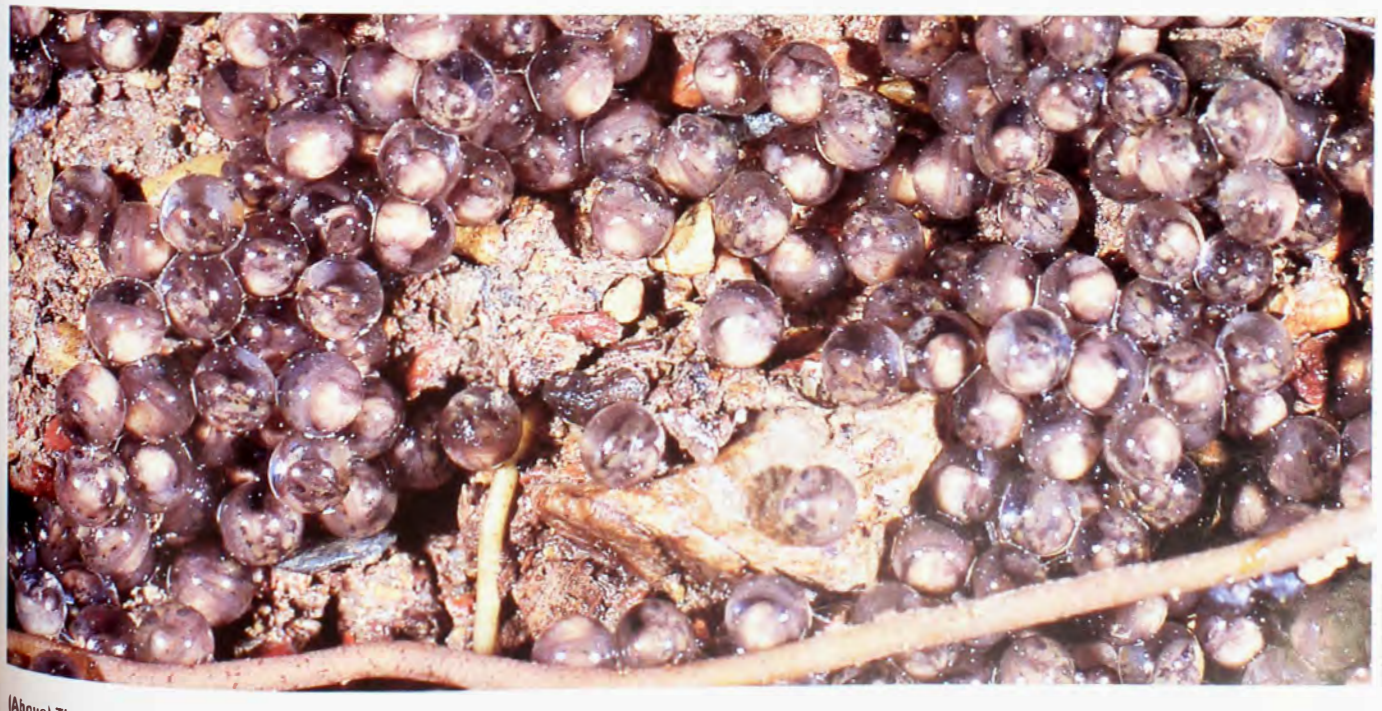
The Giant Barred Frog is one of five currently recognised species within the genus *Mixophyes* and is easily distinguished by those golden eyes. This species occurs in enclosed forest environments, such as wet sclerophyll forest and rainforest, on the coast and adjacent ranges from the Blue Mountains west of Sydney to the Bunya Mountains in southern Queensland.

I spent a lot of nights tracking the movements of these frogs through the forests around the Coffs Harbour and Dorrigo area of New South Wales finding out how they live. Using both radio-transmitters and cotton spools (that play a line out behind the frog), I followed where they went at night and where they stayed during the day. This work showed that the adult frogs stick to an area within 20 metres either side of their breeding streams, although they may move around quite a bit within this streamside area during the night. I expected that they would hide under the leaf litter during the day, but although they sometimes do, I was surprised to find that they mostly sit above the fallen leaves in a spot partly covered by low vegetation. They can see what is going on and jump away if something threatening (like me) comes too close. Other work undertaken by students at Griffith University painted basically the same picture, although they did record frogs more than 20 metres away from the stream a couple of times, which is something I never found.

The remarkable breeding habit of this frog, shared with the Great Barred Frog

A pair of amplexing Giant Barred Frogs. Females are much larger than the males and are the biggest native ground frogs found in Australia.

(Left) The most striking physical feature of the Giant Barred Frog is its golden eyes.



(Above) The female Giant Barred Frog uses her back legs to flick her eggs up onto a clear surface directly above the water. This presumably keeps the defenceless eggs clear of aquatic predator such as fish, turtles and other tadpoles.

(*Mixophyes fasciolatus*), has recently been uncovered through several observations by Michael Mahony's team at the University of Newcastle. As is usual for stream-breeding frogs, the male attracts a female by calling to her from the bank, and when she finds him, he wraps his arms around her (called amplexus). However, in this and other *Mixophyes* frogs the male starts off holding her around her arms (axillary amplexus), but then slips back to hold her around the waist (inguinal amplexus). (In other frogs, the male remains in the same position throughout the breeding process.) The female then moves off into the stream carrying him, and searches for a suitable section of the bank on which to lay her eggs. She chooses a cleared vertical surface or, even better, an undercutting that provides a bare horizontal surface directly above the water. Whilst floating in the water, she squeezes out one or more eggs onto her webbed back feet where they are fertilised by the still-clinging male. She then flings out her leg in a wide arc and catapults the egg(s) onto the chosen surface. The egg coating is sticky and most eggs adhere to the bank where they are left to develop. Within about a week, small but relatively well-formed tadpoles break out of the egg capsule and fall into the water below. By this time they are capable swimmers and, unlike the immobile and defenceless eggs, have some chance of avoiding aquatic predators such as fish, crayfish and, probably, other tadpoles.

Male Giant Barred Frogs call a few metres from the edge of the water, often right out in the open. The call is surprisingly soft given the size of this species.

Giant Barred Frog

Mixophyes iteratus

Classification
Family Myobatrachidae (southern or ground frogs).

Identification
Olive to dark brown back with varying darker spots and mottling; a series of black stripes form bars on back legs; backs of thighs black with yellow spots; distinctive golden eyes. Females up to 12 cm long, males up to 9 cm.

Distribution and Habitat
Coast and adjacent ranges from south-eastern Qld to Sydney region. (Many texts record this species to Narooma in southern NSW, but no evidence has been found to confirm this.) Found along permanent streams and rivers in rainforest and wet sclerophyll forest.

Reproduction
Lays 1,500–2,000 eggs that are flicked onto the stream bank adjacent to or above the water. Eggs hatch in 5–7 days and tadpoles take up to a year or more to metamorphose into froglets.

Behaviour
Terrestrial species that burrows under or sits on top of leaf litter or under low vegetation. Mostly active at night. Eats insects, snails, spiders and other frogs.

Status
Listed as Endangered in both NSW and Qld. Not currently listed under Federal legislation, but this situation currently under review.

Loss of forest habitat throughout the range of the Giant Barred Frog has been occurring almost since the day Europeans arrived in Australia. However, the major declines in this frog as well as a number of other species appear to have occurred in the 1970s and 1980s. This included a complete loss of the species from the Blue Mountains, at least three-quarters of the populations between the Hunter and Hastings Rivers, similar losses in far northern New South Wales, and its almost complete loss from the Conondale Ranges in Queensland. There are still a number of populations around the New South Wales/Queensland border and, interestingly, the frog remains widespread

Tadpoles are found in permanent streams where they spend a year or more growing to very large sizes before turning into froglets.

Giant Barred Frogs have strongly webbed back feet that help them swim in the large streams on which they live.

and common in the forests around Coffs Harbour and the adjacent Dorrigo Plateau in mid-northern New South Wales.

The reasons for the losses are not clear, but two other frogs in the genus (*Mixophyes balbus* and *M. fleayi*) have also suffered dramatic declines. Direct human disturbances such as land clearing, forestry and fire are likely to have had some impact on this species, but they cannot account for losses in relatively pristine environments. Furthermore, Giant Barred Frogs are often found living in tree plantations, on weed-covered streams and within narrow streamside strips of vegetation in otherwise cleared agricultural land. Clearly this frog can cope with some degree of habitat modification. Introduced predators such as

Foxes and Cats may eat the frogs, and introduced fish such as the Eastern Gambusia (*Gambusia holbrooki*) may attack and eat the tadpoles. But again, these factors don't appear sufficient to explain the widespread losses over such a short period of time.

The most likely explanation for such rapid and widespread declines in this and the other species of frogs is that a virulent disease has attacked their populations. Such a disease could not initially be found, but in the last few years an unusual fungus has been identified as the likely culprit. A species of chytrid fungus, *Batrachochytrium dendrobatidis*, has been discovered in the bodies of dead and dying individuals of many types of frogs in Australia and other parts of the world, particularly stream-breeding frogs. This microscopic fungus parasitises the frogs' skin, leading to lethargy, muscle spasms and eventually death. Chytrid fungi usually occur as free-living forms in soil or water. They are known for being a pathogen of algae and aquatic invertebrates, but there had been no previous reports or indications that they could infect vertebrates. Why this fungus has only now been found to kill frogs, and whether our frogs will be able to recover from its effects, are two questions that we have no answers to as yet.

WHY THIS FUNGUS HAS

only now been found to kill frogs, and whether our frogs will be able to recover from its effects, are two questions that we have no answers to as yet.

The reasons for the loss of the frogs may also be quite complex and involve an interaction of several factors. For example, perhaps in recent years increased UV radiation or chemicals have weakened the ability of the frogs to fight off the fungus, leading to devastating effects. No-one knows for sure and researchers continue to look for the answers.

On a more positive note, ongoing monitoring of the Giant Barred Frog throughout its range indicates that, for the moment at least, the declines have abated and numbers are reasonably stable. There are now even indications that it is returning to some sites from which it disappeared and the species may yet recover back to the levels of the early 1970s. Meanwhile, we must continue to manage factors such as habitat loss, introduced predators and change in water quality, otherwise we might still lose forever the frog with the Midas looks.

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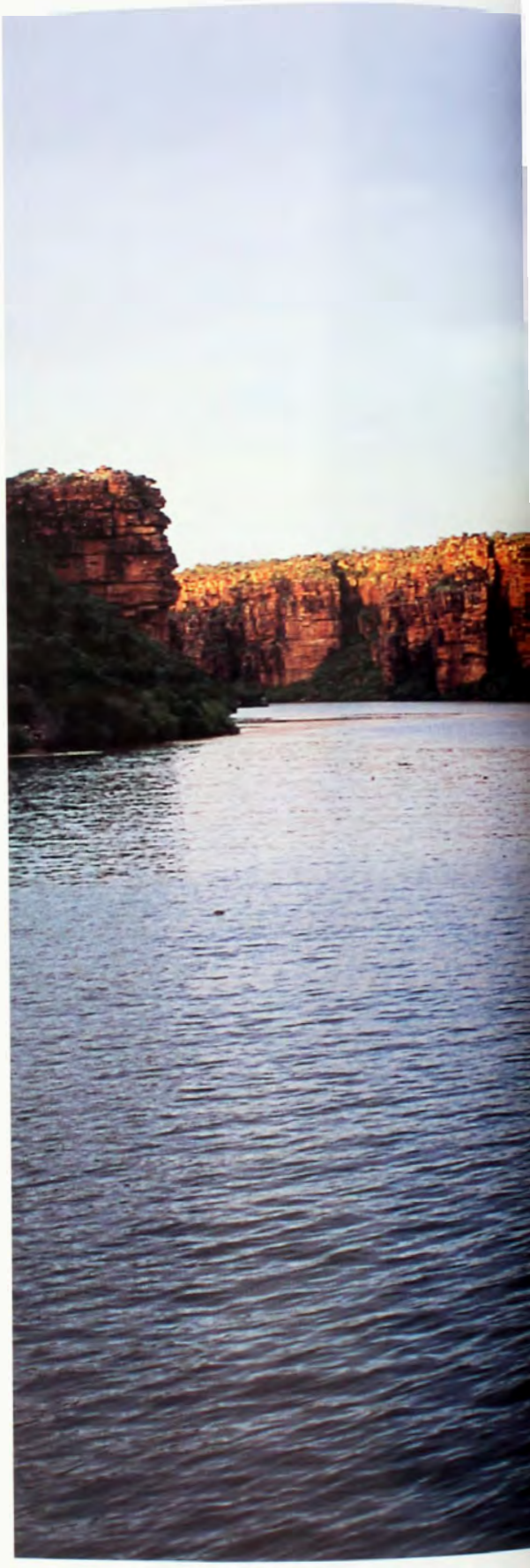
FRANK LEMCKERT IS A RESEARCH OFFICER IN THE RESEARCH AND DEVELOPMENT DIVISION OF STATE FORESTS OF NEW SOUTH WALES. HE HAS BEEN STUDYING THE BIOLOGY OF FROGS SINCE 1986 AND IN 1995 STARTED RESEARCH INTO THE IMPACTS OF FORESTRY ACTIVITIES ON FROGS.

'Bradshaw' rock art, Port Warrender.



the kimberley

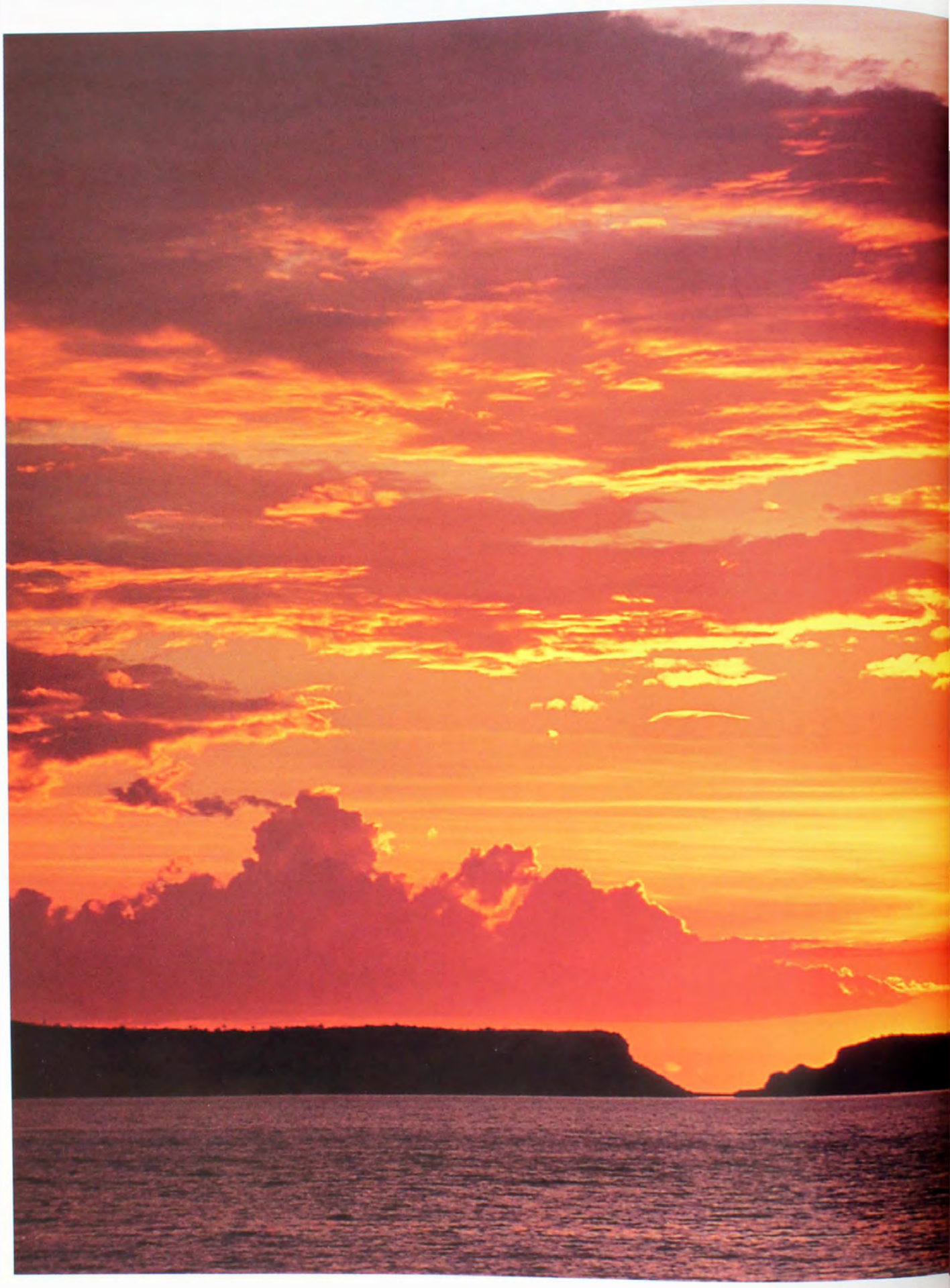
BY DICK EUSSEN
Tropical Australia Media

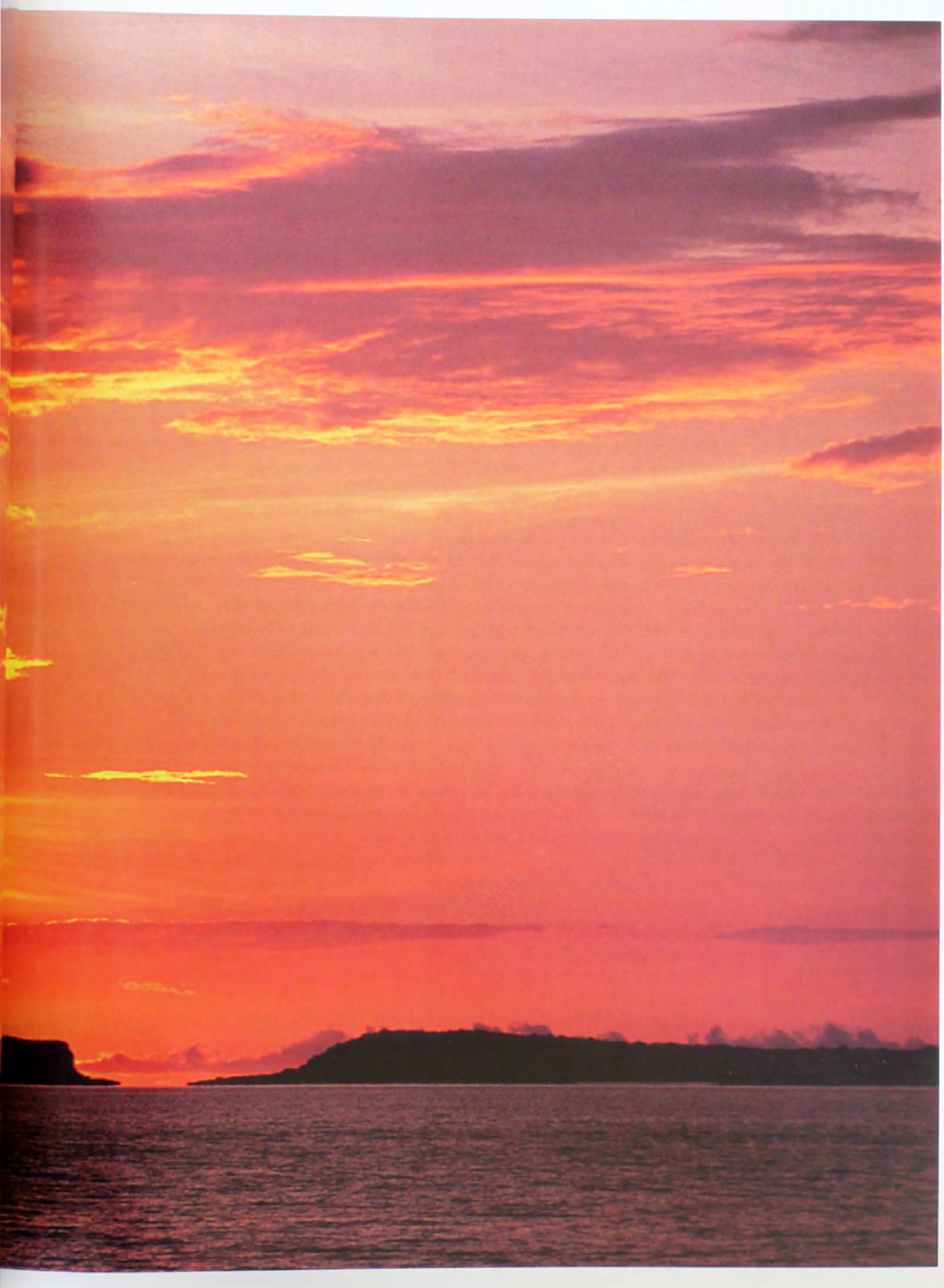
King George River Gorge.

Raft Point, Doubtful Bay.

Green Island, Camden Harbour.

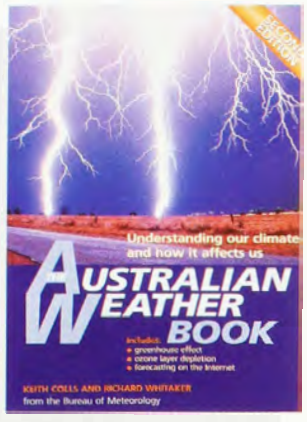
Waterfall, Berkeley River.





Sunset, Careening Bay.

reviews



The Australian Weather Book

By Keith Colls & Richard Whitaker. 2nd ed. Reed New Holland, NSW, 2001, 180pp. $29.95rrp.

As a marine biologist who spends a fair amount of time on and in the water and as a long-time bushwalker, I have a keen interest in the weather and what makes it work. Therefore, I was immediately attracted to this book, written by two Bureau of Meteorology staff members, that promised to tell me how the weather affects me, what the Aussie climate is like and how it is changing, how and why the atmosphere works, how clouds form, what instruments are used to measure weather, and the story of well-known Australian weather disasters. I was especially interested to know more about two aspects of weather that have greatly affected me personally: the Sydney southerly buster, and the extension along our east coast of high-pressure ridges into the tropics from southerly highs.

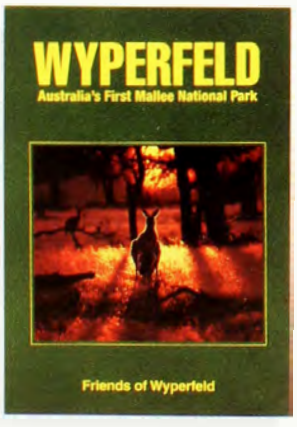
The book contains detailed descriptions of the various things that go into making up our climate and weather, although at times the writing could have been more open and friendly. In most cases, the information is there, but I had to work a bit to get at it. Most figures are clear and informative, but frequently located several pages away from where they are referred to in the text (probably the fault of the book designer rather than the authors).

The book is a mixture of the well done, and the not-so-well done. The weather trivia, like the date of the last snowfall in the Sydney CBD (1836, three times!), is interesting, and the colour photos are mostly very good. Some information is recent, like a brief section on the 1999 Sydney hailstorm ("the costliest natural disaster in Australian history"). The section on the instruments used to measure meteorological variables is detailed but, amazingly, there is no discussion on how weather predictions are put together from the information gathered. I also found a few discrepancies. For example, the text tells me that the concentration of carbon dioxide in the atmosphere is 367 parts per million, but the table on the same page tells me it is 330 parts per million. The authors could have done a better job of defining new terms they introduce. For example, the all-important Coriolis Force is first mentioned on page 52 but not even partially defined until page 55, and potential temperature and stratiform (cloud) are not defined in either the text or the two-page glossary.

And what about my particular interests? The explanation of the southerly buster is good, but I still don't know why the southerly highs ridge up the east coast, bringing with them strong south-easterly winds.

The book delivers much of what it promises, but not all. Nor does the delivery have the elegance desirable in a popular book. Perhaps Colls and Whitaker will achieve more if the book goes to a third edition.

—Jeffrey M. Leis
Australian Museum



Wyperfeld: Australia's First Mallee National Park

By Geoff Durham. Friends of Wyperfeld National Park Inc., Elsternwick, Vic., 2001, 200pp. $25.00rrp or $28.00 by mail order.

'Mallee' is an Aboriginal word that describes a growth form of eucalypts in which numerous slim trunks sprout from a large central rootstock. The word is also used to describe the fire-tolerant shrublands of semi-arid Australia that are dominated by these eucalypts. This book is about the human and natural history of an area of mallee in the Big Desert of western Victoria that is now protected within the Wyperfeld National Park.

Wyperfeld is a fascinating and vividly illustrated guide to the park that will interest bushwalkers, naturalists, historians and armchair-travellers alike. The style is entertaining and informative. The author explains the dynamic nature of the mallee community, and expands on elements that are common to other mallee areas. An extensive bibliography and index, plus appendices (including annotated lists of fauna and flora and place names) increase the wealth of information fitted into this compact and colourful book. I recommend it highly.

—Liz Cameron
Australian Museum

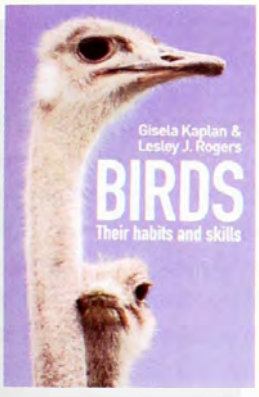
Aboriginal Australians: Spirit of Arnhem Land

By Pennie Tweedie. New Holland, NSW, 2001, 168pp. $45.00rrp.

THE PEOPLE OF ARNHEM LAND live in one of the most spectacular parts of Australia, surrounded by rocky escarpments, breathtaking waterfalls, lush forests, crystal waters, unspoilt beaches and abundant wildlife. Children are cherished; family relationships are sacred. Many aspects of Indigenous spirituality and philosophy feature strongly in people's lives today, as does their fascinating, complex and unique Australian history. But Arnhem Landers are also embracing computers, telecommunications and the Internet to keep in contact with each other and the outside world. They love videos, contemporary music and many of the things all Australians enjoy. They live in a diverse, multilingual society where many worlds come together. To capture all of this visually, in a powerful and appropriate manner, is a challenge. But it is just the sort of challenge Pennie Tweedie excels at, her photography skills combining with a deep empathy and respect for people to produce exceptionally poignant and visually stunning images. One of my favourites is reproduced twice: a close-up of an elder painted for ceremony talking on a phone, in one of dozens of communal phone booths found across Arnhem Land. For me, this image sums up what Arnhem Land is all about, the bringing together of old and new traditions in ways that add new meaning to each.

Aboriginal Australia is a rich tapestry of incredible photographs brought to life by the words and wisdom of Arnhem Landers themselves. These Aboriginal voices are what really make the book special. This section is preceded by a series of essays that sets the scene in an authoritative but accessible manner. My only criticism is that the history time-line overemphasises things that have happened as a consequence of Europeans, rather than the rich Aboriginal history, prior to contact, illuminated by archaeology. That aside, this book is highly recommended for anyone wishing to learn more about Aboriginal Australia, Arnhem Land or portrait photography.

—PAUL S.C. TAÇON
AUSTRALIAN MUSEUM



Birds: Their Habits and Skills

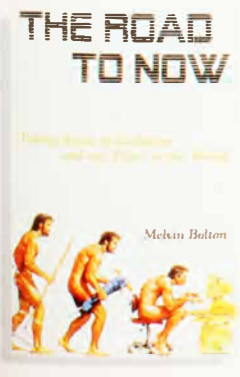
By Gisela Kaplan and Lesley J. Rogers. Allen & Unwin, NSW, 2001, 252pp. $29.95rrp.

DID YOU KNOW THAT PIGEONS HAVE THREE-DIMENSIONAL VISION, Galahs rear their young in creches and that Zebra Finch females can distinguish their father's song from the songs of other males? An ornithologist would know this, but for keen birders and people beginning an excursion into ornithology, this is the perfect book. It is highly readable, clearly laid out and packed with information.

The book discusses evolution, reproduction, the senses, communication, intelligence, the effects of humans on birds, and more. Both authors' personal insights into bird behaviour added a friendly tone to the book. I found the section on birds and humans particularly interesting, motivating me to read further afield.

Birds is a good basic textbook for beginners and an important supplement to field guides and identification books. It will extend the non-ornithologist's knowledge on how bird biology is linked to bird habits and skills.

—LEONE LEMMER
AUSTRALIAN MUSEUM

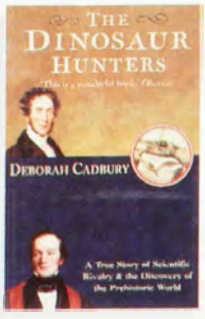


Road to Now: Taking Stock of Evolution and our Place in the World

By Melvin Bolton. Allen & Unwin, NSW, 2001, 292pp. $29.95rrp.

MELVIN BOLTON WRITES WITH GREAT CLARITY, and this big-picture look at the human species is a very easy read. Unlike many populist writers, Bolton chooses to survey our current state of knowledge and uncertainty without offering definitive answers. His approach is refreshing. All too often, populist writers push their favourite themes as if they were undeniable facts. Bolton is comfortable with uncertainty. *Road to now* is full of fascinating facts and statistics. Did you know, for example, that only seven per cent of members of America's National Academy of Sciences believes in a personal God? Bolton has more to say about genetics, brain-wiring and perception than about ecology, which is not his strength. He avoids some major topics such as megafaunal extinctions and the role of human fire, but enjoys speculating about the nature of consciousness. His lively narrative is backed up by an ample number of source notes and a brief bibliography.

—TIM LOW



The Dinosaur Hunters

By Deborah Cadbury. Fourth Estate, London, 2001, 374pp. $20.95rrp.

MOST POPULAR BOOKS ON DINOSAURS give a brief account of the first discovery of dinosaurs and other Mesozoic reptiles, mentioning the parts played by the main protagonists Mary Anning, Gideon Mantell and Richard Owen. In *The dinosaur hunters* Deborah Cadbury delves into the detail behind what is usually presented as a simple, uncomplicated account of the discovery and scientific description of dinosaurs. She reveals the deception and intrigue associated with the debut of these amazing animals which, over 170 years later, still attract widespread awe and attention.

The author has researched the subject well and put together an interesting, informative and easy-to-read story detailing the lives and interactions of the early 'dinosaur hunters'. It is interesting to note that a large proportion of these people held significant positions in the church. Some were able to come to terms with religion and geology while others struggled. There were numerous publications and often-heated debates trying to reconcile the Genesis account of the creation of the world and everything in it with the new science of geology. Geological observations and newfound fossils, particularly Mesozoic and Cainozoic vertebrates, were causing a great deal of argument about topics such as the age of the Earth and man's position in nature. It was in this framework that the story of *The dinosaur hunters* unfolds.

Without giving away too much detail, the reader is left feeling great sympathy for two of the main characters who, despite their enormous efforts, were mostly unrecognised, being the victims of unfair treatment and deception. To anyone with an interest in the history of palaeontology and the ways of science during the 19th century, this book is highly recommended.

—ROBERT JONES
AUSTRALIAN MUSEUM

Wild Solutions

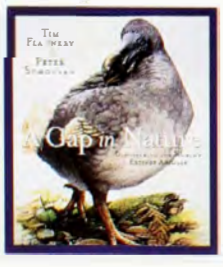
By Andrew Beattie and Paul Ehrlich. Melbourne University Press, Vic., 2001, 239pp. $49.95rrp.

THIS IS A BREATHLESSLY SUSTAINED ESSAY on the value to humans of non-human species, written by population geneticist Paul Ehrlich and biodiversity expert Andrew Beattie. A huge range of organisms is considered with emphasis on the invertebrates. The authors deal with how little we know of diversity, and then discuss the value of organisms in food webs, soil, air, water, waste, biocontrol, biotechnology, biomedicine, environmental monitoring and biochemistry. The primary message is to show that we often do not know or cannot predict what may be important, therefore everything is important. The failure of the Biosphere 2 experiment is a good example, recounted here.

The target audience is not obvious. Fellow scientists would find this book frustratingly unreferenced, and the language irritating in idiom and hyperbole ("toads...snacked on the pests, but feasted on any native animal species" [really?]; "a bonanza of brown rice hoppers"). But if this small-format book is written to catch the eye of the non-scientific public, it is presented poorly; for the text is alleviated by only a few scratchy drawings.

Most puzzling to me is that, while nearly all the stories rely heavily on accurate identification and taxonomy, support for taxonomy is underplayed in the book. Perhaps if the readers learn to appreciate the value of biodiversity from this book, they will then accept the need to explore how to study biodiversity.

—CHRIS REID
AUSTRALIAN MUSEUM

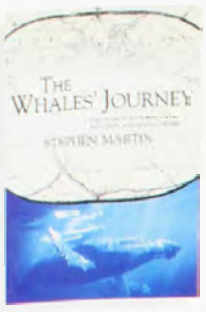


A Gap in Nature: Discovering the World's Extinct Animals

By Tim Flannery and Peter Schouten. Text Publishing, Vic., 2001, 184pp. $50.00rrp.

A GAP IN NATURE, WRITTEN BY TIM FLANNERY and illustrated by Peter Schouten, provides us with accounts and recreations of a diverse array of reptiles, birds and mammals driven to extinction in the 500 years since European exploration and settlement. This handsome volume is an eloquent epitaph to such wondrous beasts as the Dodo, Stellar's Sea Cow and the Thylacine as well as to less well-known animals such as the Bulldog Rat, Terror Skink and Toolache Wallaby. The species accounts make for fascinating reading, with Flannery's customary flair for the odd and anecdotal. Schouten's portraits have a delightful painterly quality reminiscent of classical natural historical art but with original style and design. These 103 painstakingly and scientifically accurate paintings—some of animals never previously illustrated—took four years to create using study skins, skeletal material and archival drawings. This stunning yet sobering book certainly deserves a place in the library of anyone with a passion for the art of natural history.

—ANNE MUSSER
AUSTRALIAN MUSEUM



The Whales' Journey

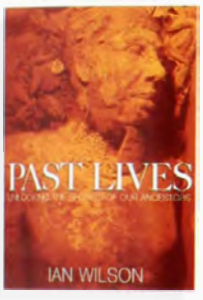
By Stephen Martin. Allen & Unwin, NSW, 2001, 251pp. $29.95rrp.

THE CONTENT OF THIS BOOK IS NOT RESTRICTED by the boundaries of its title. After a short general history of early whaling and past human interactions with these great animals, the author focuses on populations of Humpback Whales seen off the coasts of Australia. He describes the migrations to the breeding grounds off northern Australia, Tonga and Fiji, then follows the whales south again to the cold, krill-enriched waters in Antarctica. All stages of the whales' life are discussed, including aspects of behaviour, communication and navigational ability, and each chapter is well referenced.

However, this book offers far more than a dry biology text—the facts are enmeshed in rich historical accounts of commercial whaling operations and the harrowing experiences of the men involved. The reader learns of the increasing quest for knowledge based on accurate data; interesting alliances sometimes developed between whalers and scientists, such as Bill Dawbin. The book includes some graphic photographs taken by Dawbin and others.

With a sense of frustration, the author has detailed the many attempts by State, national and international bodies to control commercial whaling. The current interest and emotion evoked by whales is well illustrated by the description of a stranded Humpback on the Gold Coast; over 5,000 people witnessed its rescue. This book provides a good basis to begin to explore the biology of these amazing animals and to understand the threats to their survival, both past and present.

—TISH ENNIS
AUSTRALIAN MUSEUM



Past Lives: Unlocking the Secrets of our Ancestors

By Ian Wilson. Allen & Unwin, NSW, 2001, 216pp. $49.95rrp.

THE POPULARITY OF THE NOVELS of Kathy Reichs and Patricia Cornwell, not to mention the plethora of TV series, attests to people's fascination with the work of forensic pathologists. For those of us who share that interest, *Past lives* by Ian Wilson will be a welcome addition to the bookshelf. It takes us through the archaeological examination of a series of 20 human burials from diverse historical and geographical contexts. Each individual has an interesting tale to tell, ranging from a 500,000-year-old man in China up to a French sailor drowned off Texas in 1686.

The book focuses on the technique of post-mortem facial reconstruction. The initial chapters provide a comprehensive historical account of this technique from its earliest attempts 9,000 years ago on skulls in Jericho to the careful and statistically based modern renditions in clay over a cast of the skull. These can sometimes be uncannily accurate as witnessed by their use by the police in tracing unidentified bodies.

Although the common thread of the book is facial reconstruction, it is often the other investigative techniques that are the most interesting part of the tale. Recreating the faces of the dead brings their characters to life but it is the medical and environmental analysis that really tells us how they lived. For example the detail found in the remarkably well-preserved grave of a Scythian 'horse queen' in the frozen hills of southern Siberia provides a wealth of information about her nomadic life.

The book concludes with a discussion of some contemporary issues, including the important issue of respect for cultural sensitivities regarding human remains. *Past lives* is beautifully illustrated and the technical information is written in an easily accessible style.

—COLIN MACGREGOR
AUSTRALIAN MUSEUM

Rainforest Rhapsody

DVD from the ABC's Soundscape Series, 2001. Approx. 70 min. running time. $34.95rrp. Also available as a video for $29.95rrp.

"RAINFOREST RHAPSODY" IS THE PERFECT WAY to release stress. This DVD has managed to tailor its images and sounds to create a masterful blend that soothes the soul—the visual and aural equivalent to sliding your tired body into a hot bath. There is something very calming about the combination of the sounds of nature and classical music. Sweet tranquillity.

All the images were recorded at Wollumbin Crater, the site of the now-extinct mount Warning volcano on the New South Wales/Queensland border. Footage of pademelons, wallabies, parrots, tree frogs, snakes and lizards are married with compositions of master composers Handel, Bizet, Grieg, Elgar, Satie and others.

If I have only one criticism, it is that it ended too quickly. I had to rewind and take the journey again.

—STEPHEN COSTELLO

SOCIETY PAGES

Get involved! Across Australia there is a network of active societies, large and small, local and national, that exist to further the cause of the subject that you hold dear

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Contact: Mary Laws

Membership: $25.00

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Nerang Mail Centre
QLD 4211
Ph: 07 5527 2444
Web: *www.wildcare.org.au*
Contact: Eleanor Hanger

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Wildlife Welfare Organisation (SA) Inc.
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SA 5211
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Web: *http://users.net.au/~wildlife*
Contact: Carol Wilson

Membership: $15.00

WIRES
NSW Wildlife Information & Rescue Service
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& 1800 641 188
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Hunter Bird Observers Club
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NSW 2305
Ph: 02 4953 5942
Web:*http://users.hunterlink.net.au/hboc/home.htm*
Contact: Marion Walker

Membership: $20.00

CONSERVATION

African Wildlife Rescue Foundation Inc.
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Ph: 07 3904 7814
Web: *www.wildrescue.org.au*
Contact: Mike King

Membership: $15.00 Single, $25.00 Family

Australian Platypus Conservancy
PO Box 84
WHITTLESEA VIC. 3000
Ph: 03 9716 1626
Web: *www.totalretail.com/platypus*
Contact: Geoff Williams

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Contact: Network Coordinator

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Contact: Kasia Kucharska

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Web *www.gould.edu.au*
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Contact: Nancy Endersby

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Contact: Barry Dudman
Membership: $25.00 Family, $20.00 Single

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LAUNCESTON TAS. 7250
Ph: 03 6344 1076
Web: *www.tased.edu.au/tasonline/lnfanot*
Contact: Dr A. Pegler
Membership: $20.00 Single, $25.00 Family

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Web: *www.fats.org.au*
Contact: Arthur White
Membership: $30.00 Single, $35.00 Family, $35.00 Overseas

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C/- Monash Science Centre
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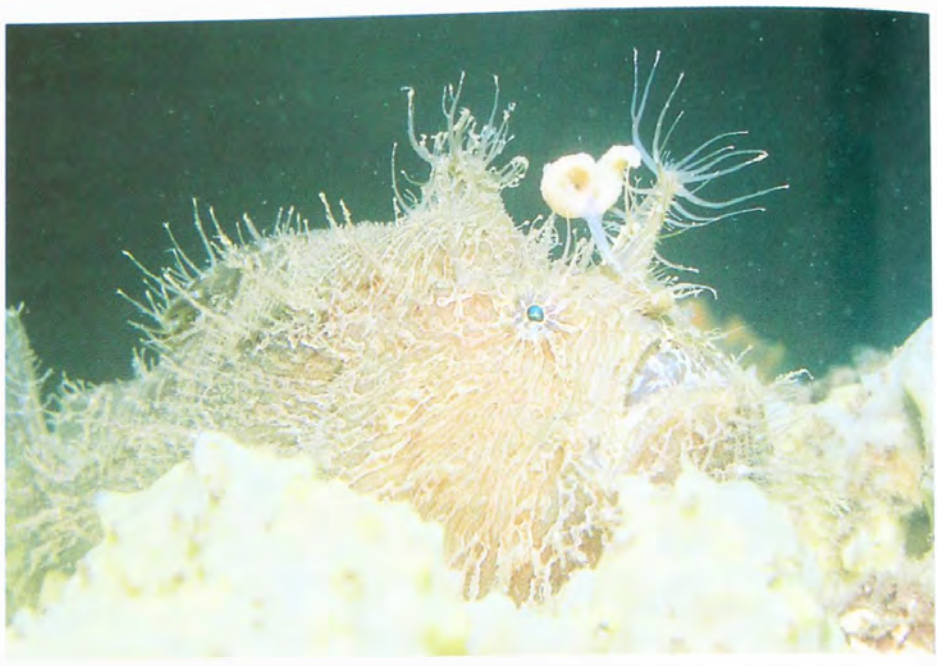

ARGUS LUMNITZER

The Striped Anglerfish, like many other fishes, can change the intensity of its colour when threatened.

Possum Song

Q: *Over the past week I've been hearing a small bird twittering at night somewhere in my garden. Despite going out with a torch I haven't been able to see it and I can't identify its call. It doesn't sound like any of the night birds described in my field guide like nightjars, frogmouths, or owls. Do daytime birds call at night?*

—Paul Janson
Lindfield, NSW

A: There are a number of small daytime birds that call throughout the night or when woken. Willie Wagtails, for example, seem quite prone to this (see "Singing Willies", *Nature Aust.* Autumn 1996). However, I suspect that what you were hearing was a Common Ringtail Possum (*Pseudocheirus peregrinus*). These possums produce a very unmammal-like twittering call during the night. Ringtails are much smaller and less noisy than the larger, more boisterous Common Brushtail Possum. Often the only signs of their presence in your garden are some missing flower buds and this strange bird-like call. Sometimes just a bit of guts and a tail, with its distinctive white tip, are found—grisly remains of a Cat's meal and one more reason to keep your Cat in at night.

—Martyn Robinson
Australian Museum

Angling for a fish

Q: *Last February I was night-fishing in the Camden Haven River. The exact location was about 1.5 kilometres upstream at Dunbogan, south of Port Macquarie. I saw an unusual fish in the spotlight near some rocks. After catching it in my net I noticed that it was about ten centimetres long and went dark when I poked it, so I took it home with me in a bucket. Can you identify what kind of fish this is from my photograph and tell me a little about it?*

—Jacki Charman
Newcastle, NSW

A: The fish you caught was a Striped Anglerfish (*Antennarius striatus*). The colouration of this species is extremely variable, ranging from reds and yellows through to green, brown or black. Individuals are sometimes heavily striped whereas others may have broken stripes, spots, or may lack markings. This species is capable of radical changes in colour and pattern over a period of weeks. Like many other fishes, however, it is also capable of rapid changes in the intensity of colour when threatened.

One of the most remarkable adaptations in this species is the first dorsal spine, which has evolved into a lure that is tipped with worm-like appendages.

PAVEL GERMAN/NATURE FOCUS

The night-time call of Common Ringtail Possums can often be confused with that of a bird.

When 'fishing' for prey, the Striped Anglerfish moves its lure in an attempt to attract potential prey. If a fish swims close to investigate the lure, the anglerfish rapidly opens its large mouth and prey is sucked in.

The Striped Anglerfish is often associated with sponges but is also commonly seen on silty substrates. It occurs worldwide in marine tropical and temperate waters, from the shallows to depths greater than 200 metres. In Australia, it is found from south-western Western Australia around the tropical north of the country and south to the central coast of New South Wales.

For more information see *http://www.austmus.gov.au/fishes/students/focus/anten.htm*.

—Mark McGrouther
Australian Museum

Food for Willie

Q: *What do Willie Wagtails eat?*

—M. Thompson
Portland, NSW

A: The Willie Wagtail (*Rhipidura leucophrys*) feeds almost exclusively on insects and spiders. Much of its prey is caught in the air, but this bird will also pick food from the ground or off vegetation. The bill is broad but not very robust. It cannot handle large or well-armoured items; smaller, soft-bodied prey comprise most of the Willie Wagtail's food.

—Walter Boles
Australian Museum

Answers to Quiz in Nature Strips (page 19)

1. *Shearwaters*
2. *Kangaroo Island*
3. *Wind speed*
4. *Bamboo*
5. *Potassium*
6. *A snake*
7. *Honey from native Australian bees*
8. *Lake Burley Griffin*
9. *Limestone*
10. *Eggs of Head Lice*

JOHN FIELDS/NATURE FOCUS

Pic Teaser

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, *Nature Australia* Magazine. Please don't forget to include your name and address. The first correct entry will win a copy of *The Australian guide to stargazing*. Summer's Pic Teaser was of an egg emerging from the rear end of a Goliath Stick Insect (*Eurycnema goliath*).

Biotechnology: evolutionary fire

Visit any major biological or medical science laboratory and it is almost certain that scientists will be studying DNA, the molecular basis of life.

ON THE BRIGHT SUMMER morning of 6 August 1945 humanity crossed the nuclear threshold with the bombing of the Japanese city Hiroshima. That event and the subsequent arms race continue to cast a deep and profound shadow over our future. During the 50 years leading up to that fateful day the esoteric science of atomic physics, which was considered to have no practical value by its proponents, became one of the greatest intellectual and technological achievements of humankind. Atomic theory was rapidly transformed into atomic technology, which led, with indecent haste, to the making and dropping of the first atomic bomb. While standing before the ruined 'Atomic Bomb Dome' at Hiroshima, perhaps our civilisation's most peculiar World Heritage site, I paused to reflect on an equally dramatic scientific revolution that is presently occurring—biotechnology.

Visit any major biological or medical science laboratory in the world and it is almost certain that scientists will be studying DNA, the molecular basis of life. Paralleling the rapid series of breakthroughs of atomic physics in the first of the 20th century, but requiring a fraction of the infrastructure, are breathtaking advances in biotechnology and information technology in the second half of that century. These include the description and synthesis of DNA, and gene-sequencing and cloning of organisms. Scientists can now routinely read, and to some degree even write, the very code of life and therefore are able to both understand and influence evolution.

But there is the rub. Nuclear weapons can be dismantled and, short of an accident, are under the complete control by humans because the missiles and bombs are inanimate machines. Unlike the mechanistic technologies of atomic physics, it is much harder, and indeed most likely impossible, to ever return *if* a 'Hiroshima-like' threshold of biotechnology is crossed. Thus biotechnology has the potential to be far more dangerous than nuclear technology. If dangerous genes escape into nature, they will probably never be brought under control, just as we are unable to comprehensively control all diseases, vermin, feral animals and weeds. There is mounting evidence that fragments of DNA can move between different species far more often than was first realised. Thus there is a risk that DNA introduced into an organism to improve its value to humans (such as in genetically modified crop plants) could 'pollute' the local ecosystem by being integrated into other organisms. If this occurs there may be quite unpredictable adverse ecological and evolutionary consequences. While there is no doubt that biotechnology will serve humankind in diverse ways, this evolutionarily powerful technology demands respect and warrants application of the 'precautionary principle'.

The difficulties of the 'atomic age' are trivial compared to the problems of 'feral' genes.

The discovery and wielding of atomic fire has changed geopolitical relations. Wars among nations at the scale of the last two great wars are now utterly unthinkable. Cleaning up the mess of the early, brash enthusiasms of the 'atomic age' has proved to be a continuing headache and, as yet, there is no agreement as to where and how nuclear waste should be stored for the long term. But these difficulties are trivial compared to the problem of 'feral' genes, for there is no biotechnological equivalent of a Geiger counter. Unlike atoms, genes are 'alive' and therefore far more elusive and difficult to catch and contain. The HIV/AIDS crisis and the recent spread of foot and mouth disease through Europe once again demonstrated how impotent humans are in controlling most other living things.

In his book *Guns, germs and steel* (1997), Jared Diamond used an evolutionary perspective to explain the rise of civilisation since the end of the Ice Age some 13,000 years ago. I believe it is reasonable to also use an evolutionary perspective to consider humanity's future. Biotechnology, with its capacity to alter the course of evolution on Earth, is in some ways a fitting twin to the current mass extinction of biological diversity due to anthropogenic-induced global environmental change. Perhaps we need a slogan to alert people to the twin dangers of the biotechnology revolution and the biodiversity crisis. I suggest we adapt Bill Clinton's famous 1992 election catchcry "It's the economy, stupid!" to read "It's evolution, stupid!".

BY DAVID BOWMAN

DR DAVID BOWMAN IS A PRINCIPAL RESEARCH FELLOW WITH THE ARC KEY CENTRE FOR TROPICAL WILDLIFE MANAGEMENT AT THE NORTHERN TERRITORY UNIVERSITY. HE IS INTERESTED IN THE APPLICATION OF ECOLOGICAL AND EVOLUTIONARY KNOWLEDGE TO MANAGE NATURAL RESOURCES.

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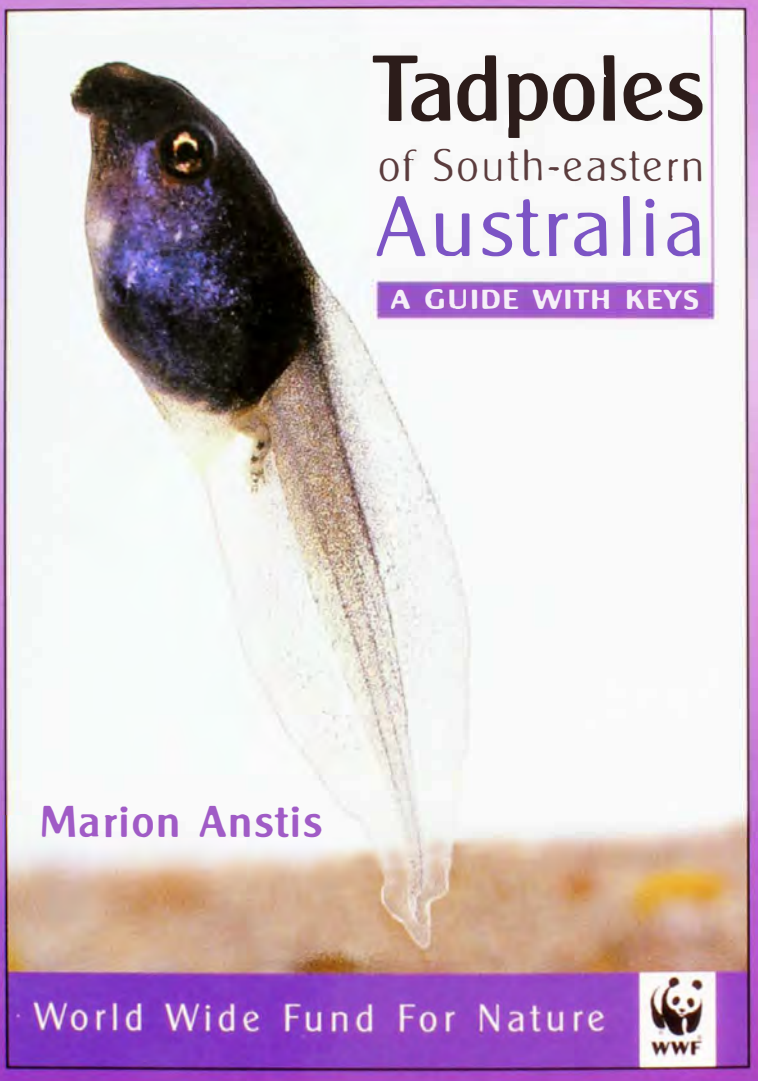

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