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WINTER 2003

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# ELEPHANT SEALS

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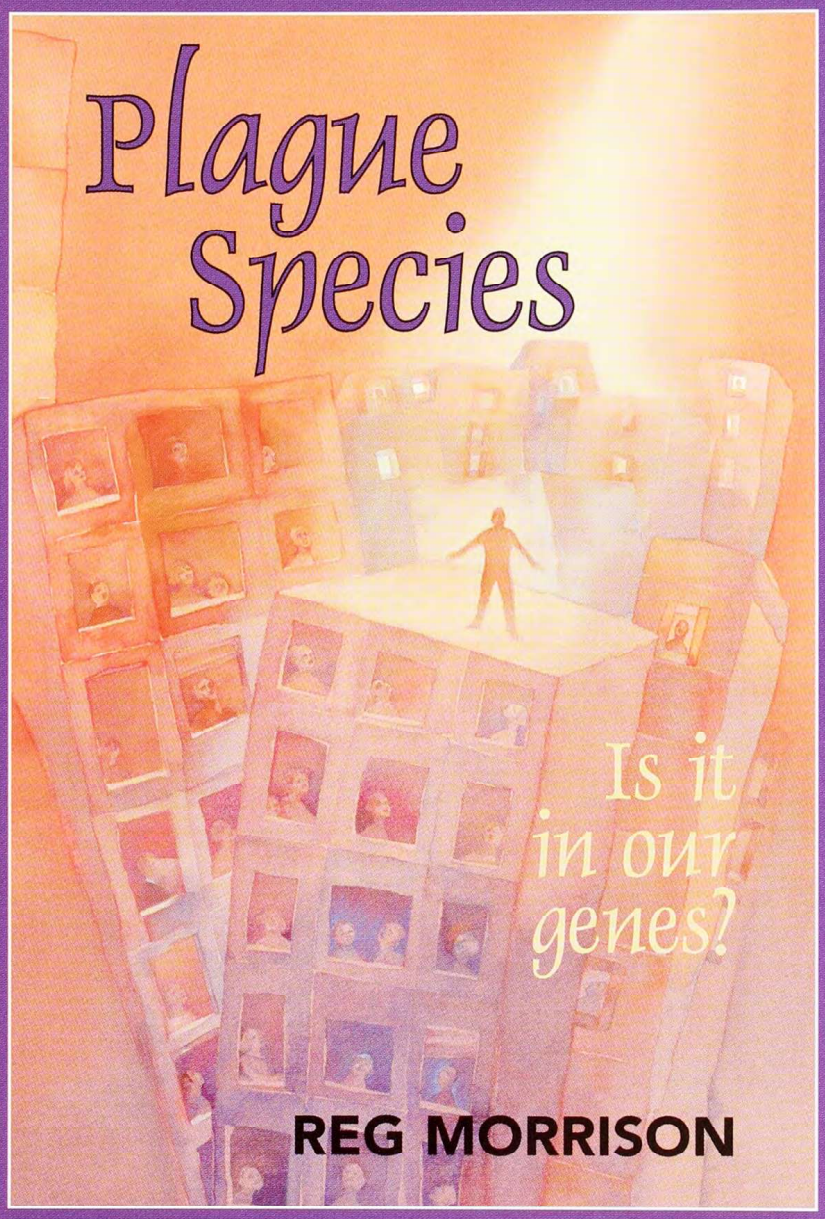


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FRONT COVER
Snoozing away the day. Southern Elephant Seals spend only about 20 per cent of their lives on land, and much of this time is spent asleep. In this way, individuals can conserve enery when ashore.
Photo by Kathie Atkinson.

You're lazing on one of Australia's glorious beaches enjoying the sunshine when a warning sounds that a tsunami is about to hit the beach and you have approximately 20 minutes to get to safety. What do you do?

You might think this is a rather silly question given the perceived unlikelihood of a tsunami hitting our coastline, but you'd be wrong. The Australian coastline displays a wealth of evidence that tsunami have been regular visitors to our shores. Edward Bryant, author of our article "Tsunami in Australia", and his colleagues have identified a range of geological features around the Australian coast that appear to have been formed by the action of tsunami.

Tsunami can be triggered by a number of events and the most likely cause for an Australian one is a submarine landslide. Although submarine landslides won't cause the most destructive of tsunami (that honour goes to meteorite impacts), they are still capable of generating giant waves like the 15-metre wall of water that wiped out the north coast of Papua New Guinea in 1998. So what do you do when you're given 20 minutes to escape an oncoming wall of water? Turn to page 44 and find out.

Southern Elephant Seals are incredible animals. They are capable of reaching depths of more than 1,500 metres, they can dive for over two hours on a single breath and they can reduce their heart rate to below ten beats per minute. After a 250-day feeding trip that takes them thousands of kilometres across the Southern Ocean they are also capable of returning to the tiny speck that is Macquarie Island. Scientists have discovered many of these incredible facts by attaching a small computer to the backs of seals, but what they are really trying to learn is why the population is suffering a slow decline.

GRAHAM ROBERTSON/AUSCAPE

**Southern Elephant Seal.**

What do a large number of our frogs, reptiles, birds and mammals have in common? They all depend on tree hollows for survival and many of them live by the rule: accept no substitute. Now consider that a tree has to be at least 150–250 years old before it even begins to form suitable hollows and you realise that most of the hollows used by animals today began growing before Captain Cook sailed along the Australian coastline. But these old trees won't last forever and our land-clearing and logging practices have meant hollow-dependent animals are facing a crisis. If we do not want to see the loss of around 300 species of animals, we need to start respecting the old trees that are left, protecting the younger ones and planting the next generation. And we need to do it now.

Beginning with this issue we are thrilled to be able to bring you a new regular feature called Global Spotlight. Global Spotlight will focus on a fascinating animal from around the world and in this issue we take a look at an African assassin bug that survives by wearing corpses. Also in this issue we look at why so many of us like to collect things, investigate the urban success of currawongs, and meet a feisty little lizard for whom body language is everything.

Jennifer

— JENNIFER SAUNDERS
*Publishing Manager*

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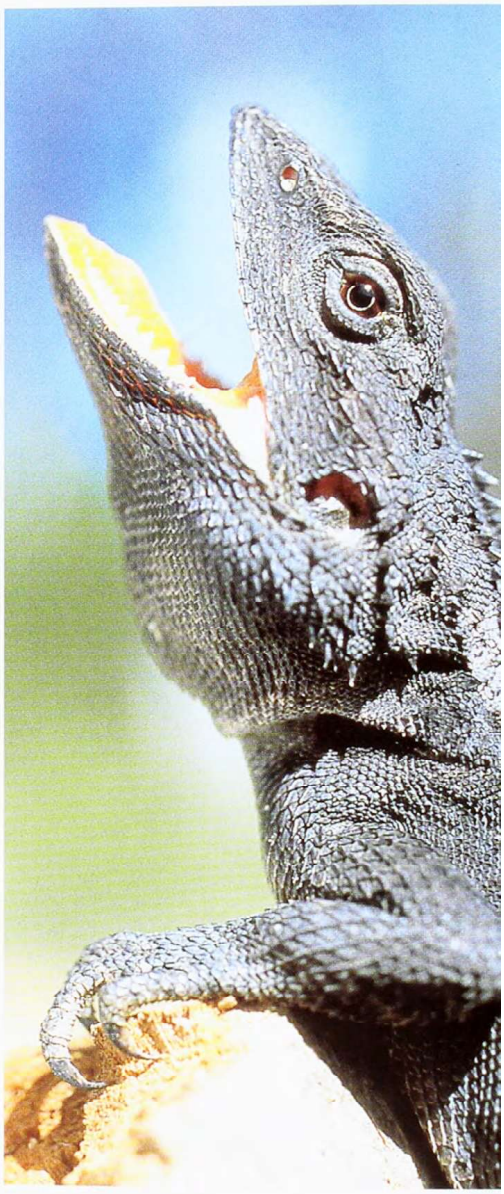

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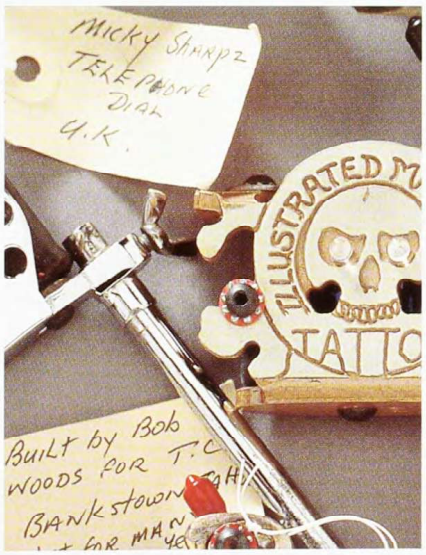


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## COLUMNS

# letters

## Yellow Faces

I was intrigued by the Nature Strip "Eat Dung and Dye" (*Nature Aust.* Autumn 2003), in which claims were made that Egyptian Vultures have yellow heads because of the carotenoids they obtain from eating dung. At times, humans too can turn orange by ingesting excessive amounts of carrots or carrot juice. I have seen such patients. However their whole skin changes colour. Presumably this also would apply to vultures if the cause were excessive ingestion of an extraneous pigment, yet the photograph accompanying the article shows that only the head of the vulture is yellow. The legs, for example, are a delicate pink.

My wife used to 'red factor' canaries. These birds have red feathers, not the usual yellow or green. With no special diet, their colour is just 'pinkish', but it is strongly enhanced to a deep red by feeding them red capsicums, carrots and other carotenoid-rich foods. A yellow canary can never be made red by feeding it such a diet. Red canaries have a genetic predisposition to redness. I believe the same situation may apply to Egyptian Vultures. In other words, there must be a genetic basis to their face colouration, which is merely enhanced by eating carotenoid-rich dung. Perhaps they are yellowish if they don't eat dung, and orange if they do?

—Alan Moskwa
Kingston Park, SA

*As you rightly point out, an excess of carotenoids in certain vertebrate species may change the natural colour of their skin. In humans, this is called carotenodermia. A similar situation occurs in the White Stork in southern Spain. Individuals feeding almost exclusively on Red Swamp Crayfish introduced from North America acquire a deep red colour in their otherwise colourless skin. In patients suffering from carotenodermia and crayfish-feeding storks, excess carotenoids escape the normal metabolic routes and show up everywhere in the skin (but not in the feathers in the case of the storks). The case of Egyptian Vultures is somewhat different. They have evolved to deal with lutein, one particular yellow pigment that makes the bulk of carotenoids in numerous food sources, including cow dung. Egyptian Vultures seem to have the necessary physiological machinery to concentrate lutein on their featherless faces. But they also show a yellowish tinge on other skin parts, particularly on the belly and the crop (normally obscured by feathers), and the brighter the face, the brighter the colour in those other body parts. Still, as you suggest, there is*

GRAHAM D. ANDERSON/NATURE FOCUS

**Apparently it's not that unusual for Tawny Frogmouths (*Podargus strigoides*) to make wheezing noises.**

*also a genetic basis to the colourful face of the Egyptian Vulture, but only those individuals eating more carotenoids (= more dung) will show the maximum expression of the colour. And that is the point: Egyptian Vultures may communicate their personal quality to prospective mates or competitors by the brightness of their faces.*

—Juan Jose Negro
Sevilla, Spain

### Tawny Wheezers

I refer to the "Wheezing Frogmouths" Q&A (*Nature Aust.* Autumn 2003). My partner and I live in northern Tasmania and are very familiar with the local birds and their calls. My partner is also a composer/sound recorder and has contributed many sounds to the "Australian Bird Calls—Tasmania" CD by David Stewart (Nature Sound).

One call that had us mystified for some time was a 'heavy breathing' sound heard late one evening. We (wrongly) concluded it was that of a Masked Owl, as we had heard that this bird makes a sound similar to that of a Common Brushtail Possum, and none of the field guides had a more adequate description of the sound we had heard. However, we soon discovered it was indeed made by Tawny Frogmouths, which now visit our place with their young each summer. The call in question is on the CD mentioned above and is described as the call of young being fed (however, whether the call is actually emitted by the young is difficult to establish).

—Sarah Lloyd
Birralee, Tas.

### ...Or Marbled Wheezers?

Several years ago, on our honeymoon, we tracked the nocturnal wheezing sound Nell Gray described in Q&A (*Nature Aust.* Autumn 2003) to two frogmouths, huddled on a branch, deep-breathing happily to one another.

For ten days, we watched the pair hunting. They looked very much like a male–female pair (one was larger), and made this noise only when cuddled up together. It seemed to be courtship behaviour (perhaps we weren't the only ones having a honeymoon!). The month was January, and the location (like Gray's observation) northern New South Wales.

None of the frogmouths we've observed since has made this noise. Given the location, we wondered if the wheezing birds were in fact rare Marbled Frogmouths (*Podargus ocellatus*). The call is not recorded in any book we've consulted, and it seems unlikely that such a distinctive sound, if it's normal for Tawny Frogmouths, hasn't been widely recorded: Tawny Frogmouths are very common birds, but relatively little is known of the behaviour and vocalisations of their Marbled cousins.

—Grayson Gerrard
& John Dawson
Fingal Head, NSW

*The birds in Gerrard and Dawson's accompanying photographs were identified as Tawny Frogmouths. Female Tawnies tend to be darker in north-eastern New South Wales and in this way may superficially resemble Marbled Frogmouths.*

—G.H.

### Destructive Humans

I am not comfortable with an attempt to validate our actions by reiterating our commonalities with other creature ("Ecosystem Engineers" *Nature Aust.* Autumn 2003). Being unique in degree is huge enough to rock the world. I am not reassured by the fact that we're not the only ones involved in destruction.

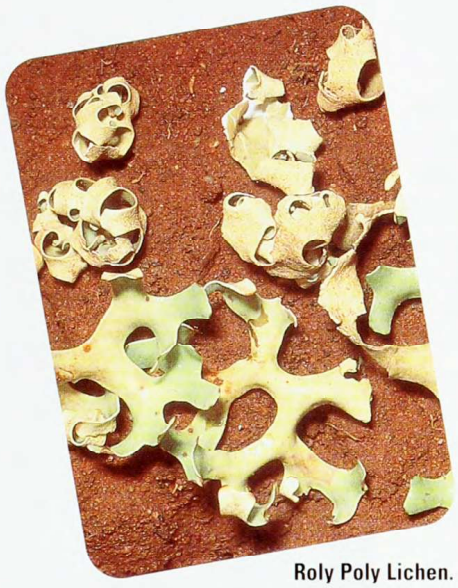
The fact is, there aren't six billion elephants, because they have been killed and restricted to demarcated areas by humans. It is not significant that we are "only different by degree" but that we are *tragically* different by degree. Unlike any other creature and against all reasons—for one would expect more from contemplative beings who are not in essence destructive—we have managed to orchestrate environmental catastrophe. I agree that destruction *per se* is not the evil. It's about supporting the balance of nature, or not. A move away from manipulation and control of natural processes (including genetic engineering) could lead us from a position of playing god to being Earth's guardians.

—Jessica Wagenfeld
Norwood, SA

**_Nature Australia_ requests letters be limited to 200 words and reserves the right to edit them for sense. Please supply a daytime phone number and type or print your name and address clearly. The best letter in this issue will receive a copy of *Life on the ice*. The winner this issue is Alan Moskwa.**

# *Winter*

**Compiled by Geordie Torr and Martyn Robinson**



DAVID ELDRIDGE

**Roly Poly Lichen.**

## Lichen time

Winter is a good time to look for one of nature's great partnerships—lichens. Each individual lichen is a 'coalescence' of two rather different life forms: an alga and a fungus. The alga uses photosynthesis to produce oxygen and sugars, while the fungus provides the living structure and breaks down raw materials for its partner. The alga can usually live without the fungus, but the opposite certainly isn't true. So much so that the fungi aren't choosy, and sometimes the same lichen species (named after the fungus) will be inhabited by one of several different algae, giving the colony a multi-coloured appearance.

During dry weather, many lichens shrivel up, looking crispy and dead. When it rains, however, they quickly absorb water, expand and 'resurrect' themselves. When you go looking for lichens, take a small spray bottle of water with you. When you find a crispy-looking patch, give it a spray and then have another look in ten minutes time. The change is often remarkable.

Perhaps the most remarkable of all is the Roly Poly Lichen (*Chondropsis semiviridis*) of arid southern Australia. Unlike most lichens, it doesn't grow fixed to anything, and when dry it forms a ball, about the size of a small marble, that blows around in the wind. Being dry and fragile, bits often break off, but this is all to the good. When it rains, the bits unroll, turn green and start to grow. Interestingly for a desert species, it has a problem with heat. If it gets wet in summer, the algal component can cook (steam, to be precise), so the lichen is usually only found where winter rains are the norm. Dry heat doesn't bother it at all.

To learn more about lichens, grab a copy of *A practical guide to soil crust lichens and bryophytes of Australia's dry country* (1997) by David Eldridge and Merrin Tozer.

## Watch out for whales in winter

Winter is the time when the big baleen whales come north from Antarctica to give birth and mate. Humpbacks (*Megaptera novaeangliae*) ride the prevailing north-flowing current during the first leg of their migration, which often brings them close to shore, making them an ideal species for whale watching.

The need for and timing of this long-distance journey, which can cover distances of 12,000 kilometres and take them to the Great Barrier Reef, are both to do with fat. Because the babies have little or no blubber, they would quickly freeze in the Antarctic. The adults, on the other hand, have a thick layer, so to prevent overheating they can only head north to give birth in autumn and winter.

The calves grow extremely quickly, putting on up to 60 kilograms per day on their mothers' rich milk, which they can produce at a rate of 600 litres per day. Interestingly, the adults don't feed for most of the migration; their thick blubber, no longer needed in the warmer water, is used to tide them over.

Once the calves have put on their new blubber overcoats, the whales

FRANCOIS GOTHIER/AUSCAPE

**Humpback Whale.**

KATHIE ATKINSON

Flame Robin.

begin the long trip south, the young conserving energy by riding in their mother's slipstream. This trick allows them to keep pace with only 75 per cent of the effort.

For more about whale migrations and good spots to see them, check out *Whale watching* (2001) by Peter Gill and Cecilia Burke.

### Moving down in the world

Whales and birds are famous for their long-distance winter migrations, but some species undergo much shorter seasonal journeys. Each year, Pink and Flame Robins (*Petroica rodinogaster* and *P. phoenicea*) and Pied Currawongs (*Strepera graculina*), among others, undergo an altitudinal migration, flying down from the mountains to the coastal areas.

Why? Well, apart from the obvious—it gets bloody cold up there—the cold weather slows plant growth and invertebrate activity, so there's less food available. In contrast, there's still plenty to eat down on the coast, where it stays relatively warm year-round. Come spring the abundant alpine vegetation and flowers burst forth with the returning warmth, attracting insects and providing a feast for the birds and their young, which they can raise without competition from the stay-at-homes down on the coast.

To learn more about the animals of the Australian Alps and how they deal with winter, visit **www.australianalps.ea.gov.au/edukit/fauna.html**.

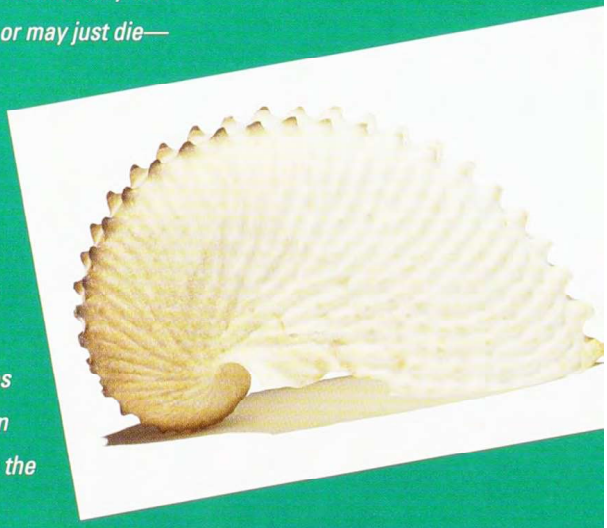
## FROM THE COLLECTION

*The Paper Nautilus (*Argonauta nodosa*) is a peculiar beast. It's a type of octopus, but instead of living on the sea floor, it actively swims or drifts around with the ocean currents. The males are tiny (three centimetres in length), but females grow much larger, forming the beautiful, fragile shell-like egg case that gives this species (and others in the genus) its name. The case can be more than 30 centimetres in diameter.*

*Here's where things get really bizarre. The male's third arm on the left is a reproductive arm or hectocotylus. When nautiluses 'mate', this arm breaks off and takes up residence in the female's shell, where it can impregnate her when required. The male may then grow a new arm or may just die—no-one seems sure.*

*The name hectocotylus was coined for the reproductive arm by the zoologist Georges Cuvier in 1829. On finding an arm in the shell of a female, he assumed it was a parasitic worm—hectocotylus means 'many-suckered worm'.*

*The earliest specimen of a Paper Nautilus in the Australian Museum's collection (shown below) was deposited by a museum collector by the name of Brazier in 1874 from what was then Six Mile Beach (now known as Newcastle Bight) in New South Wales. There may have been earlier specimens but over time the shells deteriorate into fragments, so earlier ones were often thrown away. For more about these odd octopods, visit* **www.mlssa.asn.au/journals/1997Journal.htm.**



STUART HUMPHRIES/NATURE FOCUS

*Geordie Torr is a freelance science writer and Martyn Robinson is the Australian Museum's resident Naturalist.*

# nature strips

COMPILED BY GEORGINA HICKEY

RICHARD FULLAGAR, KARINA HOLDEN, KAREN MCGHEE, RACHEL SULLIVAN, ABBIE THOMAS, GEORDIE TORR AND VANESSA WOODS ARE REGULAR CONTRIBUTORS TO **NATURE STRIPS**.

## Lionesses Prefer Brunettes

On the Great Plains of Africa, the age-old question that continues to vex human society is being asked once again. Blondes or brunettes? Which are more attractive—not to gentlemen this time—but to Lionesses?

The Serengeti has its share of blonde bombshells and tall, dark and handsome Lions (*Panthera leo*). Despite the melange of manes, no-one has ever determined what factors influence the colour or thickness of the feline's mane. That is, until Peyton West and Craig Packer from the University of Minnesota headed out to Tanzania's catwalk to tackle the hairy question.

West and Packer began by examining photographic records collected over four decades of Lion research. Early analysis indicated that Lions with darker manes had higher testosterone levels, were more mature and were well nourished. It appears mane colour is not inherited, but rather indicative of health. The fact that an individual's mane changes colour over the years also supports the theory.

Next, the researchers placed life-sized models of Lions within the territory of a pride. Each dummy came with an array of wigs of differing shades and lengths. Male Lions deliberately avoided the dummies wearing long, dark manes, yet females seemed to gravitate towards dark manes

JOHN SHAW/AUSCAPE

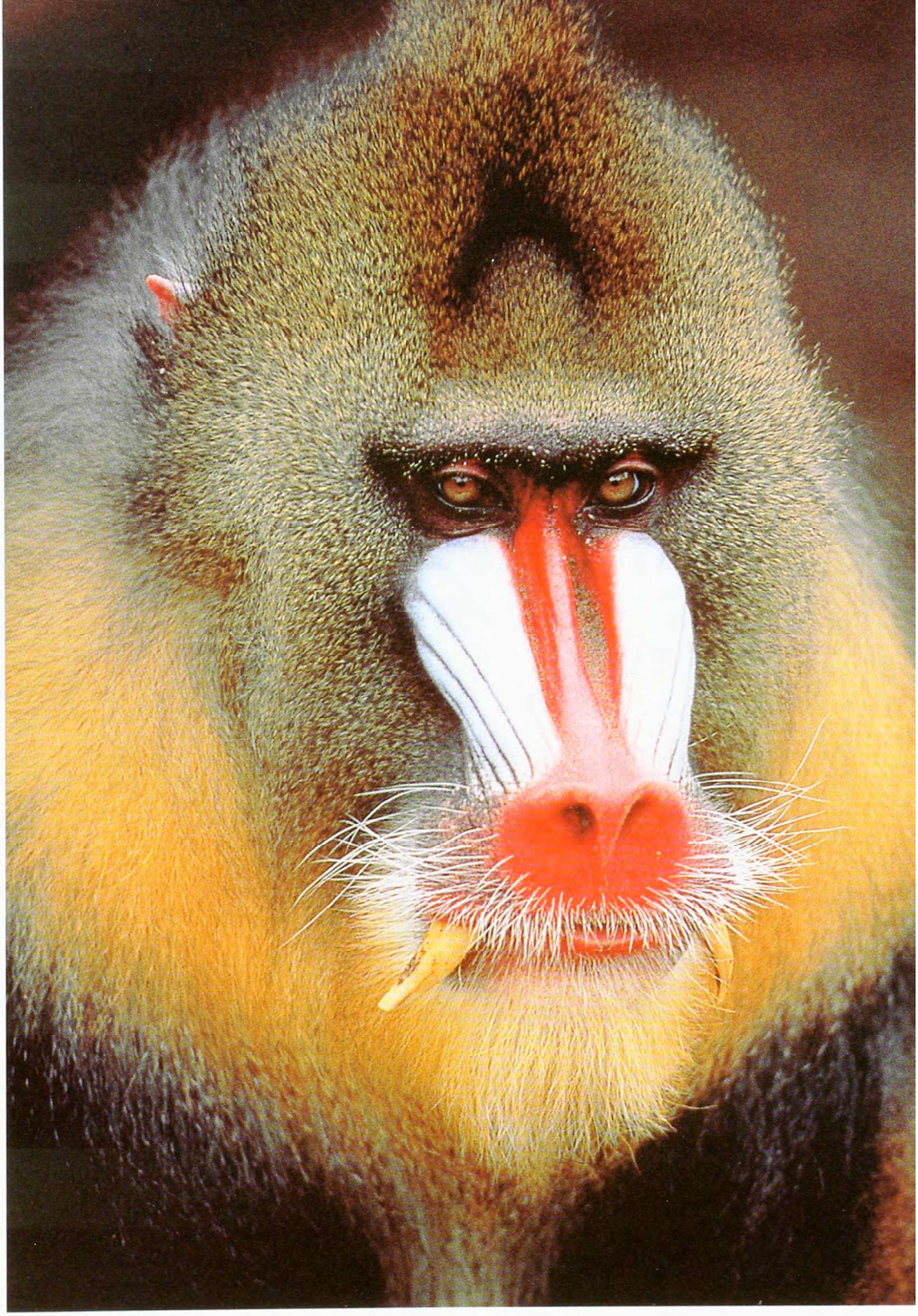
**Dark-maned Lions are hot—both physically and figuratively.**

(long or short), often displaying sexual behaviour. By preferring males with darker manes, the Lioness is likely to gain a healthier mate, resulting in direct fitness benefits to her offspring. Likewise, the male's avoidance of these dark, handsome strangers lowers the potential cost of fighting off stronger, more aggressive rivals.

But like the Peacock's tail, maintaining a full flowing mane can be costly on the hot African savanna (see "The Mane Thing", *Nature Aust.* Autumn 2003). Using infrared cameras, the researchers quantified the heat difference between blondes and brunettes. Dark-haired beauties suffered a significant thermal load from their manes, suggesting again that only males in prime condition could take the heat.

Brunettes may be more beautiful in the eyes of the Lioness. They may have superior survival and competitive abilities to blondes in the pride. But the question remains, which have more fun?

—K.H.



**The male Mandrill has a face that you'd never forget.**

SCHAFER & HILL/PETER ARNOLD/AUSCAPE

### Handsome Mandrills

Male Mandrills aren't big on fidelity—you can see it in their bright blue and red faces.

Found in the rainforests of central Africa, Mandrills (*Mandrillus sphinx*) look rather like baboons and, like baboons, are mainly ground-dwelling, omnivorous and highly social. Hence, everyone assumed they were related to baboons and that they too lived in groups consisting of a single dominant male with a harem of females.

But it turns out they aren't that closely related to baboons at all. So a team led by Kate Abernethy (Centre International de Recherches Médicales de Franceville) met in Gabon to find out whether their social systems were different as well.

What they found was that Mandrills live in extremely large, stable groups called hordes. The mean size of these hordes was 620, but groups of up to 845 individuals were recorded—the largest stable groups of any wild primate population.

Absent from these enormous groups were breeding-age males, which seemed to prefer living a solitary, bachelor existence. There was only one thing that could bring them back into the fold...sex.

When females became sexually receptive, between June and November, males would appear—grunting (for up to 12 hours at a time!), marking things with their scent, and, of course,

GUNTHER SCHMIDA

**Archerfish are not only excellent marksmen, but great retrievers too.**

mating. The number of males visiting a group at any one time was positively correlated with the number of females displaying red and swollen bottoms.

The researchers speculated that this "love-'em-and-leave-'em" approach explains the male's outragious facial colouration, not to mention their large size (male Mandrills weigh more than three times the average female)—one of the largest sexual dimorphisms of any primate. They suggest that, without the normal long-term social bonds that build up with time in a group, the males need to gain the attention of prospective mates quickly, and a bright blue and red face will certainly do that.

—G.T.

### Archerfish Do it Without Looking

Archerfish are excellent shots, squirting water at an unsuspecting insect, then rushing to devour it as it hits the water. But new research has found they can retrieve their quarry without even a glance.

When baseballers run to catch a ball, they must continually watch it to check its position during flight. But archerfish can calculate where the prey will land within one hundredth of a second after hitting a target.

Samuel Rossel and colleagues (Albert-Ludwigs-Universität Freiburg in Germany) studied the remarkable hunting technique of archerfish using a video camera. They suspended a dead fly above the tank and waited for the fish to take aim. Within a tenth of a second after a fish had 'shot' its prey with water, it turned rapidly to align itself with where the prey would land and, without any further checking, headed straight in that direction.

But do fish really decide what to do so early in the hunt? In a further experiment, the fly was made to change directions after it had been hit by a fish. It was tied to a fine piece of cotton so that, when it was knocked off its perch, it travelled in one direction for an instant but then was pulled back in a different direction. The archerfish still rushed to the spot where the prey would have landed had it not changed direction, showing that the fish only observed for the first few milliseconds before making its move.

Archerfish hunt in groups and there are always plenty of hangers-on. The first fish to reach the fly eats it, regardless of which fish shot it down. Archerfish can't afford to waste time watching their prey sail through the air. Their automatic response has evolved to enable them to get there first, or go hungry.

—A.T.

### The Human Tangled Bush

The latest contender for the oldest human ancestor comes from Chad in central Africa. Nicknamed Toumai, the new species (*Sahelanthropus*

*tchadensis*) has been hailed as the human fossil find of the century—partly because it challenges the 'tidy' model of human evolution, and also because it suggests it was in central Africa around forested lakes that humans first evolved, rather than in the savanna grasslands of East Africa.

Michel Brunet (Université de Poitiers, France) and a huge international team of researchers assigned six specimens (including a nearly complete skull) to the new hominid species. There are some skeptics, like Milford Wolpoff (University of Michigan), who believe Toumai is more ape than hominid. This criticism is perhaps not unexpected, considering the bones are so primitive and date (on the basis of faunal association) between six and seven million years ago—not long after Chimpanzees and humans parted genetic company. However, Brunet is adamant that measurements on the key characters that distinguish hominids from apes (such as smaller teeth and bipedal posture) indicate the Toumai skull belonged to an adult male hominid.

**The skull of Toumai: could this be what we've all been looking for?**

Perhaps the most striking feature of Toumai is its prominent brow ridge. This is especially surprising because it is typical of much later human ancestors like *Homo erectus*. How can evolutionary characters like this re-appear millions of year later? According to Bernard Wood (George Washington University), shared morphologies are not necessarily inherited from a common ancestor, and we should not assume that distinctively human characteristics only evolved once. He argues that the Toumai discovery casts doubt on the 'tidy' model of human evolution, which presents a linear progression

### When Flowers Mean No Sex

Some orchids have evolved flowers that look and smell like female insects. Male insects are attracted to the blooms, attempt copulation and, in the process, facilitate pollination.

It's a ruse that produces clear benefits for the orchids. But how does it affect the insects? That's what Australian National University researchers Bob Wong and Florian Schiestl asked when they delved into the relationship between the orchid *Chiloglottis trapeziformis* and the wasp *Neozeleboria cryptoides*.

Wong and Schiestl began their study by showing that male wasps are unable to differentiate between pheromones released as long-range sexual attractants by female wasps and those dispersed by their floral mimics.

It turned out to be a different story, however, after the liaisons became more intimate. In field trials using artificial orchid colonies set up in a eucalypt forest frequented by the wasps, the researchers found that the male insects eventually saw through the floral deception. They seemed to learn that, no matter how much the orchid blooms smelled like potential mates, copulating with them was a waste of time. As a result, the number of visits they made to the flowers decreased over time.

For female wasps placed in or near the colonies, this was bad news. They too appeared to be eventually dismissed as time-wasting mimics and ignored by potential mates. Being flightless, the females depend on males to carry them to food during the course of copulation. Attracting males is therefore critical to their survival as individuals as well as the species.

This so-called 'site-based avoidance strategy' by males means that female wasps have a much greater chance of attracting mates away from sites where the orchids proliferate.

—K.McG.

COURTESY FLORIAN SCHIESTL

**A male wasp (*Neozeleboria cryptoides*) attempts to mate with the orchid *Chiloglottis trapeziformis*. Does familiarity breed contempt?**

from *Orrorin tugenensis* to *Sahelanthropus tchadensis* to *Ardipithecus ramidus* to *Australopithecus anamensis* to *Australopithecus afarensis* to *Homo habilis* to *Homo erectus/Homo ergaster* to *Homo sapiens* (us).

Wood suspects that early human evolution is more like a tangled bush than the conventional model of a branched family tree with one solid trunk. In his 'tangled-bush' model, there are likely to be early apes and humans that are ancestors of neither, and he suggests that identifying the very first hominid in a 'tangled' but scanty fossil record may be just about impossible.

—R.F.

### The Physics of Dieting

Want to quickly shed a couple of kilograms? Then you could try sitting in a sauna until the weight drips off. Wrapping your body in plastic film and then going for a brisk walk would have the same effect. Or you could simply move your scales from the shag-pile in the bedroom to the tiles on the bathroom floor.

As every hard-core dieter knows, carpet is a far less encouraging location for your scales than a hard surface during weekly weigh-ins. And that, according to University of Cambridge physicist David MacKay and his student Jon Pendergast, can no longer be dismissed as a dieter's myth.

The pair found you could actually expect to weigh about ten per cent less on a set of standard analogue scales placed on a hard surface than when positioned on a soft surface.

When a person steps onto analogue scales, a series of

**When were Cats first introduced to Australia?**

fulcrums (or levers) shifts a spring-loaded plate, the movement of which is read on an external dial. On a soft surface, such as carpet, the fulcrums shift slightly more than they would on a hard surface, and this in turn initiates more movement in the metal plate and a greater reading on that all-important dial.

The researchers found that the effect occurred also in digital scales but to a far less extent than in the analogue model.

Because scales are usually calibrated during manufacture on a hard surface, the tiled bathroom floor is likely to provide a more accurate assessment of your weight than a carpeted surface.

—K.McG.

BRETT LOCHMAN/LOCHMAN TRANSPARENCIE

**Pussy Cat, Pussy Cat . . .**

The role of Cats in the decimation of Australian wildlife is well documented, but there has been considerable argument about whether their arrival coincided with the arrival of European settlers, or whether they came earlier by other means, such as through Aboriginal colonisation, Indonesian trepangers or early European seafarers.

Now Ian Abbott from the Department of Conservation and Land Management in Western Australia has

JOE McDONALD/AUSCAPE

**North American Porcupines have quills that know when to let go.**

conducted an extensive literature review to settle the question about when Cats first made landfall in Australia. His intentions were more than academic, however. Pinpointing a time for the predator's arrival is not only critical in establishing its role in the decline and disappearance of native mammal and bird species, it may also affect future species-management strategies.

Abbott found no evidence that Cats were on mainland Australia before European settlement, nor was there any record of Cats being found beyond settled areas in expeditions made between 1788 and 1883. He did find, however, that once introduced in multiple coastal locations between 1824 and 1886, they spread rapidly until almost the entire continent had been colonised in 1890.

Cats were initially slow to spread because of competition and threats from other predators like Dingoes, Wedge-tailed Eagles and quolls. But with the spread of pastoralism and expansion of European civilisation, those competitors were removed and Cat populations were free to explode.

Several factors hamper attempts to determine whether Cats were responsible for the early decline of any mainland species. Cats have coexisted with all mammal species in Tasmania for 200 years and, following extensive Fox-baiting in south-western Western Australia, native animal populations recovered rapidly, despite the continued presence of feral Cats.

The literature indicates that colonisation of mainland Australia by Cats is only one factor that might have contributed to the decline of native mammals; other facts that must be considered include climate change, predation by Aborigines and the Dingo, pastoralism, inappropriate use of fire and extensive land clearing.

—R.S.

## Smart Quills

The quills of a porcupine are used in defence but, after jabbing an opponent, it's in the porcupine's best interest to extract them as quickly as possible. For this reason porcupines have evolved 'smart quills' that know when to let go.

Uldis Roze (Queens College, New York) captured eight North American Porcupines (*Erethizon dorsatum*). To simulate contact with an opponent, when the captive porcupines assumed a defensive position and raised their quills, Roze struck a styrofoam cube against the erect quills. Once the animal was anaesthetised, he measured the tension needed

to pull them out of the porcupine's skin. He found it was far easier to pull out quills that had been embedded in styrofoam (or his hand!) than for non-impacted or relaxed quills.

Roze explains that when a porcupine's erect quills are rammed into an opponent's flesh, the quills are thrust backwards by the impact. In this situation, self-stabbing is prevented by a 'shoulder' near the quill's slender base, however the back-travel shears the quill's attachment to surrounding tissue and allows it to be readily removed. Relaxed quills, or those that have not sustained an impact, remain firmly attached.

The adaptations that make quills so effective against opponents also pose a hazard to the porcupines, says Roze. Because porcupines frequently fall out of trees, they risk self-impalement but have evolved an antibiotic coating on the quills that reduces infection (see *Nature Aust.* Winter 1995). By evolving adaptations that reduce the risk of attack and self-attack, and that enhance quill separation after an encounter, quills remain an effective weapon while reducing incidental costs to their owner.

—R.S.

## Consuming Passions

If chocolate is the gift of love, then humans have been 'making love' for over 2,600 years. Jeffrey Hurst (Hershey Foods, USA) and archaeological colleagues from the University of Texas have discovered the world's oldest evidence of chocolate consumption at Colha, in northern Belize, Central America. This pre-dates other finds by about 1,000 years.

The researchers discovered the remains of chocolate (*Theobroma cacao*) inside three early Mayan pottery vessels with long high spouts. This


TERRY G. POWIS, COURTESY THOMAS R. HESTER & THE COLHA PROJECT

**Early Mayan choc pot, used for making a frothing chocolate brew.**

## Crab-cracking Snakes

Next time you find yourself sucking the flesh from a neatly cracked crab's leg, try to image how you would go consuming the crustacean without hands. This is precisely the dilemma that faces two species of snake found in Singapore.

A common tenet in herpetological circles is that snakes swallow their prey whole. But when a team of scientists led by Bruce Jayne (University of Cincinnati) looked at the stomach contents of Gerard's Water Snake (*Gerarda prevostiana*) and the White-bellied Mangrove Snake (*Fordonia leucobalia*), they found crab species that were significantly larger than the gape of the snakes' mouths. And what's more, many of the crabs had been dismembered. Could these be the only snakes known to break up their food into more manageable pieces before swallowing?

In order to solve this mystery, the researchers served Gerard's Water Snakes nice crab dinners, turned the lights down low, and then recorded their eating habits using infrared video. Viewing the tapes, they saw the serpents performing some clever contortions. Having grasped the crab in its mouth, each snake pulled it through a loop of its body and then continued to pull while coiled around the crustacean. (For a video of this extraordinary behaviour, see *http://www.biology.uc.edu/faculty/jayne/videos.htm*.) The snakes were thus able to tear the legs off the crab and even rip up the carapace, enabling them to consume crabs much larger than their mouths.

Gerard's Water Snake only selects freshly moulted crabs, and so is able to tear the carapace of large crabs apart. The White-bellied Mangrove Snake, however, eats hard-shelled crabs and must be content with just the legs.

—G.T.

ROBERT VALENTIC/NATURE FOCUS

**Female wolf spiders follow the beat of the drums.**

style of pot is known only from the Preclassic Period (900 BC to AD 250). According to later written records, Mayans (and neighbouring Aztecs) preferred their chocolate as a frothy beverage, produced by pouring liquid chocolate back and forth between vessels. However, in these earlier pots froth could also have been made by introducing air down the spout (much like blowing bubbles into a drink through a straw).

Chocolate is made up of a unique combination of over 500 compounds, the most diagnostic being theobromine. Applying highly sensitive analytical techniques, Hurst and colleagues were able to identify theobromine in the dried residues from the interior surface of the vessels.

Theobromine is thought to stimulate the heart and nervous system (so much so that a chocolate bar may poison the family pet). Other chemicals in chocolate supposedly act as antidepressants, antioxidants and even aphrodisiacs. But whether such benefits were known to the Mayan manufacturers of chocolate, or whether they simply drank it for the pleasure, is unknown.

—R.F.

## Drumming for Love

Every girl loves a talented musician, and female wolf spiders are no exception. Scientists have found that the female wolf spider *Hygrolycosa rubrofasciata* judges her potential suitors on the length, not the strength, of their drumming.

Male wolf spiders make a drumming sound by striking their abdomen against the ground. Wolf spiders live in open bogs and meadows, and in the mating season males patrol their area, stopping occasionally to drum on dry leaves and grass.

The females 'hear' the sound with thousands of tiny vibration receptors, which are mostly on her legs. Being hunters, these spiders are extremely sensitive to vibrations, local air movements, and sound. They detect the drumming not only via the vibrations that travel through the ground, but also from the sound waves that travel through the air.

Silja Parri and colleagues from the University of Jyväskylä in Finland played digitally recorded wolf-spider drummings of different lengths and speeds to female spiders. They found that females preferred males that drummed for the longest time, but had no preference when it came to how fast they could drum.

The researchers suggest that female spiders, like some insects, assess their partners' physical and genetic features by the quality of their calls. In the case of wolf spiders, drumming is hard work. Anyone can make a few loud noises, but only the strongest and the fittest will be able to keep up the drumming over a long period of time.

And the winner is...drumroll...

—V.W.

## Frog Chauffeurs

As frog fathers go, members of the family Microhylidae are a pretty special lot. Many of the males hang around after the female has laid her eggs, guarding the eggs against attack from predators and fungal disease. But while studying frogs at Crater Mountain in Papua New Guinea, David Bickford (University of Miami) found that males of at least two species, *Liophryne schlaginhaufeni* and *Sphenophryne cornuta*, go above and beyond the call of parental duty.

Like those of other Papuan microhylid frogs, the eggs of these species hatch into fully formed froglets. At some point after this happy event takes place, Dad loads the kids onto his back—as many as 22 of them at a time—and hops off into the forest. He carries them for distances of up to 55 metres, the froglets alighting from their moving

transport one at a time over a period of up to nine nights.

Females of a cave-breeding Jamaican frog also transport their offspring on their backs, carrying them out of the caves in which the species breeds (see *Nature Aust.* Winter 1996). However, this is the first time such behaviour has been studied in male frogs. Bickford speculates that it evolved to disperse the babies more widely, thereby reducing inbreeding, predation and competition for food.

—G.T.

**DIY dispersal: a male frog (*Liophryne schlaginhaufeni*) takes his kids for a ride.**

COURTESY DAVID BICKFORD

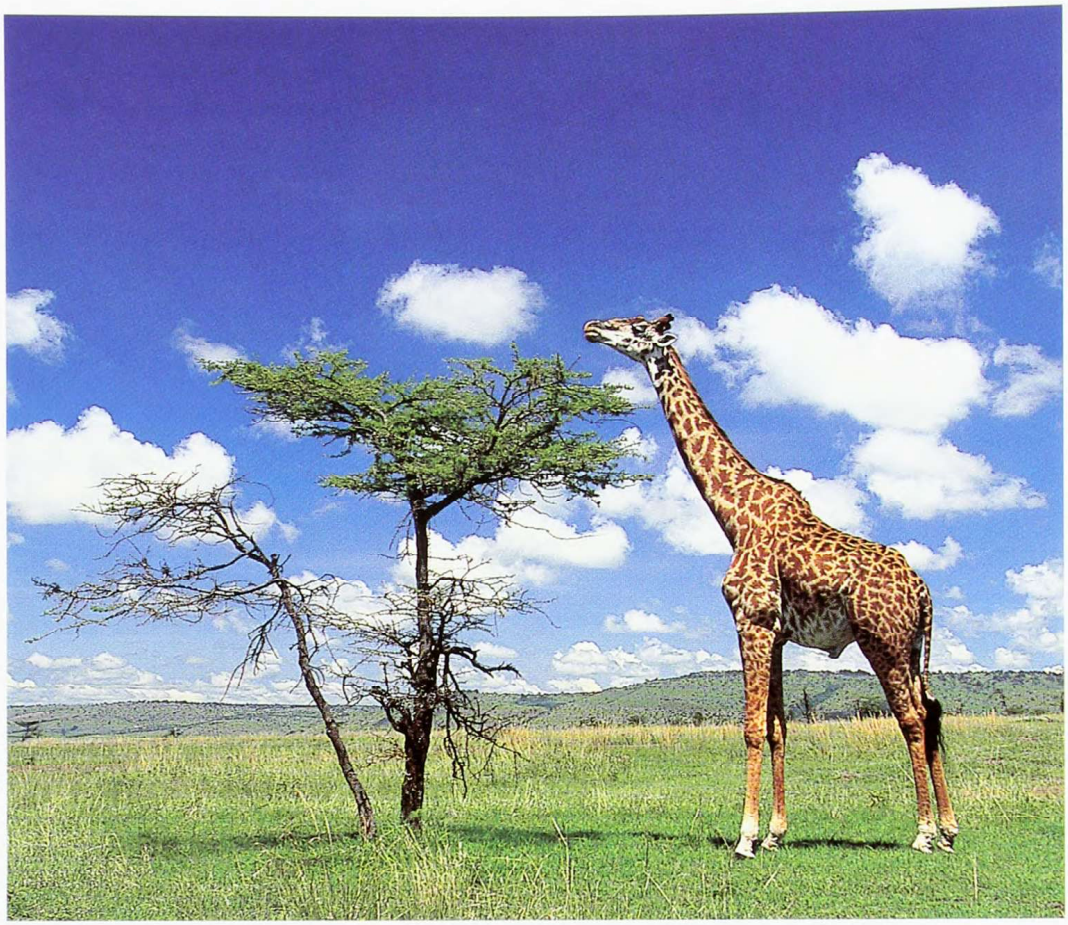
### Lopsided Jealousy

Are less attractive lovers more likely to be jealous? Many scientific studies have shown that better-looking individuals get more sex and have more babies. So if you're no Clark Gable or Marilyn Monroe, you could be forgiven for envying those with fairer features.

But is envy really the reason? Not so, according to Canadian researchers who argue that more subtle, evolutionary forces are at play. Indeed, they suggest that jealousy might enable less attractive lovers to make their mate faithful.

William Brown and Chris Moore from Dalhousie University investigated the relationship between attractiveness and jealousy. A standard measure of attractiveness is how symmetrical someone's features are, such as foot and hand width or ear length. Combining these gives a figure for fluctuating asymmetry (FA)—an indication of how symmetrical one's features are. Brown and Moore measured a group of students for FA, then gave them two questionnaires—one to test how jealous they get in romantic situations, the other to find out how jealous they are generally.

Sure enough, the researchers found that the more asymmetrical (lopsided) people were, the more romantically jealous they were too, and this was true for both men and women. However, there was no correlation between asymmetry and the tendency



FERRERO-LABAT/AUSCAPE

**Eau de Giraffe may be quite repulsive.**

to be jealous generally, such as in the work place.

If jealousy is an evolutionary strategy, it has a high cost, manifested in marital conflict and violent relationships. Brown and Moore suggest that the trade-off for this cost, at least for less attractive individuals, is that jealousy helps stop their partners from straying.

—A.T.

## Long-necked Stinkers

It has been said that Giraffes are particularly high—not just in stature but also on the nose. Their odour has been described as "most disagreeable, musky, nauseating" and detectable from 250 metres downwind. One early naturalist even suggested the smell might repel Lions and other predators.

William Wood (Humboldt State University) and Paul Weldon (Smithsonian Institution) put their noses together to find out what was behind the supposed stench. They took hair samples from the neck, shoulders and back of a male and a female captive-bred Giraffe (*Giraffa camelopardalis*), and isolated the various compounds adhering to the hair. They identified 11 major volatile compounds, from both sexes.

Two alkaloids (indole and skatole) appeared to be largely responsible for the smell. Both have an intense faecal odour at high concentrations but become pleasant in very dilute solutions. Interestingly, indole also occurs naturally in some flowers. (This may explain why a few jonquils, for example, smell so sweet, yet in large bunches smell foul.) The two alkaloids were found in higher concentrations on the male Giraffe, but neither was found in the Giraffe's closest relative, the Okapi (*Okapia johnstoni*).

Many of the volatile compounds are known to deter microorganisms (including those that cause skin diseases, such as tinea, Golden Staph and acne). As the researchers explain, each may have only a moderate effect on its own but when acting together could be quite potent. The compounds may also inhibit parasites. One, *p*-cresol, inhibits ticks at concentrations that appeared on both the male and female Giraffe.

Just how effective these compounds are at repelling microorganisms, parasites or even predators of wild or captive Giraffes remains to be seen.

—G.H.

## All Aboard the Sperm Train

In one Gary Larson cartoon, a single sperm outstrips its competition with the help of an outboard motor. Now researchers have found that, in the race to get to the egg of the Wood Mouse (*Apodemus sylvaticus*), the quickest route to success is joining a sperm train.

Harry Moore (University of Sheffield) and colleagues discovered that hundreds of thousands of sperm link together and beat their tails in unison. Within five minutes of the sperm entering the reproductive tract, hooked structures that were lying flat on each spermatozoon's ventral surface reach out and grab the hook or tail of their nearest stablemate. With so much 'flagellum power', the train moves towards the egg at nearly twice the speed of a solitary spermatozoon.

After about half an hour, the sperm train starts to break up, with the sperm committing genetic harakiri by undergoing what is referred to as a premature acrosome reaction. This causes the release of enzymes that break down cell-adhesion molecules, making it impossible for the sperm to bind to the egg. Few sperm—possibly just the train driver—remain unaffected by the altruistic mass-sterilisation and survive intact to fertilise the egg.

Wood Mice are highly promiscuous, with males scrambling to mate with as many females as possible. They have developed extremely large testes, which produce lots of sperm to out-compete their rivals. In the same way that individuals are more likely

to cooperate and help their closest of kin, it makes sense that spermatozoa may display altruism and cooperate when inter-male sperm competition is so intense.

—R.S.

### Go Gadget Crow!

Could crows be about to overtake primates in the smart stakes? Recent research has revealed that the New Caledonian Crow (*Corvus moneduloides*) has a talent for tool-making that far surpasses the fiddle sticks Chimpanzees have mastered.

In a series of laboratory trials conducted at Oxford University, Alex Kacelnik and colleagues observed their captive crow 'Betty' devise tools in order to retrieve food. Betty was presented with a small piece of wire, while her bucket of food was placed out of reach inside a pipe. After assessing the situation, Betty used her beak to fashion a hook out of the straight piece of wire and used this gadget to fish for her food. Betty's cognitive capabilities are all the more astonishing, considering she had had little exposure to wire before the trials and no training with pliant material. The researchers are lauding these clever crows as the most innovative tool-makers in the animal kingdom.

In the wild, New Caledonian Crows have also been observed making tools to retrieve insects from holes in trees and logs. The gadgets they manufacture include tapered implements made from pandanus leaves, thin probing tools, and hooks shaped from twigs and barbed leaves. Use of tools of one kind or another throughout the range of the species indicates that the crows have some inherited predisposition for tool use, but the process by which they learn about different tools is unknown. The complexity of their tool kit proves these unassuming birds have perhaps the greatest cognitive capabilities of all non-human animals.

—K.H.

### QUICK QUIZ

1. *What type of animal is a knobtail?*
2. *Where would you look to find a spermaceti organ?*
3. *What was the name of the oil tanker that broke in two and sank off the Spanish coast in November last year?*
4. *Which is the only non-human primate to practise tongue kissing?*
5. *What is the faunal emblem of Queensland?*
6. *Name the major river that runs through WA's Kimberley district.*
7. *What do sea kraits mainly eat?*
8. *Which layer of the atmosphere do we live in: the ionosphere, stratosphere or troposphere?*
9. *What does the term osteophagy refer to?*
10. *What were Swamp Buffaloes in Australia initially harvested for?*

*(Answers on page 82)*

JEAN-PAUL FERRERO/AUSCAPE

**New Caledonian Crow: master tool-maker.**

# Thumbs down to the Sewer Rat

*The diseases carried by Sewer Rats have accounted for more human deaths than all the wars in history combined.*

MY OLDER BROTHER, WHOSE bedroom I shared until I was seven, was Nature's consummate tease with a repertoire of tortures and abasements stolen from the dungeons of Ming-the-Merciless. One of his specialties was to lie casually on his bed and slowly verbalise an inventory of the goblins, snakes and other crawling things he said he could see sliding around under *my* bed.

Naturally, I said I didn't believe him, but each night around bedtime he must have felt smug seeing me sprint from the bathroom and leap a good two metres onto my bed, making sure those feet of mine got nowhere within striking distance of anything slithering under my mattress.

Then one day he met his match. He and two mates had cornered a Sewer Rat in the garage and were busy prodding and tormenting it.

Now cornered Sewer Rats, like Trade Unions at Easter, will strike with little provocation. Some zoologists say this is attributable to fear while others contend that the Sewer Rat just has a natural vicious streak that is nastier than that of any of its cousins.

For whatever reason, the rat let out a screech and leapt at my brother's face. But, alas, like my fist on so many occasions, it only got half way there, to be stopped in mid-flight by his quick left block. All was not lost however, for the rat found a mark and latched on to the knuckle of his thumb. And there, with its infectious-looking yellow teeth buried to the bone, it dangled like a mouldy chorizo sausage in a deli window.

The commotion brought Dogs and mothers running from all directions. While the ladies screamed and ran round in circles, my brother had to climb up onto the work bench to get away from our Fox Terrier, rendered delirious by the intoxicating mix of rat fumes and confusion. The Dog kept barking and jumping up at the rat, the mothers kept yelling at my brother to come down and negotiate, and he resisted all offers of help because every time he tried to jerk the rat off, it dug its teeth in deeper.

Finally the day was won when Mrs Lusch, the local kindergarten teacher, burst into the fracas. A generously padded woman, tall as she was wide and well versed in bringing chaos to order in seconds, she summed up the situation quickly then whacked the swinging rodent senseless with a few well-directed sweeps of her umbrella.

Sewer Rats (*Rattus norvegicus*), or Brown Rats as they are known in more polite circles, are an accidental (inevitable) shipping introduction to Australia from northern China via Europe. In Australia they are primarily city and waterfront rats, at home puddling around filth and squalor, and eating anything their powerfully built bodies can tackle and dispatch—birds, fish, mice, prawns, chickens, shellfish and eggs. Overseas there are records of them setting on and killing newly born lambs and piglets. Meat-eaters by choice, but probably mainly plant-eaters by necessity, they'll settle for paper, soap, faeces and shoes when the going gets tough. Human food leftovers are also high on their list of preferences, and these rats are the ones regularly seen running out of garbage piles and into gutter pipes late at night in the city.

In Sydney's underground railway tunnels around Central and Town Hall, we used to shoot stones from slingshots at the Sewer Rats that were then thick in the black, spooky tunnels. In between train arrivals they would scurry out of the darkness looking for scraps below the platform before charging back into the sooty gloom just before the next train rumbled in.

Sewer Rats tend to live life down low and dirty, and although they *can* climb (running along overhead telephone lines when necessary), they are essentially tunnellers, digging and living together in tightly run packs where communication is by scent, posture and ultrasonic signalling. Here, the same well-worn runways might be used by the colony for up to 20 years. A big dominant male rules the rat pack, and all young males are driven away as soon

## Brown Rat

*Rattus norvegicus*

**Classification**
Family Muridae. Also called Sewer Rat.

**Identification**
Large, brown-grey, coarse-furred rat, 440 mm total length (near-naked tail 200 mm), 300 g, aggressive. Confused with Black Rat (*R. rattus*), which has tail longer than head–body and longer ears.

**Habitat and Distribution**
Worldwide. In major coastal cities and ports of Aust., extending north to around Cairns. Usually associated with water.

**Biology**
Carnivorous by choice, practically anything else by necessity. Females breed at 6 weeks, gestation 22 days, up to 18 young born (average 9) per litter, weaned at 20 days.

**BY STEVE VAN DYCK**

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**Cornered Brown or Sewer rats will strike with little provocation.**

as they begin to mature. When the social order is thrown into imbalance, for example when a campaign of poisoning is undertaken, and the dominant male is killed, minor explosions in rat numbers might occur as young males flood back into the undisciplined colony. Even in good times life is a short affair for most Sewer Rats, with 97 per cent of newly weaned youngsters dying before maturity and 95 per cent of adults dying at around a year old. Very few live to be geriatrics capable of defending themselves and their home pad at the ripe-old age of three.

The home range of each established rat is surprisingly small (perhaps a radius of 25–50 metres) but, astonishingly, the Sewer Rat has been recorded travelling up to three kilometres each night to plunder a particularly attractive food resource (trapped eels in this case!). Its love of wet feet and human company has elevated its reputation as a food spoiler and disease vector to a staggering height above other mammals. In fact, it has been claimed that the diseases carried by Sewer Rats have accounted for more human deaths than all the wars in the history of humanity combined.

As startling as this revelation is, children who play with pet rats (really just white laboratory strains of the same *Rattus norvegicus*) aren't likely to join the grizzly statistics. The disease-delivering lice, fleas, worms, bacteria, protozoans and viruses have long been factored out of the lab rat's life history, just like most of the crawly things that humans once carried got eliminated when we embraced personal hygiene. As for the incalculable generations of white lab rats that have abandoned squalor, effluent and garbage for the sake of medical science, many might say the score is settled!

My brother, who carries a certain thumb scar to this day, would say that, where rats are concerned, some scores are never settled. Me? I have no problems with long whiskers, bulgy eyes and scaly tails...just so long as I don't notice them twitching under my bed. □

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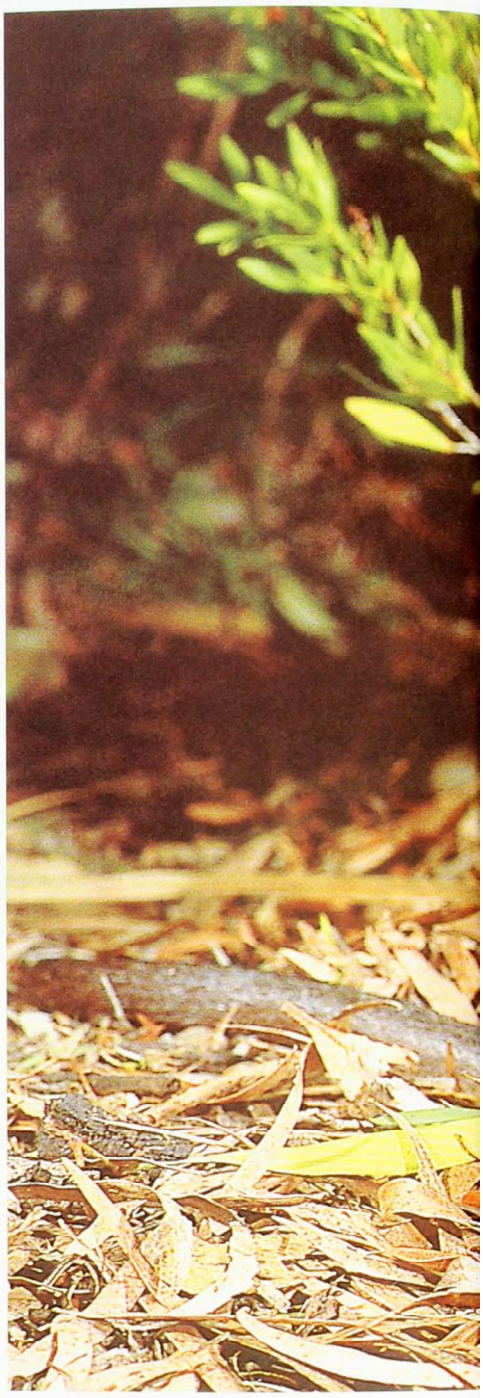
DR STEVE VAN DYCK IS A SENIOR CURATOR OF VERTEBRATES AT THE QUEENSLAND MUSEUM WHERE HE HAS WORKED SINCE 1975.

# Gilbert's Potoroo

*Australia's rarest mammal clings to existence on the slopes of Mount Gardner in Western Australia.*



A ROCKY, WINDSWEPT PENINSULA jutting into the Southern Ocean is home to the only known population of Gilbert's Potoroo. Australia's rarest mammal, it clings to existence on the slopes of Mount Gardner in scenic Two Peoples Bay Nature Reserve, 35 kilometres east of Albany, on King George's Sound, Western Australia. Its protruding eyes, heavy, hairy jowls and long, slightly Roman nose give this one-kilogram marsupial a somewhat mournful appearance. Gilbert's Potoroo (*Potorous gilbertii*) is very similar in appearance to the Long-nosed Potoroo (*P. tridactylus*) of south-eastern Australia, but both of these species can be easily distinguished from the much larger Long-footed Potoroo (*P. longipes*) of eastern Victoria and southern New South Wales.

In 1840, English naturalist John Gilbert obtained the first specimen of this potoroo at King George's Sound. He sent it home to John Gould, who named the species *Hypsiprymnus gilbertii*. Several more specimens were collected in the 1860s and 1870s but, with no further records, by 1970 the species was considered extinct. In that year, as if things weren't bad enough for Gilbert's Potoroo, it was 'downgraded' to being a mere subspecies of the Long-nosed Potoroo. In 1994, however, Elizabeth Sinclair (University of Western Australia) caught several mysterious mammals in Two Peoples Bay that, on comparison with museum specimens, proved to be Gilbert's Potoroos. Furthermore, DNA techniques showed them to be as different from Long-nosed Potoroos as they were from Long-footed Potoroos, so Gilbert's Potoroo was reinstated to full species status.

At Two Peoples Bay, Gilbert's Potoroos live in dense *Melaleuca* heath with a sedge understorey, spending the day in squats between clumps of sedges. The population is estimated to be less than 40 animals, consisting of five distinct colonies, and so far no other populations have been found. This tiny population size qualifies the species as Critically Endangered.

*Its protruding eyes, hairy jowls and slightly Roman nose give this marsupial a mournful appearance.*

Gilbert's Potoroos are highly dependent on underground-fruiting fungi. Many mammals eat these truffle-like fungi, but only the Long-footed Potoroo comes anywhere near Gilbert's Potoroo in its preference for these delicacies. Over 90 per cent of the diet of these two potoroo species is made up of 'truffles', which they dig up with their long front claws during the night.

Female Gilbert's Potoroos, like other potoroos, carry one young in the pouch at a time and can produce two within a year. They can hold an embryo in suspended development or diapause, and this will start to grow if a pouch young is lost. Gestation length is not known precisely, but indications are that it is at least as long as the 38 days of the Long-nosed Potoroo.

Gilbert's Potoroos were not widespread even in the early days of European settlement in Western Australia. They seem to have been numerous around Albany, but Gilbert did not hear of any in other parts of the colony and the only distant record was a skull found near a cave in the Margaret River area near the west coast. The survival of Gilbert's Potoroo on Mount Gardner seems to be linked to the long time since substantial fire. It is easy to imagine how clearing for agriculture frag-

**BY TONY FRIEND**

JIRI LOCHMAN / LOCHMAN TRANSPARENCIES

mented the habitat of the potoroo and how wildfires then wiped out local populations one after another. Recolonisation of remnant habitat was unlikely because the animals rarely cross wide-open spaces. As Foxes moved into the area in the 1920s, the potoroos would have been forced even deeper into thickets and away from open land. Plant dieback caused by *Phytophthora* infection may also threaten the habitat of this species by dramatically changing the structure of the vegetation.

The recovery plan for Gilbert's Potoroo, implemented by the Western Australian Department of Conservation and Land Management, includes monitoring and research of the wild population, searches for other colonies, and captive breeding using conventional techniques and possibly assisted reproduction techniques currently under investigation. The immediate aim is to provide sufficient new animals for reintroduction to suitable habitat away from Two Peoples Bay. Residents of the Albany area have formed the Gilbert's Potoroo Action Group, which helps to raise public awareness about the potoroos, assist with recovery work and raise sorely needed funds. Long-term survival of Gilbert's Potoroo depends on this. □

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# Growing where birds breed

*Australia is one of very few countries in the world with specialist seabird plants.*

IN AUSTRALIA, THE MOST INFERTILE of continents, the richest soils found naturally are those that develop on seabird isles. Around our southern coastline, wherever cormorants, shearwaters and other seabirds gather to breed, their wastes produce soil very rich in phosphates and nitrates. The guano (accumulated droppings) left by Australasian Gannets (*Morus serrator*) was even mined as fertiliser.

Vegetation is often killed by guano, which is effectively a natural pollutant. But although most plants suffer from too much of it, some plants called 'ornithocoprophiles' thrive on the stuff.

Leafy Peppercress (*Lepidium foliosum*) is Australia's most dedicated ornithocoprophile. Some years ago I found legions of these curious small shrubs by swimming out to a limestone outcrop near Beachport, South Australia. I could not fathom why the cresses were sprouting all over the barren isle among Little Penguin (*Eudyptula minor*) nests but not growing at all on the mainland a mere 30 metres away. (Seabirds, to elude predators, nest mainly on islands, so ornithocoprophiles favour islands too.) I later realised that this plant is—please pardon the jargon—an obligate ornithocoprophile, a plant confined to bird rookeries.

Australia has another four rookery specialists, although they occasionally grow elsewhere: Coast Hollyhock (*Malva* sp.), a lanky shrub; the Bass Strait Groundsel (*Senecio capillifolius*); Cook's Tussock Grass (*Poa cookii*) found on Macquarie Island; and the Pisonia Tree (*Pisonia grandis*) of coral cays—the world's only tropical seabird plant. Black Noddies (*Anous minutus*) nest on the Pisonia's limbs, and whole stands of trees may die if birds stop visiting. Other plants prosper around rookeries but are by no means confined to them, including pigfaces (*Disphyma crassifolium* and *Carpobrotus* species) and Blue Tussock Grass (*Poa poiformis*). These plants, known as facultative ornithocoprophiles, grow well in guano-enriched soil but don't rely on it. Antarctica also has lichens that do best near birds.

Australia is one of very few countries in the world with specialist seabird plants. New Zealand is another (with eight species), while others occur on isles off California and Mexico, and the Pisonia Tree grows on many Pacific and Indian Ocean islands. Rookery specialists are unknown anywhere else, although further species probably await recognition. They are most likely to arise in regions where rain (which washes guano away) seldom falls while birds are breeding, and where the parent soil is infertile, heightening the value of fertilisation. Fish-eating birds produce much richer fertiliser than most animals.

Botanist Mary Gilham visited many seabird isles around southern Australia and noted that succulents often replace sclerophylls, trailing herbs replace shrubs, annuals replace perennials and exotics replace natives. Brittle shrubs are battered by bird traffic, giving way to succulent creepers such as Bower Spinach (*Tetragonia implexicoma*), which trail over the dying shrubs and confound their woes. Succulent plants cope well with the excess nutrients by drawing water into their leaves to dilute the salts absorbed. Vegetation change can occur quickly. On the Mud Islands near Melbourne, ecologist Jeff Yugovic recorded rapid replacement of Grey Saltbush (*Atriplex cinerea*) shrubland by Coast Hollyhock after ibises and Silver Gulls (*Larus novaehollandiae*) began breeding there *en masse*. The hollyhock, unknown from the isles in 1972, now dominates eight hectares. Its fibrous stems withstand damage from birds.

Australia's seabird islands are often invaded by large numbers of European weeds, aided by Silver Gulls, which spread the seeds in their droppings. This raises the possibility that some of these plants may have evolved in seabird rookeries in northern Europe. In

PHOTOS: TIM LOW

**Leafy Peppercress depends on seabird excrement for its survival. It is one of six peppercress species with this dependency, the others growing on small islands off New Zealand.**

**BY TIM LOW**

**Karkalla (*Carpobrotus rossii*) is one of the succulent creepers that does best in guano-enriched soil around cormorant colonies in south-western Australia. The red fruits were eaten by Aborigines.**

Britain, weeds such as Chickweed (*Stellaria media*) and Dwarf Nettle (*Urtica urens*) grow mainly in gardens, farms and other disturbed, nutrient-enriched places, including seabird islands. They may have evolved alongside birds, later invading human settlements when these emerged. This could explain why rookery specialists appear to be absent from regions with a long history of farming—the plants expanded their frontiers long ago. The same shift could occur here. On one island, Gilham found Coast Hollyhock thriving away from a rookery, beside buildings and alongside weeds. It's a noteworthy fact that all of Australia's most specialised rookery plants (except the Pisonia) are closely related to European weeds. Human and seabird colonies have much in common, being disturbed, polluted places.

Rookery plants have more opportunities than most plants to disperse vast distances—as seeds attached to voyaging birds. All of Australia's temperate specialists come from genera well represented in the northern hemisphere. Coast Hollyhock belongs to a genus, *Malva*, with about 75 species in the northern hemisphere but only two in Australia (which are closely related). The first *Malva* seed ever to sprout here probably came in mud attached to a sandpiper or other migrant bird returning from its breeding grounds on the northern tundra.

Seabird islands are amazing places. But most visitors only notice the birds, when the plants that sprout among them are just as interesting and worthy of admiration. □

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TIM LOW IS A BIOLOGIST AND THE AUTHOR OF SIX BOOKS, THE MOST RECENT OF WHICH IS *THE NEW NATURE* (PENGUIN).
HE IS GRATEFUL TO JEFF YUGOVIC FOR ACCESS TO HIS DETAILED THESIS ON THIS TOPIC.

MOST HOLLOWS USED BY FAUNA OCCUR IN TREES THAT BEGAN GROWING BEFORE COOK SAILED INTO BOTANY BAY!

# RESPECTING OUR FOREST VETERANS

**BY PHILIP GIBBONS & DAVID LINDENMAYER**

AUSTRALIA RECENTLY LOST ITS LAST LIVING Gallipoli veteran in Mr Alec Campbell. His death, however, did not extinguish the Anzac spirit, but only served to highlight the contribution our war veterans have made to this country. Australia is also losing many of its forest veterans—large, old and decaying trees. However, while these veterans make an important contribution to this country, they don't always receive the respect they deserve.

KATHIE ATKINSON

**This shallow hollow affords protection to the nest of a White-browed Woodswallow (*Artamus superciliosus*).**

Large, old, decaying trees frequently contain hollows, which are places where around 300 of our frog, reptile, bird and mammal species sleep, rear young, seek shelter from the weather, or evade predators. Australia's hollow-nesting fauna includes most of our parrots, cockatoos, ducks, owls, insectivorous bats, possums and gliders, and an unknown (but undoubtedly huge) number of invertebrates. Some species, such as the Common Brushtail Possum (*Trichosurus vulpecula*), find places like the ceilings of houses suitable alternatives to hollows. Insectivorous bats will use cracks in fence posts, even tractor exhausts, as roost sites. But for most hollow-nesting species there is no feasible substitute for tree hollows: without them they simply would not survive.

AUSTRALIA'S LOGGED FORESTS, agricultural landscapes and urban areas contain substantially fewer trees with hollows than they did when Captain James Cook arrived. To city-dwellers, large, old, decaying trees are at risk of dropping limbs on our children and are therefore removed. To those with a fireplace, these trees are a source of heating and disappear up chimneys on frosty evenings. To foresters, these trees contain little timber of commercial value and may be replaced by a younger, more vigorous crop. To farmers, large, old paddock trees can be a nuisance because they impede their harvesters and irrigators.

**HOLLOW FORMATION**

*is an excruciatingly slow process across a range of Eucalytus trees.*

Pioneering work in the 1980s by a forester called Charlie Mackowski highlighted why the careful management of tree hollows is an important conservation issue. His research suggested that hollows suitable for fauna did not begin to appear in eucalypts until they were at least 150–250 years old. Coupled with the fact that eucalypts can live for up to 500 years, this means most hollows used by fauna occur in trees that began growing before Cook sailed into Botany Bay!

Subsequent research has confirmed that hollow formation is an excruciatingly slow process across a range of eucalypt tree species. This is because eucalypt wood is relatively durable and also because Australia lacks animals like woodpeckers capable of excavating hollows. Instead, our hollow-nesting fauna relies on a myriad of fungi and invertebrates, such as termites, to slowly decompose and excavate the heartwood of eucalypts. The outer living wood, or sapwood, of eucalypts is more resistant to attack by these organisms, so hollows

**This large River Red Gum (*Eucalyptus camaldulensis*) was standing when Captain James Cook sailed into Botany Bay. One of its large hollows contains nestlings of the Nankeen Kestral (*Falco cenchroides*).**

JEAN-PAUL FERRERO/AUSCAPE

**The Gouldian Finch (*Erythrura gouldiae*) is an endangered species from northern Australia that relies on tree hollows for nesting. Several pairs may nest in different hollows within the same tree.**

only appear when decay is exposed after a branch snaps or the tree is damaged by fire. This slow process, plus the longevity of eucalypts, means that, while hollow trees can be quickly lost, they cannot be readily replaced.

The importance of this research is illustrated in Australia's intensely farmed and logged landscapes. If you drive through farming land, you see a pleasant rolling vista dotted with large paddock trees that were left by European settlers when they began clearing in the 1800s. These paddock trees are critical for the survival of some hollow-nesting species, such as the Superb Parrot (*Polytelis swainsonii*). But you may notice that something is missing: there are very few younger trees to replace these once they die and collapse. This is because eucalypt seedlings that establish near paddock trees are grazed by Sheep, Cattle and Rabbits and therefore do not survive. A recent study on the south-west slopes of New South Wales showed that more than 90 per cent of remnant woodland patches had no regeneration of trees whatsoever. An absence of periodic recruitment means that we will eventually face a prolonged period without hollows across farming land in Australia.

The slow rate of hollow formation is also a problem in our native forests that are managed for timber production. These are logged on cycles of 30–80 years—well short of the 150–250 years required for hollows to form. Therefore State (public) forest-management agencies throughout Australia make a point of specifically retaining old habitat trees. Still, research indicates a gradual but steady decline in hollow numbers over successive logging cycles because habitat trees do not always survive the effects of logging and exposure, and there are insufficient young trees protected from logging and exposure to replace these as they die and collapse.

HANS & JUDY BESTE/LOCHMAN TRANSPARENCIES

**The Rainbow Lorikeet (*Trichoglossus haematodus*) is an example of a native species that is becoming more prolific in parts of Australia and may therefore represent a threat to other native species that compete for hollows.**

PHIL GIBBONS

**Trees in paddocks are an important source of hollows for wildlife, but are disappearing from our agricultural landscapes because of dieback caused by factors such as salinity and a general absence of regeneration in grazed and cultivated paddocks.**

If it's not enough that there is a dwindling supply of hollows in some landscapes, hollow-nesters must also compete with a suite of introduced species that use hollows. These include the Common Myna (*Acridotheres tristis*), Common Starling (*Sturnus vulgaris*), House Sparrow (*Passer domesticus*) and Honey Bee (*Apis mellifera*). Some of these species aggressively vie with native fauna for suitable holes. The Common Myna will even stuff several hollows full of grass, twigs, string and plastic to stop other native birds nesting near it.

Some native species also pose a threat to other (usually less common) native hollow-nesters. Examples include the Common Brushtail Possum, Galah (*Cacatua roseicapilla*), Long-billed Corella (*C. tenuirostris*) and Rainbow Lorikeet (*Trichoglossus haematodus*). These species either occur in very large numbers or have increased their distributions since European settlement.

WHAT CAN BE DONE TO IMPROVE the plight of Australia's hollow-nesting fauna? We must learn to live with our 150–500-year-old forest veter-

KATHIE ATKINSON

**The Common Ringtail Possum (*Pseudocheirus peregrinus*) is one native species that will readily use nest boxes erected in surburban areas, however exotic species should be discouraged.**

ans rather than simply removing them when they get in the way, recognising that their legacy is one that cannot be replaced in our lifetime. For example, some local councils plant shrubs around the base of old, decaying trees that tend to drop limbs, as an alternative to cutting them down, thus discouraging people from walking or picnicking under them.

We must start growing the next generation of hollow trees—in forests, agricultural lands and in urban areas. The problem really is urgent. The longer we wait, the more chronic and prolonged the hollow shortage will be and the more difficult and expensive it will be to conserve the species affected. In rural areas, we believe that Australia needs to implement a grazing system that allows natural regeneration to periodically occur so that young trees can establish in paddocks and thus replace those being lost. In our native forests, management agencies need to begin taking actions now to recruit the next generation of hollow trees, recognising such actions as an integral part of sustainable forest management, rather than an impediment to production.

We also need to find a sustainable source of firewood for our towns and cities. Australians burn more wood for heating than we export as woodchips. Making greater use of waste timber, establishing plantations specifically for firewood and encouraging alternatives to firewood as a source of heating may all have a role to play in achieving this end.

Are nest boxes the solution to our declining hollows? Thousands of nest boxes throughout Europe now support populations of native birds, which help maintain the health of forest ecosystems by harvesting copious quantities of insects. Some of the Australian fauna has benefited from nest-box programs. The Sugar Glider (*Petaurus breviceps*) was successfully reintroduced to Tower Hill State Game Reserve in Victoria with the use of nest boxes. And, by attracting Masked Owls (*Tyto novaehollandiae*), nest boxes have been used as part of a strategy of rodent control on Sugarcane farms in Queensland.

However, nest boxes are not a panacea. They can attract introduced and superabundant species and are prohibitively expensive if intended for large areas. It is also important to acknowledge that nest boxes mounted on young trees cannot replace the myriad functions performed by large, old trees, such as the habitat they represent to decay-causing invertebrates and the nectar and pollen resource they provide. So, erecting nest boxes carries with it a responsibility to discourage introduced species, and nest boxes should never be viewed as an adequate substitute for the real thing.

Just as Alec Campbell's legacy will live on, so too should we be striving to ensure that the legacy of our forest veterans endures. Around 300 of our frog, reptile, bird and mammal species depend on them. □

**FURTHER READING**

KATHIE ATKINSON

Once a hollow is colonised by the European Honey Bee (*Apis mellifera*) it will not be occupied by native fauna—even well after the hive is vacated.

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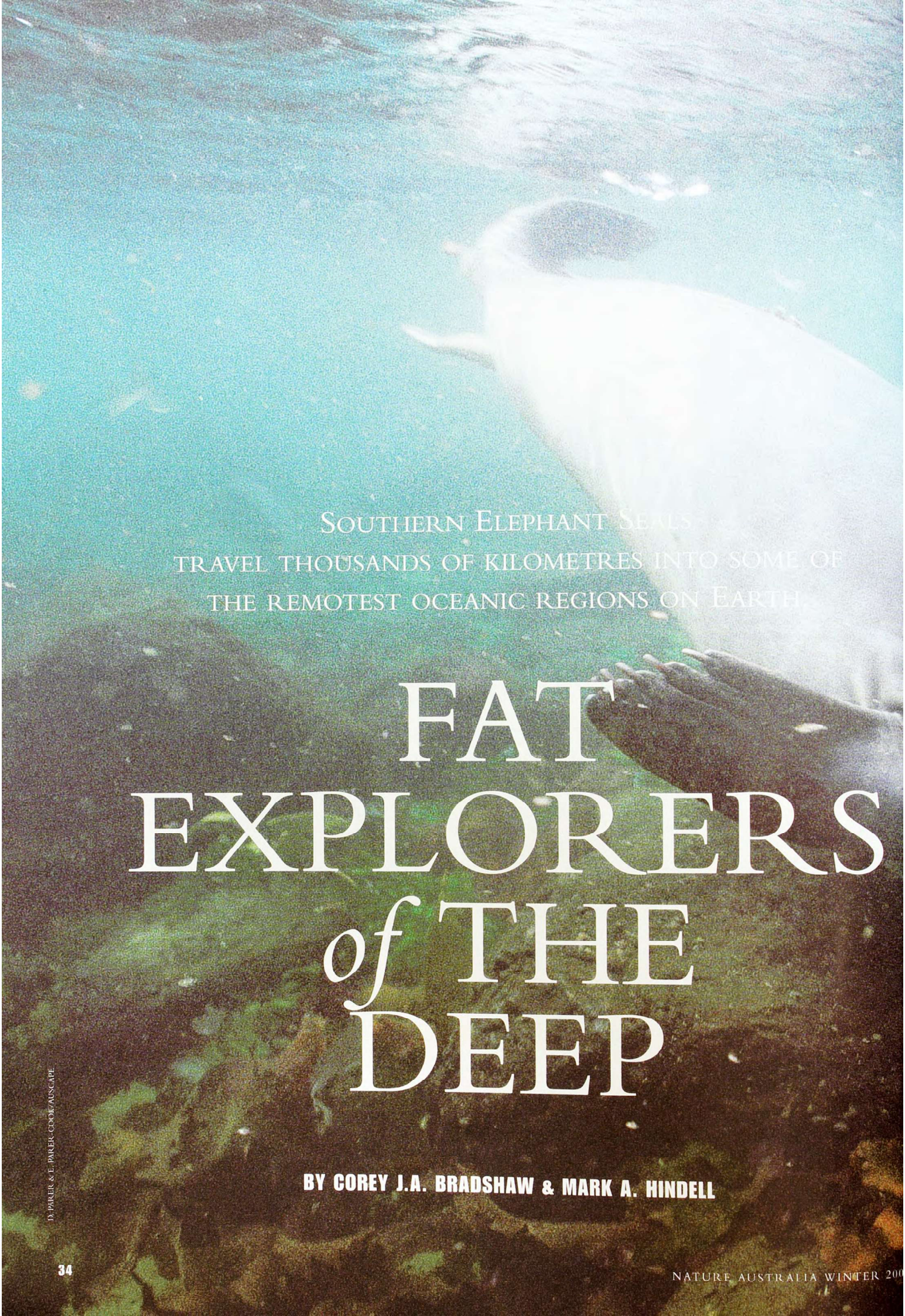
PHILIP GIBBONS IS AN ECOLOGIST WITH THE NEW SOUTH WALES NATIONAL PARKS AND WILDLIFE SERVICE. HE HAS UNDERTAKEN EXTENSIVE RESEARCH ON HOLLOWS IN TIMBER PRODUCTION FORESTS AND AGRICULTURAL LANDSCAPES. DAVID LINDENMAYER IS A SENIOR FELLOW AND ASSOCIATE PROFESSOR AT THE CENTRE FOR RESOURCE AND ENVIRONMENTAL STUDIES AT THE AUSTRALIAN NATIONAL UNIVERSITY IN CANBERRA. HE HAS WORKED EXTENSIVELY ON HOLLOW-USING ANIMALS IN AUSTRALIAN FORESTS AND WOODLANDS FOR 20 YEARS.

WAYNE LAWLER AUSCAPE

Many nocturnal birds, like this Australian Owlet-nightjar (*Aegotheles cristatus*), roost in tree hollows during the day to evade predators.



SOUTHERN ELEPHANT SEALS [illegible]
TRAVEL THOUSANDS OF KILOMETRES INTO SOME OF
THE REMOTEST OCEANIC REGIONS ON EARTH

# FAT EXPLORERS *of* THE DEEP

BY COREY J.A. BRADSHAW & MARK A. HINDELL

D. PARER & E. PARER-COOK/AUSCAPE

A young Southern Elephant Seal plays in the shallows around Macquarie Island.

ONE OF THE FIRST things we noticed when we started visiting Macquarie Island was that the beaches appeared to be *alive*. Thousands of tonnes of very fat Southern Elephant Seals (*Mirounga leonina*) sleep, play, moult and breed on the wind- and wave-swept shores of this, Australia's most southerly island. It takes about three days by ship to complete the 1,500-kilometre voyage to Macquarie Island from Hobart—a trip that plucks the visitor from the sanctuary of human civilisation into the fury of the great Southern Ocean. While many humans would find this tiny, 35-kilometre-long 'rock' in the middle of the wildest sea on the planet somewhat daunting, over 70,000 elephant seals call it home for part of each year.

However it is not a 'home' in a sense that is meaningful to humans. Elephant seals are more aquatic than terrestrial, and spend only about 20 per cent of their lives ashore. The rest of the year they prowl the vast expanses and depths of the Southern Ocean looking for fishes and squids to fuel their *huge*, fat bodies. And huge they are. Males can weigh over 3,700 kilograms and be up to five metres long—heavier than a bus and longer than a large ute. In the breeding season when two of these monsters disagree over access to females, you want to make sure you're well clear of the negotiations. Although still hefty, females typically weigh seven to ten times less than the males (400–800 kilograms) and, if you didn't know better, you'd think they belonged to different species.

But how do we know all this about elephant seals and, more importantly, what were we doing on this remote subantarctic island? Perhaps a little history is required to help understand what has led us, and other research teams, to investigate this population of Southern Elephant Seals at Macquarie Island.

THE HEYDAY OF EUROPEAN exploration throughout the Southern Ocean was in the late 18th and 19th centuries, a period when many seal species were hunted. Their rich, and what may have seemed inexhaustible, supply of pelts saw the decimation of fur seals and sea lions from all but the remotest of islands. The Southern Elephant Seal soon followed suit because its blubber was the source of the purest oil then known. By the end of the 19th century, the impressive Macquarie Island population of seals, as well as many others, had been dramatically reduced.

In the early 20th century, a combination of reduced numbers of animals and a struggling market for seal products

**An adult female beginning her moult far from the sea's edge in the tussock grass.**

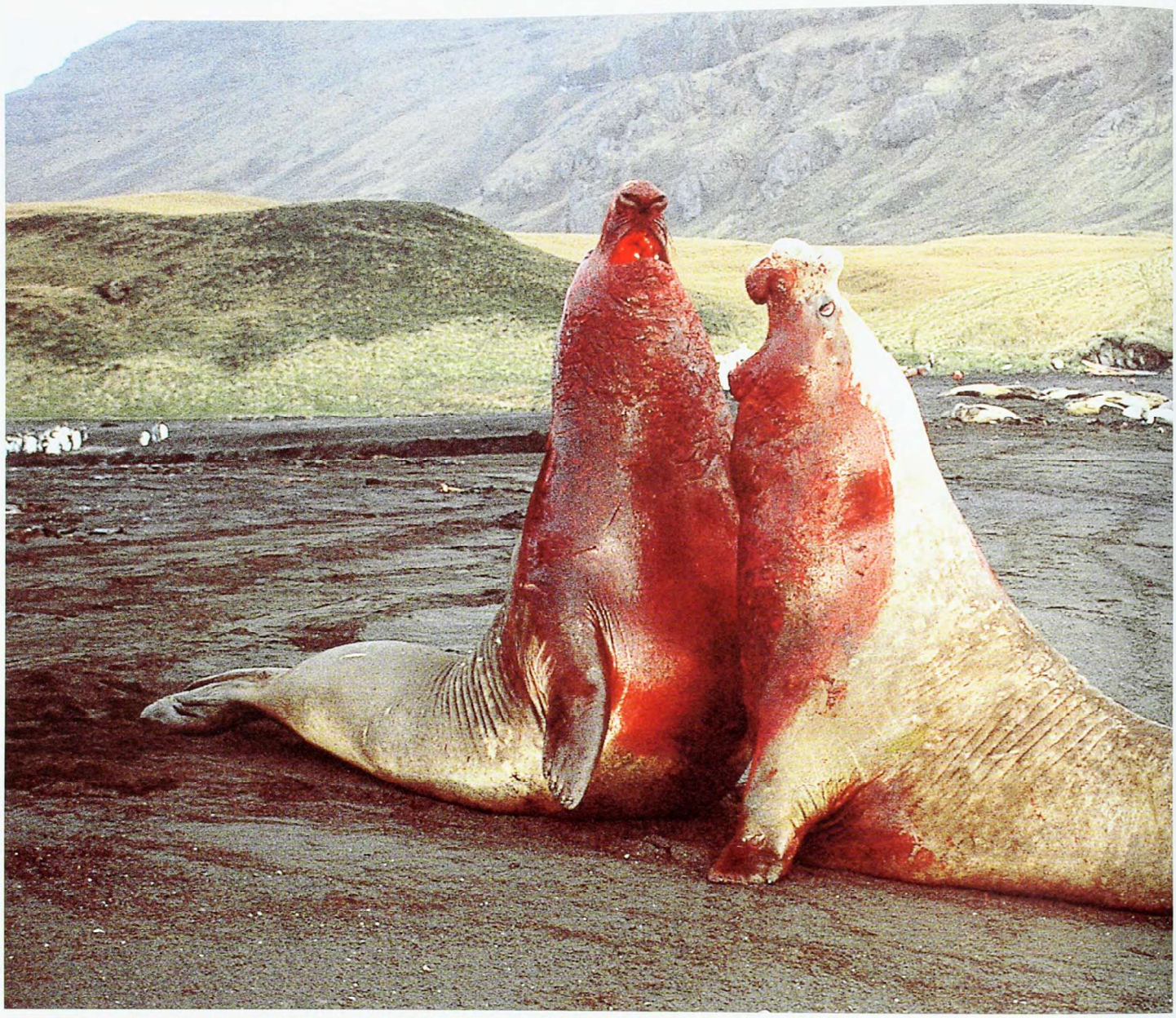
KARAH WERTZ

GRAHAM ROBERTSON/AUSCAPE

**A young male Southern Elephant Seal guards a small harem of females competing for space on the beach with Royal Penguins (*Eudyptes schlegeli*), one of Macquarie Island's four resident penguin species.**

gave many seal populations a chance to recover. This was a slow process but, by the 1950s, elephant seals were once again a prominent feature of Macquarie Island's wildlife. Then in the 1980s came the disturbing discovery that the population had again fallen, this time by 50 per cent in less than 40 years, and not only at Macquarie Island, but at most of the breeding sites around the Southern Ocean.

What had caused this second population crash? This is not an easy question to answer for an animal that spends most of its life at sea. Furthermore, the long lifespan of this species and the fact that changes to ocean ecosystems generally occur gradually mean that it can take many years before sufficient information is available to provide an answer. Nonetheless, we were determined to address this serious problem. We started by examining all the possible factors that could have caused the decline. Many possibilities, such as disease, direct human disturbance, lack of space and increased numbers of predators, were ruled out quickly for lack of supporting evidence. What did become clear was that the number of young animals surviving their first few foraging trips at sea was less than the number of adults dying each year. In other words, the population was not replacing itself,



D. PARER & E. PARER-COOK/AUSCAPE

**Two bloodied males battle over the right to mate. These skirmishes are relatively rare (most challenges are averted by a short roar), but two equally matched males can inflict heavy damage and even death of the loser.**

and it seemed to be a question of food supply. Our recent research program has therefore focused on understanding how the animals (mainly adult females) find and acquire their food.

Most of us tend to take for granted the task of finding food. However, when your larder is the great Southern Ocean it is not as easy as going to the supermarket. Adult female elephant seals have two foraging trips each year: a 75-day trip after the breeding season (seals breed ashore from September to November), and a 250-day over-winter trip after the moult (most adult females come ashore to moult in January to February). Not only is the sheer amount of time they spend at sea amazing, but also the distances travelled. We have discovered that, even during the shorter trip, these animals travel thousands of kilometres away from the island into some of the remotest oceanic regions on Earth.

How do we know where they go? We use a clever little computer device that is glued to the hair on the female seal's back prior to departing the island. This data-logging device (less than 0.1 per cent of the seal's weight) collects information on her geographic position, the depth of the dives achieved, the swim speed and the temperature of the water. When she comes back to the island to breed or moult, we sedate her and cut the unit away from the hair. We then download the data to computer and prepare the unit for re-use on another seal. We also weigh and measure her to determine how much fat she accumulated while feeding at sea. These data have proven essential to understanding how Southern Elephant Seals collect their food and, more importantly, how foraging behaviour changes as the physical and biological properties of the ocean change over time.

Amazingly, we have recorded depths of more than 1,500 metres in a single dive. Last year we recorded one eight-year-old female diving to 1,631 metres (more than a mile) in a dive that lasted almost an hour. Moreover, we have records of dives lasting up to two hours on a single breath. That's deeper and longer than the dives of most whales, and only the 40-tonne Sperm Whale can perform similar feats.

How do they do it? With the best equipment and special air mixtures, humans can only dive down to about 180 metres. Even reinforced submarines have difficulty reaching the same depths as elephant seals. So what makes these animals so special? All animals require oxygen to complete the complex metabolic processes that occur in every cell. However elephant seals are able to limit the amount of oxygen used by their cells, and store more oxygen in their blood than almost any other mammal.

When an elephant seal begins to dive, its heart rate immediately drops from 60–70 beats per minute to around 30–40 beats per minute. So even though the seal is swimming vigorously, its heart rate actually declines. Incredibly, the longer the seal dives, the lower its heart rate becomes, and it can drop to below ten beats per minute during a long dive. This reflects the general reduction in oxygen consumed by the cells. Also, elephant seals have a much higher number of red blood cells than most other mammals, and the oxygen-storing molecule haemoglobin in these cells is far more efficient than our own. Their muscles are laden with another oxygen-storing molecule, myoglobin, but in higher concentrations than in land mammals. Seals also are able to restrict their blood flow to only the vital areas of the body—the central core and the brain. The peripheral tissues, even active swimming muscles, can survive for long periods without significant blood flow—a scenario that would spell cellular death for most other species.

FASCINATING AS THIS MAY BE, DOES it really tell us anything about how these animals find their food and, more importantly, can it help us understand what is causing the slow decline? The answer is yes, but we still have a lot more to learn. Combining information on foraging behaviour, physiology, demography and diet has allowed us to put together the beginnings of a picture that shows how seals respond to changes in their environment, and how this may ultimately flow on to the regulation of population size. For example, the tracking results, together with the physiological information, enable us to estimate the amount of food eaten by these animals in specific regions of the Southern Ocean. Of course, we cannot alter the amount of food available in the oceans

D. PARER & E. PARER-COOK/AUSCAPE

**Southern Elephant Seals have one of the largest size discrepancies between males and females in the mammal world. The mating process begins when the male sashays toward the receptive female. He proceeds to pin her body with his large flipper, and further immobilises her by biting her neck. Older females are often heavily scarred around the neck and head from these matings.**

J. HARRINGTON

**Two pregnant Southern Elephant Seals equipped with data-loggers return to Macquarie Island after seven months at sea. Each data-logger holds information on more than 10,000 individual dives made over winter.**

to test how relative changes in prey availability might affect foraging behaviour and success in elephant seals, but we can use the natural variation in the environment to provide what is known as a 'natural' experiment to examine food limitation. For this we need to monitor the population for many years so that we measure seal behaviour during years of contrasting prey abundance. We know that the fatter a mother seal is when she returns to the island to give birth, the more likely her pup will survive its first, and most difficult, year of life. Measuring the amount of fat accumulated at sea during years of relatively high and low food availability allows us to predict how much food can be reduced before it affects pup survival and sends the population into decline.

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is an international body managing human fisheries within Antarctic waters. Our research has shown that elephant seals are important consumers of fishes and squids within the CCAMLR management zones. Indeed, we estimate now that the elephant seal population at Macquarie Island eats at least 610,000 tonnes of prey per year, which is about 1,000 times the annual commercial fisheries catch within the CCAMLR zones immediately to the south of Australia

ANDREW HENLEY LARUS

**(Above) Corey Bradshaw and his colleagues check the island regularly for marked seals to add to the long-term database. Repeat sightings of marked individuals allow for the calculation of survival rates and an estimate of the overall health of the population. (Right) Elephant seals are the only seal species to go through a 'drastic' annual moult where they lose not only the hair, but the skin as well (much like the moult of many lizard species). The process is energetically costly, with an individual seal losing up to a third of its body weight in 30 to 40 days ashore.**

COURTESY COREY J.A. BRADSHAW

and New Zealand. At present the reduction in total prey available due to commercial fisheries is negligible and unlikely to be the direct cause of the population decline at Macquarie Island. However, if fishing pressure increases, we might expect competition with species like elephant seals. The population is already in decline, so any significant reduction in their food supply from fishing operations could push the decline even further.

Satellites measuring changes in the properties of the ocean over time are allowing us to understand how elephant seals respond to environmental change. Pictures of the ocean's properties from satellite images of sea-surface temperature, chlorophyll concentration (indicative of phytoplankton growth), sea-ice cover and oceanic fronts give an insight into the little-known ocean world in which elephant seals live. As global climate processes change in response to human activities, these phenomena can lead to marked changes in the distribution of the elephant seals' prey. We know that changing temperatures and currents in the ocean can alter plankton abundance and, ultimately, that of the squid and fish species on which elephant seals feed. Events such as the increasing frequency of El Niño climate patterns and trends in global warming may very well threaten the entire Southern Ocean ecosystem, so elephant seals represent a sensitive, representative and accessible measure of the ocean's overall health.

Another fascinating, yet potentially worrying, discovery is that adult female elephant seals are extremely faithful to the areas of the ocean in which they feed. It is mind-boggling in the first instance that they can even find the tiny island of Macquarie after months of travel thousands of kilometres away, but how do they then turn around and find the same general patch of ocean in which to forage? Obviously some aspect of the ocean's structure must remain constant year after year for these seals to know where to return. We still really do not know how they do it, but

A sedated Southern Elephant Seal is placed in a mesh net for weighing.

## Southern Elephant Seal

*Mirounga leonina*

**Classification**
Family Phocidae ('true' seals).

**Identification**
Extreme sexual dimorphism; males up to 3,700 kg with enlarged 'nose' (proboscis), females up to 800 kg. Short, sparse, grey to blonde hair. Large fat reserves, up to 40% of body weight. Newborns have woolly black hair that is shed within weeks of birth. Drastic annual moult, with hair and skin being shed in large sheets.

**Distribution and Habitat**
All parts of Southern Ocean. Spends most (70–80%) time foraging at sea. Adults come ashore twice per year to breed (Sep.–Nov.) and moult (Dec.–Apr.). Estimated world population around 650,000, with 70,000–90,000 at Macquarie Island.

**Reproduction**
Males guard harems of sometimes 100s of females. Females start giving birth at 3–6 years and continue annually until > 20 years. Lifespan: males about 15 years, females 23. Pups weaned and abandoned by mother at about 24 days.

a number of explanations have been suggested. Humans return to their favourite restaurants and shops using detailed maps, signs and directions from others. Perhaps elephant seals can read certain 'signs' in the ocean, like using the alignment of the Earth's magnetic fields for navigation as do many birds. Perhaps they can detect subtle temperature gradients in the water, or they may actually be able to taste the water to determine their own whereabouts. Regardless of the mechanism, the behaviour of returning to the same part of the ocean year after year is cause for concern. We know now that, even though local conditions in the ocean change from year to year, individual seals appear unwilling, or even unable, to move to other regions. This means that individual seals are vulnerable to even small changes in local food supply. This may be the key to understanding the continued slow decline in numbers and may allow us to identify regions of the ocean that must remain clear of additional human pressures.

Past overexploitation of the Southern Ocean environment through the extensive harvesting of whales, seals and fishes, and recent global climate change affecting sea-ice distribution and ecosystem structure, are all possible candidates for the reduction in food supply that has led to the elephant seal decline.

So what does the future have in store for these magnificent explorers of the deep? As technology improves, and thus our ability to measure the nuances of their behaviour, we hope to identify areas of the ocean crucial to their survival. Remote miniature cameras that can photograph their feeding activity are now available, and we are investigating their use on elephant seals. With more information on population structure, behaviour, diet and the changes in the ocean, hopefully we can prevent the loss of this most impressive species. □

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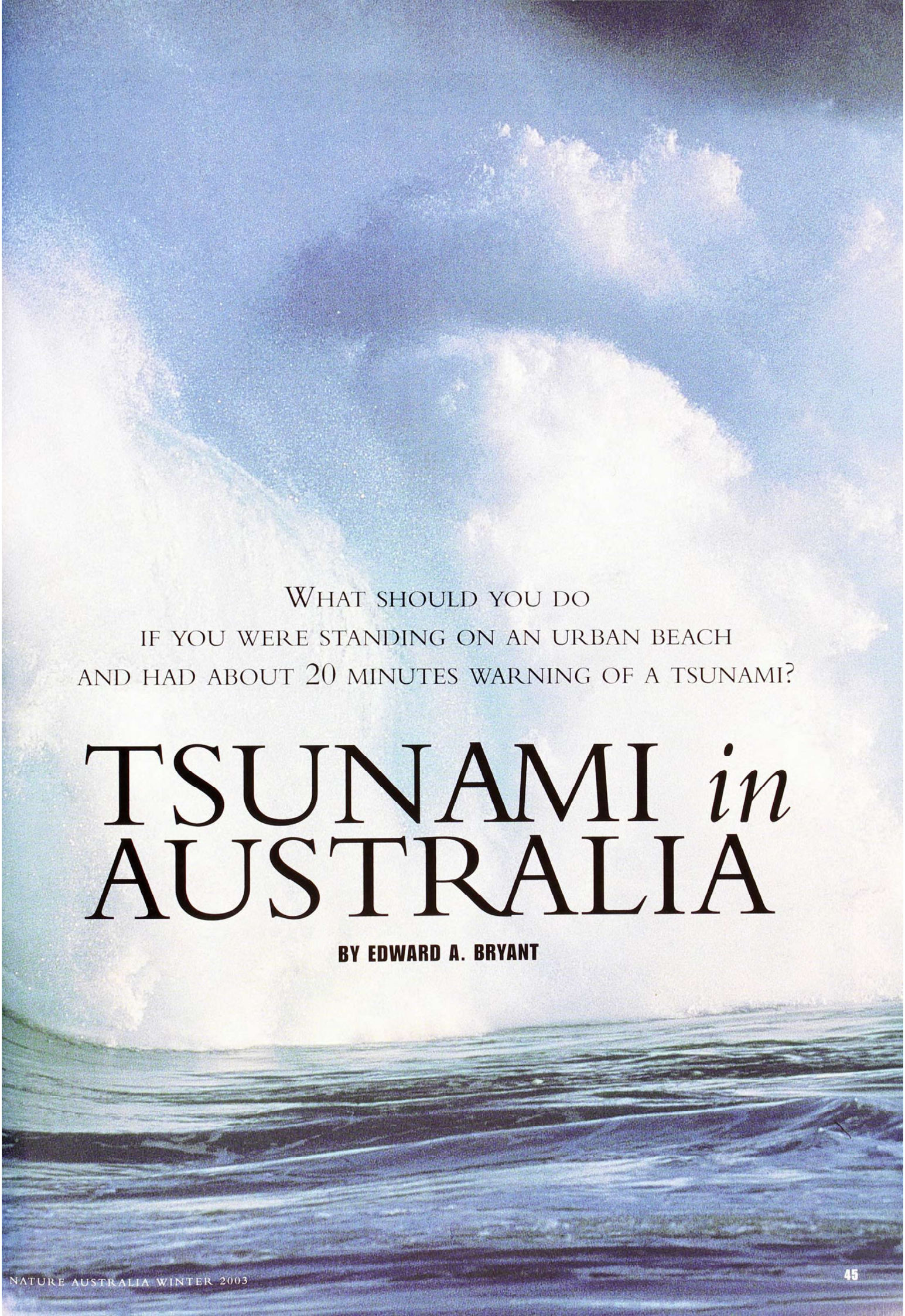
SCOTT WINER–OXFORD SCIENTIFIC FILMS/AUSCAPE

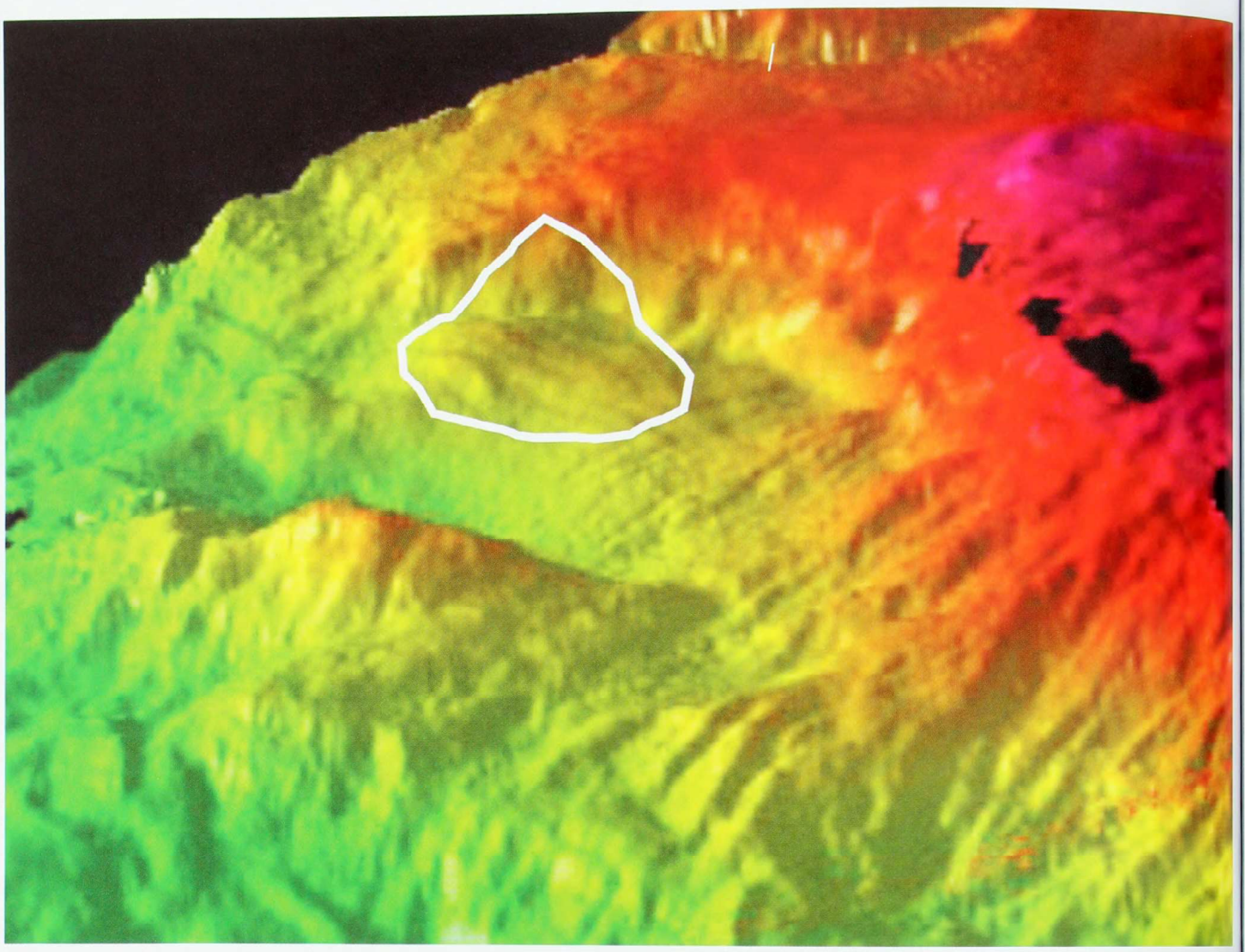
**Tsunami waves have a spacing of tens of kilometres between crests. This causes them to increase rapidly in height in water depths of less than 20 metres. Unlike storm waves (pictured) they do not break in a surf zone, but tend to crash onto the shore or surge over a coastline.**



WHAT SHOULD YOU DO
IF YOU WERE STANDING ON AN URBAN BEACH
AND HAD ABOUT 20 MINUTES WARNING OF A TSUNAMI?

# TSUNAMI *in* AUSTRALIA

**BY EDWARD A. BRYANT**



COURTESY D.R. TAPPIN (MARINE GEOLOGY 175 (2001) 1–23)

**Image of the offshore bathymetry (seafloor depths) opposite Sissano Lagoon on the northern coastline of Papua New Guinea. Depths range from 700 metres (purple) to 3,000 metres (green). The upper amphitheatre has been formed by repetitive slumps. The most recent one responsible for the 17 July 1998 tsunami is outlined by the white line. It was relatively small and spread sediment over a pre-existing mound at the lip of the amphitheatre.**

OF ALL NATURAL HAZARDS, tsunami would have to be among the scariest. Without warning, they can appear out of nowhere, barrelling down on a shoreline with a sound like a jet plane landing metres away. Such was the experience on the north coast of Papua New Guinea in the early evening of 17 July 1998.

Twenty minutes after a moderate earthquake, a wall of water up to 15 metres high swept over the Aitape Coast. The wave moved so fast that it was preceded by a blast of air, flattening many people to the ground. They were then swept four kilometres inland into the mangroves at the back of Sissano Lagoon. Another ten minutes later and over 2,000 people had died, 1,000 were injured and 10,000 made homeless. Intriguingly my colleagues and I have found evidence in Australia for prehistoric tsunami much bigger than this one.

TSUNAMI ARE LONG WATER WAVES generated by offshore earthquakes, volcanoes, submarine landslides, or extraterrestrial impacts with the ocean. The characteristic that makes tsunami so dangerous is their exceptional wavelength (distance between wave crests) compared with their height. In the open ocean, except for very rare events, tsunami do not exceed 0.5 metre in height, yet the spacing between waves can be hundreds of kilometres. When such a wave enters shallow water (10–20 metres deep), its height increases substantially so that the wave can override the coast without breaking or losing energy.

In the Pacific Ocean region, earthquakes account for the greatest number of tsunami (82 per cent), while volcanoes and submarine slides each account for five per cent. Until recently, submarine slides were underrated as significant hazards generating tsunami. The Papua New Guinea tsunami in 1998 changed all that. The earthquake that occurred just before was too small to generate such a large wave, and recent mapping of ocean depths has shown evidence for fresh submarine slides on the steep slopes that flank the coast. Similarly steep topography is scattered throughout the oceans—from continental slopes to volcanic islands and seamounts—and these areas are equally prone to submarine slides. In the geological past, huge chunks of the Hawaiian and Canary Islands have slipped into the ocean generating waves that might have had heights of 20 metres or more in the open ocean. Even chunks of the Norwegian continental slope have col-

COURTESY FRED TERRY

HUGH DAVIES

Warapu village along the Aitape coast of Papua New Guinea before (top) and after (bottom) the 17 July 1998 tsunami. The tsunami went from right to left into the lagoon. Note the sandy sediment deposited by the wave and the bending of supports that once held up a house.

lapsed as recently as 8,000 years ago, sending waves more than five metres in height across the North Atlantic.

Meteorite impacts with the ocean are just as underrated. While no historical event has been recorded, native peoples in many countries, including Australia and New Zealand, have legends about comet and meteorite impacts. They also have numerous legends about tsunami. For example, coastal Aborigines in South Australia tell the story of Ngurunderi who lived in the sky. He had two wives who fled down to the Earth, and he went after them. He eventually found them wading in the waters around Kangaroo Island. He was so angry that he ordered the sea to rise up as an enormous 'tidal wave' and drown them. The waters rushed in and did just that, turning the wives into stone, which today can be seen off the coast of Cape Jervis as the rock formation known as The Two Sisters.

THE FACT THAT LEGENDS ON TSUNAMI exist in Australia should not be viewed as unusual. After all, Australia is an island continent that lies exposed to active seismic and volcanic zones to the north. The problem in Australia is that the historical record is not long. The biggest tsunami measured on the Sydney tide gauge was one metre high following an earthquake in Chile on 10 May 1877. The north-western coast, however, has the greatest frequency of tsunami in Australia, and the largest events, because it lies closest to Indonesia, which is subject to large earthquakes and explosive volcanism. An earthquake there on 19 August 1977 generated a tsunami that measured 1.5 and 2.5 metres on tide gauges at Port Hedland and Dampier, respectively. Both the Krakatau eruption on 27 August 1883 and an earthquake in East Java on 2 June 1994 generated tsunami that ran up over four metres above sea level along this coast. However, the Australian coastline contains a wealth of geological evidence for repetitive tsunami on a scale much greater than this historical record.

My colleagues and I have identified a range of features around the Australian coast that appear to be formed uniquely by tsunami. For example, there are numerous piles of boulders aligned like fallen dominoes along the top of cliffs at Jervis Bay, New South Wales. Dating of shells mixed with the boulders indicates that the waves washed over these cliffs around AD 1480. This event also produced one wave that overran the 130-metre-high headland flanking the south of Jervis Bay. And, along the ocean side of the northern headland at Gum Getters Bay, boulders the size of boxcars were stacked parallel with each other to the top of a 30-metre-high cliff.

**Overlapping boulders stacked against a 30-metre-high cliff face on the south side of Gum Getters Inlet, New South Wales. Some of these boulders are the size of a boxcar. Note the person for scale. The blocks are not a result of cliff collapse because they reach to the top of the cliff. They were most likely deposited there by a tsunami.**

TED BRYANT

More dramatic are features carved into bedrock that render much of Australia's rocky coastline so scenic. Multiple vortices in fast-moving water can sculpture solid bedrock into distinctive stacks, arches and sea caves. Many of these features have been attributed, without substantiation, to long-term erosion by wind-generated waves. However, some features lie well beyond the reach of normal or even high-energy waves. One example is the enigmatic rock formation known as Cathedral Rocks near Kiama on the New South Wales south coast.

TED BRYANT

Tsunami can also generate giant circular vortices that can carve out whirlpool features 8–10 metres deep and 20–40 metres in diameter in the bedrock. Often, there is a central plug left at the centre of the whirlpool where currents have been less intense. Whirlpools with only half a circular outline indicate that the erosion occurred in the space of a few minutes towards the back of a mega-tsunami wave crest.

No known earthquake-generated tsunami has ever carved out large-scale features such as whirlpools and stacks. These require a catastrophic mechanism such as a meteorite or comet impact with the ocean. Fortunately, our research has only been able to identify two tsunami events over the past 10,000 years large enough to produce such bedrock erosion—one in about 4000 BC, and the AD 1480 event, which corresponds to a peak in comet and meteorite observations made by Chinese, Japanese and European

**Inverted, keel-like forms at Cathedral Rocks, 90 kilometres south of Sydney. The tsunami washed over Bombo Headland in the background. The stacks were carved by horizontal vortices of water within a few minutes.**

**What's in a name?**

The term tsunami is Japanese for a harbour (*tsu*) wave (*nami*), because such waves in Japan are more noticeable in harbours where they get trapped and undergo amplification following offshore earthquakes. They are not associated with the tides, as the colloquial term 'tidal wave' might suggest. Note that in Japanese, both the singular and plural of tsunami are the same.

TED BRYANT

**Whirlpool bored into bedrock by a vertical vortex of water on the south side of Atcheson Rock, south of Wollongong. The potholes around the floor of the whirlpool indicate the presence of smaller multiple vortices embedded in the main vortex. The tsunami carved this feature within a few minutes as it overtopped a 20–25-metre-high headland.**

astronomers.

Astronomers believe that a comet came into the inner solar system within the last 20,000 years and fragmented. Periodically the Earth passes through the most concentrated part of the debris tail at 500–1,500-year intervals. The coincidence of dates from tsunami deposits in Australia and comet sightings in the northern hemisphere, around AD 1480, suggest that one such fragment might have struck the South-west Pacific region at that time. Apart from random meteorites, the Earth will not intercept this comet trail again until AD 3000.

WHILE AUSTRALIA'S EAST COAST IS not in any imminent danger of another comet- or meteorite-induced tsunami, tsunami generated by submarine landslides cannot be ruled out. Radiocarbon dating of shells from other tsunami deposits suggests that a significant tsunami occurs along the New South Wales coast every 1,000 years or less. The source of these events is not difficult to envisage. There are over 170 submarine landslide scars on the edge of the continental shelf along the New South Wales coast. They have not been dated, but they are geologically recent, otherwise they would have been covered in a thick coating of sediment. Any of these slides could have generated a localised tsunami. Some of the scars are large. One off northern Wollongong is 20 kilometres long and 10 kilometres wide. It would have generated a tsuna-

mi that affected a considerable length of the coast south of Sydney. At present, there is no detection system in place in Australia to warn against tsunami generated by nearby submarine slides. Even if there were, people would have only 20–30 minutes to evacuate to safety. But they could do it.

Not all coastlines are equally vulnerable to tsunami. Beaches, headlands and cliffs on the open coast are all clearly unsafe. However, if the beach is set within a bay, the safest place to flee to if a tsunami approaches is inland at one of the ends. Islands are also dangerous. They tend to sit farther out on the continental shelf. More importantly, tsunami will wrap around islands and become higher on the lee side. The centre is the safest place on an island to seek refuge. And, if there is a tsunami warning and you are on a boat, you should never come into shore, shelter behind a headland, or enter a harbour. Tsunami increase dramatically in height over the last 20 metres depth of water, and also increase in size inside harbours.

Rivers leading from bays are also vulnerable. Tsunami can travel up a river, increasing in height as the river narrows, and eventually spilling over the banks and swamping floodplains. Coastal floodplains within a few metres of sea level again are at risk. A ten-metre-high wave could conceivably travel eight to ten kilometres inland on a delta covered in pasture, but only 500 metres on a forested delta, and even less if houses covered the floodplain.

With this knowledge at hand, what should you do if you were standing on an urban beach and had about 20 minutes warning of a tsunami? Turn and run to the nearest multi-storey building, and take the elevator to the top floor, or run up one or two flights of stairs. Not only would you be above flood level for most of the tsunami experienced in recent years, but a concrete-reinforced building stands the best chance of escaping destruction.

These safety points are universal. They are worth remembering on your next holiday to any shoreline, whether it is on Waikiki Beach in Hawaii, the windswept coast of northern Scotland, or even the banks of Warragamba Dam on the outskirts of Sydney. A tsunami will happen again, sometime soon, on a shoreline near you. □

TED BRYANT

**Overlapping boulders on top of 33-metre-high cliffs at Mermaids Inlet on Little Beecroft Peninsula, Jervis Bay, New South Wales. While undated, they were probably carried there by a tsunami around AD 1480. The boulders are aligned to the south-east, which is the direction the tsunami came from.**

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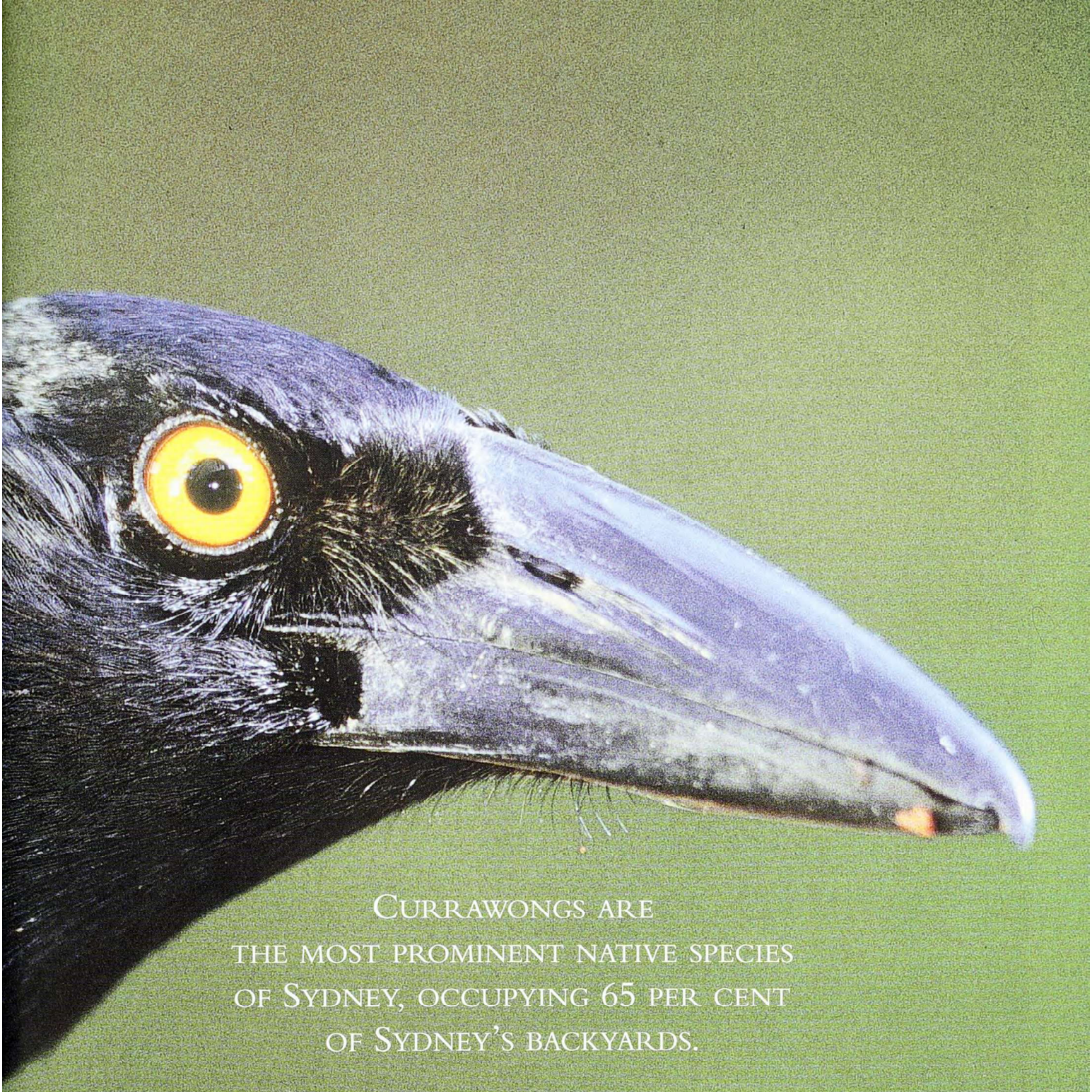
**Tsunami facts**

- Tsunami are most frequent in the Pacific Ocean (53.3% of all events) and East Indies (20.3%); the Atlantic Ocean accounts for less than 2% of events.
- One of the most widespread (far-reaching) tsunami occurred in the Atlantic Ocean, following the Lisbon (Portugal) earthquake, 1 Nov. 1755. It reached 7 m above sea level in the West Indies and affected The Nether lands in the North Sea.
- Biggest (highest) recorded earthquake-induced tsunami followed Russia's Great Kamchatka earthquake, 17 Oct. 1737, reaching >60 m above sea level on Kurile Islands (north of Japan).
- Largest recorded death toll from a tsunami was 50,000 people, Taiwan, 22 May 1782; followed by 36,000 associated with eruption of Krakatau (Sunda Straits), 27 Aug. 1883.
- Earthquakes account for most tsunami (82% of events), followed by volcanoes and submarine slides (each 5%).

PHOTO: STEPHEN J. KOCHMAN TRANSPARENCIES

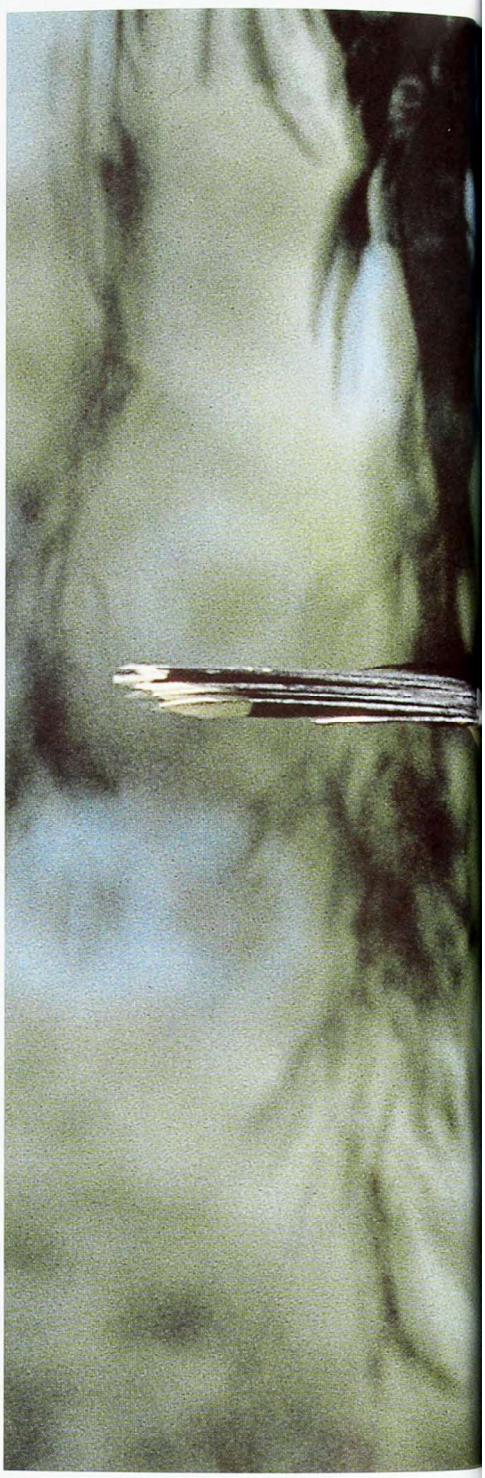
The large, powerful beak of the Pied Currawong is used to consume foods ranging from berries to birds.



Currawongs are the most prominent native species of Sydney, occupying 65 per cent of Sydney's backyards.

# URBAN CURRAWONGS

BY RICHARD MAJOR



WHILE CLEANING OUT 50 years of accumulations to my parents' bower in suburban Sydney, I was reminded of my earliest encounters with Pied Currawongs (*Strepera graculina*). There, abandoned in the back of a kitchen cupboard, was Milk Bottle Protector Mark III—a standard, six-cell carry crate with a weighted plastic shroud. It was a striking innovation for its day, standing out amongst the egg cartons, cups or Cats that 'protected' the cream on the neighbours' milk.

A Pied Currawong's beak is a top-quality tool. As well as its historic use in puncturing the foil caps on milk bottles, this six-centimetre pincer can pluck berries, gobble eggs, snatch insects and dismember vertebrates, ranging from tiny skinks to plump turtle-doves. Currawongs are also partial to bulldog ants served with formic acid, and stink bugs stewed in their own juices. Their catholic tastes and adaptability have made them the most prominent native species of Sydney, occupying 65 per cent of Sydney's backyards. And, their power and influence is spreading. The latest figures from the *New Atlas of Australian birds* show that, in the last 20 years, sightings of Pied Currawongs have increased by 39 per cent in Brisbane and 47 per cent in Melbourne. However, instead of revelling in the ever-growing chorus of these native suburban songsters, many people despise these tall poppies. To appreciate why, it is necessary to understand the factors leading to their supremacy.

PIED CURRAWONGS ARE BIRDS OF eastern Australia that traditionally breed in spring and summer in the Great Dividing Range. In autumn and winter they form foraging flocks of 20 to 200 birds, some of which stay in the mountains while others move to lower altitudes, including the sites of our major cities. However, until about 30 years ago, they rarely nested in cities, returning to the mountain forests in the spring.

Numbers of Pied Currawongs and the length of their low-altitude vacations increased dramatically through the latter half of the 20th century. This was probably due to an increase in food available in suburban areas—and not just the cream and pet food that currawongs steal, or the food scraps they scavenge from rubbish bins and picnic areas. Our choice of garden plants has a marked impact on the wildlife that inhabits our cities. Currawongs are significant fruit-eaters and they readily take ornamental offerings in the form of red, orange, blue or black berries, which decorate many suburban gardens.

The digestive tract of fruit-eating birds is typically short, allowing for fast processing. The energy-rich sugars are

KATHIE ATKINSON

**The regurgitated pellets of Pied Currawongs disperse both native and exotic plants through bushland.**

ROBERT BRUCE SHEPHERD/NATURE FOCUS

**Pied Currawongs have readily incorporated exotic berry-producing plants into their diet, boosting the survival of both the birds and the plants.**

rapidly digested, while the less-edible skins and seeds promptly reach the back door. For example, the Silvereye (*Zosterops lateralis*) movement is a real allegretto, taking just six minutes and with an average of eight seeds per bar. However, for currawongs, most seeds don't even make it to the intestine. Five to fifteen minutes after ingestion, Pied Currawongs regurgitate seeds and skins in 'pellets'—rather unattractive, inch-long objects that mysteriously arrive on the handrail of your verandah. These seeds are effectively dispersed away from the parent plant, and often in moist sites, conducive to germination, because currawongs tend to regurgitate after a drink. With some Pied Currawong pellets containing over 160 privet seeds, a runaway cycle between these fruit-eating birds and their food has developed. Ornamental garden plants that beget berries beget weeds. And weeds beget more weeds, helping currawongs to beget more currawongs.

Many native fruiting plants of south-eastern Australia produce their berries in autumn. Winter, on the other hand,

is a time of native fruit scarcity, and is likely to have been a time of significant mortality for young Pied Currawongs. Traditionally, currawongs gorge themselves in the autumn, putting on considerable weight and then losing it gradually over the winter. But unlike the native foods, many introduced berries, particularly privets, persist throughout the winter and into the spring, eliminating the resource bottleneck for young currawongs that move into cities. This is likely to have improved survival of the birds, and allowed them to remain at low altitudes into the spring.

It is only since 1970 that significant numbers of Pied Currawongs have remained to breed in residential areas, and the incidence of breeding is becoming higher each year. (Paralleling this is an increase in the number of sightings of the migrant Channel-billed Cuckoo, *Scythrops novaehollandiae*, which parasitises currawong nests.) The 2001 Birds in Backyards nesting survey found that Pied Currawong nests were the third most commonly encountered nests in Sydney. And when currawongs breed, their diet changes. Vomit-sifting by a student at the Australian National University found that, in autumn, nearly 100 per cent of the pellets of Pied Currawongs contained fruits and seeds, while virtually none contained bird remains. However in spring, although 90 per cent of pellets still contained fruits and seeds, 41 per cent of pellets contained the remains of birds. This reached a peak in late November, when 55 per cent of pellets contained bones and feathers, and 11 per cent contained eggshells. Currawongs are clearly active hunters and not just placid vegetarians.

**WITH ITS LARGE BEAK** *and executionary habits, it is perhaps not surprising that many urban humans view the Pied Currawong as sinister.*

## Pied Currawong

*Strepera graculina*

**Classification**
Family Artamidae. Two other species of currawongs (Black and Grey) also found in Aust.

**Identification**
Large (42–50 cm); mostly black with white patches on wings, and base and tip of tail; yellow eye; large black beak. Males larger than females. Loud, musical 'curra-wong, curra-wong' and wolf-whistle.

**Habitat and Distribution**
Forests, woodlands, parks and gardens along east coast of Aust. from Cape York to south-western Vic., but not in Tas. where Black Currawong occurs.

**Biology**
Eats insects, berries, seeds, lizards, birds (eggs, nestlings, adults), small mammals, carrion. Breeds Aug.–Dec. Lays 3 eggs in bowl-shaped stick nest, built in fork of tall tree. Life span 14 years.

WITH ITS LARGE BEAK, BLACK body, beady yellow eyes and executionary habits, it is perhaps not surprising that many urban humans view the Pied Currawong as sinister. At the Australian Museum, we receive many requests each year for information on how to destroy this protected species! Some scientists have expressed concern that the unnaturally high numbers of currawongs combined with their predatory habits might be having adverse effects on our other native birds. Such concerns led to a call for a cull of millions of Pied Currawongs in

ROB DRUMMOND

**The Silvereye, like the Pied Currawong, is a fruit eater, but it also forms part of the catholic diet of this 'superbird'.**

1991. However, helpless eggs and nestlings are irresistible food items for many avian, reptilian and mammalian predators. How big an impact does the Pied Currawong have compared with other predators?

To address this question, the Australian Museum conducted the Nest Test in 1994, in which 1,800 volunteers around Australia took part in a mail-order predation experiment. The scientific sleuths set fake Willie Wagtail nests in likely locations in their gardens and monitored them over a two-week 'incubation' period. Nests contained fake eggs made of modelling clay, which retained the beak and tooth imprints of any predators that sampled them. Sixty-four per cent of nests were attacked during the experiment, and analysis of the egg remains back at the Museum revealed that 63 per cent of predation was by birds with large beaks. Furthermore, predation was significantly higher in the eastern States, home of the Pied Currawong, as well as in gardens in which currawongs were seen more frequently. The Pied Currawong's guilt was confirmed by 134 volunteers who actually caught the birds

ESTHER BEATON

**The parasitic Channel-billed Cuckoo is increasing in abundance around Sydney, tracking the trend of its Pied Currawong host.**

in the act of attacking eggs.

A predilection for plasticine might seem like questionable evidence on which to cull currawongs. But these results are well supported by separate studies in Canberra and Wollongong, which showed that a pair of Pied Currawongs kills about 40 broods (up to two kilograms) of small birds to raise one brood of its own.

So, are Pied Currawongs responsible for the decline of small species like Superb Fairy-wrens (*Malurus cyaneus*) and Silvereyes in urban areas? Many other environmental factors, such as insecticides, Cats, diminishing bushland and other superabundant and aggressive native species (like the Noisy Miner, *Manorina melanocephala*), probably all contribute to the decline of small birds in cities. To demonstrate conclusively that Pied Currawongs are having a significant effect, it is necessary to reduce their abundance in an area and measure the response.

**ARE PIED CURRAWONGS**

*responsible for the decline of small species like Superb Fairy-wrens and Silvereyes in urban areas?*

Eliminating a protected species, even on a small scale, provides an interesting moral dilemma, but the New South Wales National Parks and Wildlife Service (NPWS) has permitted two currawong removal trials. NPWS staff shot 22 adult Pied Currawongs that were nesting on Cabbage Tree Island off the coast at Port Stephens. These currawongs were feeding their chicks on morsels torn from adult Gould's Petrels (*Pterodroma leucoptera*), a threatened species, known to breed only on that island. After removing the currawongs, violent deaths of Gould's Petrels dropped from at least 43 in one breeding season to virtually none the following year, and since then numbers of Gould's Petrels have dramatically increased.

Removal of Pied Currawongs on the mainland is more difficult, both in terms of getting the permits and preventing colonisation by replacement currawongs. However, research at the University of New England detected a 21 per cent reduction in nest predation rates on artificial nests, after a partial removal of currawongs from Imbota Nature Reserve. These two removal experiments demonstrate the potential of Pied Currawongs to influence reproductive success of small birds.

However, to determine whether an increase in reproductive success of small bird species would lead to an increase in

the frequency with which we see these birds as adults, ongoing removal over a larger geographical area is required. Perhaps it is time that we tried such an experiment in the northern suburbs of Sydney, where Pied Currawongs are now present in 79 per cent of backyards, and small birds are at their lowest abundance.

BUT IS IT PC TO CULL PCS ON AN extended basis? At present it seems not. NPWS has run into extraordinary difficulties in its attempts to cull even feral animals such as Red Deer and Horses from land set aside for nature conservation. What is the likelihood of culling a native species in the most ecologically degraded landscapes? We need to recognise that native animals in unnatural densities, like kangaroos in isolated national parks, Noisy Miners in fragmented woodlands and Pied Currawongs in cities, have the potential to have greater impacts on biological diversity than some of the immigrants that dominate the agenda. However, before applying an engineering solution like bullets or poisons, we must be prepared to make the necessary adjustments to the environment to prevent populations from again increasing. Unfortunately, the switch to homogenised milk and later the screw cap did not solve the currawong problem. Real inroads will need to be made into removing pest plants from bushland and gardens, and converting more lawn into the shrubbery that provides shelter for small birds.

But is it worth the effort? Are small bird species that inhabit our cities in any danger outside these habitat anomalies? At this stage, no, but recent estimates suggest that one in five Australian birds is in decline. With Pied Currawongs thriving in regional towns adjacent to the woodlands where many threatened birds reside, currawongs may compound the decline caused by land clearing. A fundamental change in our collective response is required if we are to be successful in preserving our smaller birds in the long term. At present there does not appear to be the community will to change, possibly because our largely suburban population has lost contact with wildlife. How can we expect people to develop a wildlife ethic if they are not stimulated by nature's diversity? To my way of thinking, small birds in urban areas are the most conspicuous ambassadors of biodiversity, and preserving them is fundamental to keeping alive our dwindling interest in things biological.

Pied Currawongs and their interactions with ornamental plants, bushland weeds and small birds present a microcosm of the complexity of human interactions with the environment, that couldn't be any closer to home. The interplay also provides a tangible demonstration of the capacity of individuals to alter the environmental settings that determine the beaky faces of suburbia. We are presently privileged to have this ecological drama playing out in our own backyards, but I fear that, if we do not show some of the adaptability of the Pied Currawong, the next generation will have a fauna as homogenised as the milk that sidelined Milk Bottle Protector Mark III. □

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COURTESY RICHARD MAJOR/ AUSTRALIAN MUSEUM

**Pied Currawongs can kill 40 broods of small birds in the process of raising one brood of its own.**

LIKE MANY LIZARDS, THE JACKY HAS EVOLVED AN EXTRAORDINARY VISUAL COMMUNICATION SYSTEM CENTRED ON TAIL-WAGS, PUSH-UPS, ARM-WAVES AND HEAD-NODS.

# DRAGON BODY LANGUAGE

**BY TERRY ORD**

IT STARTS WITH A SUBTLE twitch to the tip of his tail, but soon escalates into a thrashing, side-to-side motion. Then, with rapid flexes of his two front legs, the lizard bobs his torso up and down in a series of push-ups. There is a quick shuffle as he moves farther up the branch followed by those intriguing push-ups again. At the same time he puffs out his throat, sucks in his sides, arches his back and turns a darker shade of grey.

There is a flash of motion from the ground below and a second lizard comes into view. Both lizards eye each other off, assessing the situation, then the lizard on the ground responds with his own quick series of push-ups.

If you live in Sydney, you may have seen these lizards on your walks through bushland in and around the suburbs. However, they can be easily missed if they are sunning themselves high up on a tree branch where they blend into the bark. Most people only notice them when they are disturbed and scurry off through the undergrowth. They are known as Jacky Lizards (*Amphibolurus muricatus*) and, at first glance, appear to be rather unimpressive-looking members of the dragon lizard family (Agamidae). This family includes such noted celebrities as the Bearded Dragon (*Pogona barbata*) and Frilled Lizard (*Chlamydosaurus kingii*), but, alas, no fancy head gear for our Jacky Lizard!

The Jacky Lizard lives not only in

T & V BLAGDEN-NATURE FOCUS

**The Jacky Lizard relies on an extraordinary method of communication during competitions over territories and social dominance. Through a series of tail and push-up displays, a complex game of assessment is played between two opposing males.**

Sydney, but throughout urban and rural habitats across south-eastern Australia. Despite their prevalence, surprisingly little is known about even the most basic aspects of their ecology. Prior to starting my studies, we knew almost nothing of their social behaviour except for a few tantalising snippets embedded deep in the scientific literature. Amazingly, these snippets didn't even come from Australia, where the species is endemic, but from an American biologist, Charles Carpenter, who kept several of the lizards at a University of Oklahoma field station. In a research paper published in 1970, he briefly described their displays and commented on their possible function in mediating disputes over territories and dominance status.

Like many lizards, the Jacky has evolved an extraordinary visual-communication system centred on tail-wags, push-ups, arm-waves and head-nods. This surprises many people, who generally don't think of lizards as being particularly brilliant communicators. In fact, I was once asked on a radio program why I had settled on lizards, and not some other model system (such as birds), to satisfy my ambition to study animal communication. The interviewer, like many people I meet, had simply assumed I had been one of those kids who had always been fascinated by lizards and had subsequently extended this childhood passion into their research. The truth is, I had very little experience with these animals until after I joined the team at the Animal Behaviour Laboratory run by Chris Evans at Macquarie University. It was here that I discovered these creatures were excellent models for exploring how and why animals communicate.

Lizards signal in a variety of ways. Some, like skinks, use olfactory cues through scent-marking to get their message across. However, for the dragon lizards and the closely related iguanas, communication is primarily conducted using visual displays centred on push-ups and head-nods. Looking into the literature, out of the approximately 60 agamid species found in Australia, I was disheartened to find information on social behaviour for only ten, and most of these were anecdotal observations described in research papers over 20 years ago. In contrast, the charismatic iguanas of the Americas have been, and still are, the subject of considerable research interest, with the number of studies published reaching into the hundreds.

However, it is possible to take advantage of the close evolutionary ties between the iguanas and agamids. By bringing all the available information together, some interesting insights into the evolution of lizard display behaviour

KATHIE ATKINSON

**Jacky Lizards undergo periodic skin shedding, which typically begins near the head and leg areas.**

KEN GRIFFITHS

**A semi-arboreal reptile, the Jacky Lizard can often be seen sunbaking on dead wood and rocky outcrops, from which it can also oversee its territorial borders.**

RICHARD PETERS

become apparent. For example, I found that those lizard species that fiercely compete for access to resources, such as territories and mates, are also the ones that have typically evolved an elaborate communicative system. This suggests competition for resources has been a fundamental force driving the evolution of display behaviour in these animals.

Lizards are by no means the only animals in which this phenomenon can be found. From frogs to deer, conflict has helped drive the evolution of social communication. This fact has interested scientists for decades and lizards provide an ideal group for exploring it—they are territorial, often compete intensely for resources, and mediate disputes using an often complex system of visual displays.

OBSERVATIONAL STUDIES OUT IN the field are a particularly useful means for identifying interesting behavioural phenomena. However, while it is possible to speculate on the function of this behaviour, often experimental research needs to be conducted in captivity to directly test the various hypotheses. For my studies I have used video images. Through video editing, an experimenter has complete control over both the morphology and the specific behaviour of an animal appearing on the screen. This allows the researcher to present animals with a particular set of stimuli and, by recording the behavioural responses these stimuli elicit from subjects, to extrapolate the function of complex sequences of behaviour.

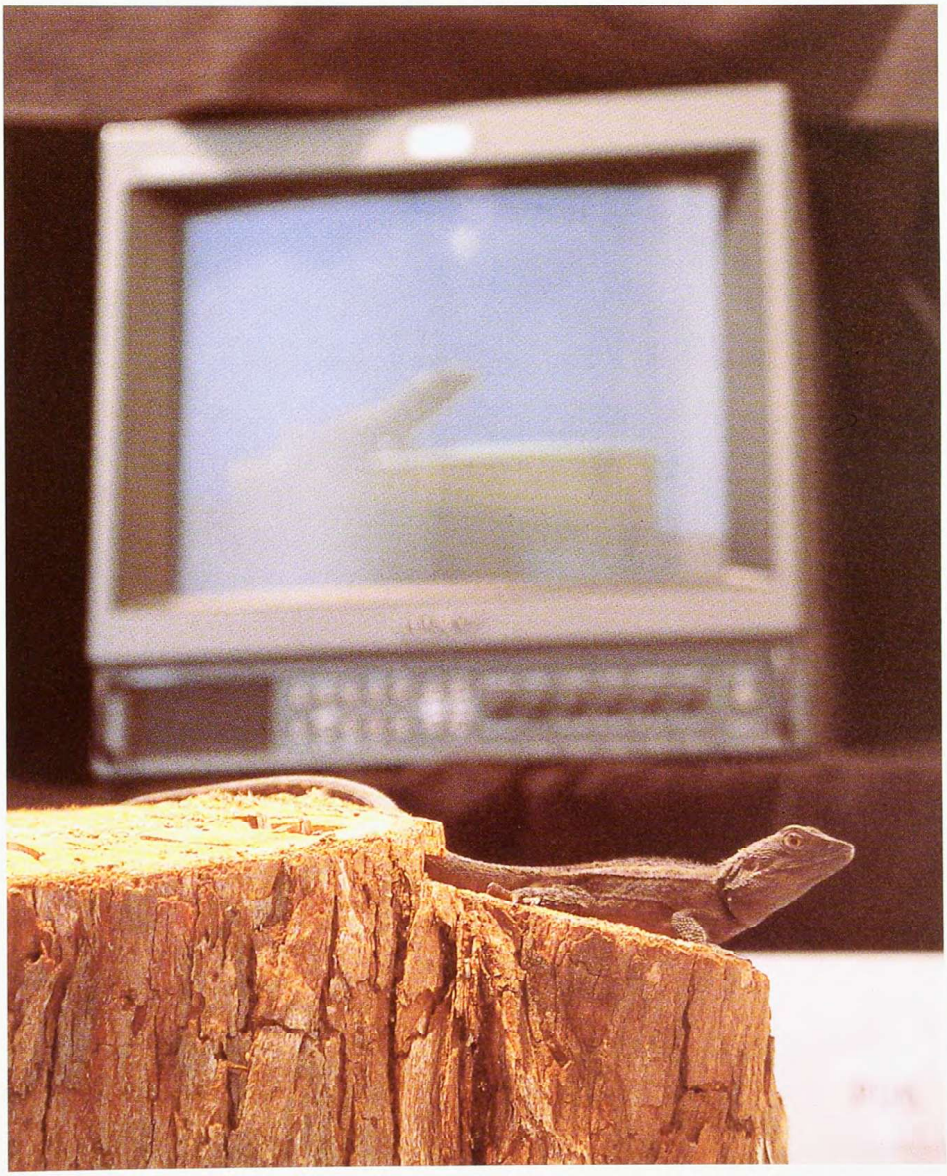
Since its development in the early 1980s, video playback has proven to be

Lizards used in video playback experiments were caught in the wild using a small string noose on the end of a fishing rod. Here the author records body measurements and determines the sex of a Jacky Lizard near Botany Bay.

a popular and successful tool in the study of animal behaviour and has been used in research on spiders, crabs, fishes, frogs, birds, primates and lizards. In fact, in my own behavioural experiments, some of the more confident lizards become so excited by the rival depicted on the screen that they launch themselves at the monitor in an attempt to bite and topple the video intruder off its perch.

Using this technique, we now know that Jacky Lizards have a display repertoire of several different signals, each performed depending on the situation at hand. In birds, territory holders often use a 'broadcast' song to advertise their presence to rivals and discourage territorial infringements by neighbours. A similar system is most likely operating in Jacky Lizards, which can often be seen on high perches within their territory performing push-up displays. While these displays are not directed to any specific individual per se, they are probably being used to assert their continued presence in a territory. This is important, as we know from studies on related species that, once a resident lizard is removed, a territory is soon taken over by a rival.

Things start to heat up, however, when territorial infringements actually occur. In these situations, several different displays may be performed by a competitor. Push-up displays are the primary aggressive signal used by Jacky Lizards. When these displays are conducted in the presence of another lizard, signal sequences typically begin with several rapid, broad flicks of the tail. As yet, the precise function of these tail displays is unknown, but Richard Peters, another researcher in the Evans' lab, is testing the hypothesis that it may orient a rival towards the



RICHARD PETERS

Jacky Lizards respond to video images as if confronted by a real opponent. By tailoring the behaviour of the video lizard, researchers can investigate the functions of displays during territorial disputes.

KEN GRIFFITHS

**Jacky Lizards are visually orientated animals that rely on fast-moving insects for food.**

## Jacky Lizard

*Amphibolurus muricatus*

**Classification**
Family Agamidae (dragons).

**Identification**
Snout–vent length 8–10 cm, tail about twice as long. Body colour light grey to dark brown/charcoal. Body markings consist of a narrow, pale, dark-edged lateral stripe that is often divided by a series of large, angular, blackish patches. Lining of mouth bright yellow. Males typically larger than females.

**Distribution and Habitat**
Urban and rural habitats from south-eastern SA to north-eastern NSW. Dry sclerophyll forest, rocky outcrops and coastal heathlands.

**Biology**
Mainly insectivorous, but may eat small amounts of vegetable matter (e.g. small flowers). Breeding begins in about Oct., during which time social interactions are at their highest. Females lay 3–9 eggs late Oct. to early Feb. in small, shallow burrows in sandy soil, often leaving leaves and lichen over the area as camouflage.

displaying lizard. The logic follows that, if a rival is not paying attention, then the signal is probably going to be pretty ineffectual. Peters suspects that the displaying lizard first catches the attention of an opponent through a series of conspicuous tail-flicks, before proceeding with the more information-rich push-up display.

What sort of information is likely to be transmitted during push-up displays? To answer this question, Evans and I collaborated on a series of video-playback experiments and found that an opponent performing many push-ups was perceived as significantly more threatening than one performing only a handful of displays.

To interpret this, we need to understand some basic physiology. Activity is energetically costly. This is true for all of us, but for lizards it is particularly important because of their ectothermic ('cold-blooded') lifestyle. Basically, performing push-ups is an exhausting business for a lizard. For this reason, push-up displays are an ideal way to convey information on stamina and physical endurance.

Why is this sort of information important? In lizards and many other animals, there is often intense competition over territories, mates and other resources. If these contests lead to physical combat, there is the obvious risk of injury. What is interesting is that most animal conflicts generally do not escalate to the point of fighting. Instead, many animals have evolved methods allowing competitors to assess opponents and avoid fighting when they are unlikely to win. If a dispute can be resolved without resorting to combat, both sides ultimately benefit. Generally, it is only when animals are evenly matched that contests have to be resolved through fighting.

So how does a Jacky Lizard back out of a contest dispute? By using two additional displays: arm-waves and head-nods, which we believe are appeasement signals. They are performed at much slower rates, and are typically repeated for longer periods, than aggressive tail and push-up displays. In our video-playback experiments, some lizards unable to match the push-up displays of the

video lizard performed slow arm-waves and head-nodding instead. Basically, if a lizard suddenly finds himself confronted by a superior opponent, then an appeasement signal will reduce the likelihood that a potentially dangerous conflict will ensue. Such appeasement signals may be important during accidental boundary infringements by a neighbour, or when a stranger unwittingly stumbles into a territory-holder's domain. Appeasement signals are also important in the maintenance of dominance hierarchies when lizards are forced to occupy the same home range—a situation that can occur in times of limiting resources.

THERE IS STILL MUCH TO LEARN from these animals. For example, displays that are designed to be conspicuous to rivals may also attract unwanted attention from potential predators, particularly birds. Current research is now focusing on the role of predation risk in shaping lizard behaviour. It is also reasonable to expect that a diet made up of fast-moving insects (as is typical for many visually displaying lizards) would be coupled with a visual system tailored to detect rapidly moving objects; otherwise, how would lizards be able to capture their prey? One future avenue of research might investigate whether this visually enhanced system for detecting fast-moving prey may have 'opened the door' for the evolution of more subtle movements to be incorporated into lizard displays.

Next time you're out walking in one of our local nature reserves, take it a little slower. Listen to the noises of the bush more closely and let your eyes wander off the track a little farther than usual. If you hear a faint scurry from a nearby shrub, wait a while and you may be lucky enough to catch a glimpse of a Jacky Lizard bobbing its head. Don't dismiss it as just another of those common lizards. Take stock and remember they are playing a valuable role in unlocking many of the secrets behind the evolution of animal communication. □

**Clutches of three or more eggs are laid by females following a summer breeding season that sees a peak in social behaviour between Jacky Lizards.**

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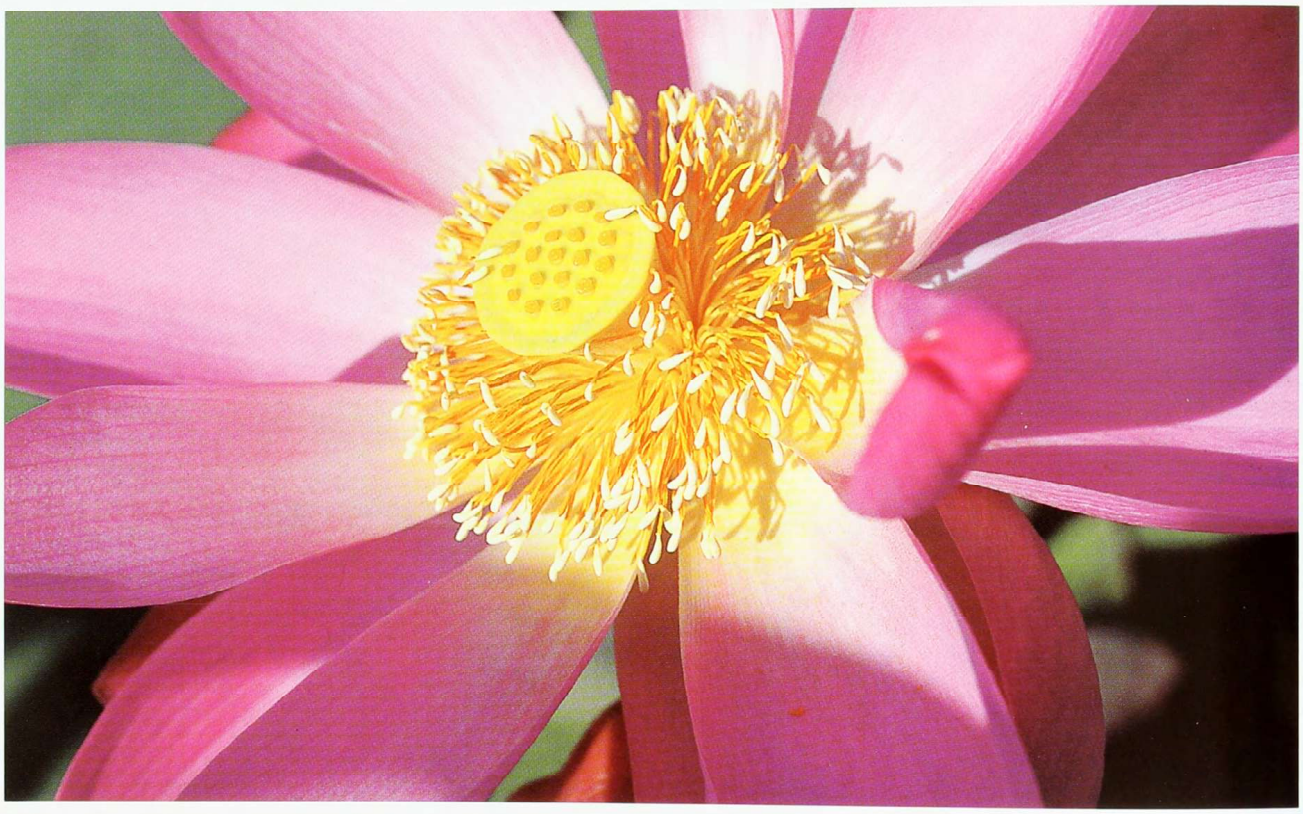
DR TERRY ORD RECENTLY COMPLETED HIS PH.D. ON THE SIGNAL BEHAVIOUR OF THE JACKY LIZARD AT MACQUARIE UNIVERSITY, SYDNEY, AND IS NOW WORKING IN THE DEPARTMENT OF BIOLOGY AT INDIANA UNIVERSITY, USA. HIS RESEARCH CONTINUES TO FOCUS ON THE EVOLUTION OF COMMUNICATION IN LIZARDS.


HE WOULD LIKE TO THANK CHRIS EVANS, DAN BLUMSTEIN AND RICHARD PETERS FOR THEIR ASSISTANCE DURING THE RESEARCH.


KEN GRIFFITHS



Sacred Lotus (*Nelumbo nucifera*), Northern Territory.

# the tropics

**BY DICK EUSSON**
Tropical Australia Media

Bitter Springs, Elsey National Park, Northern Territory.

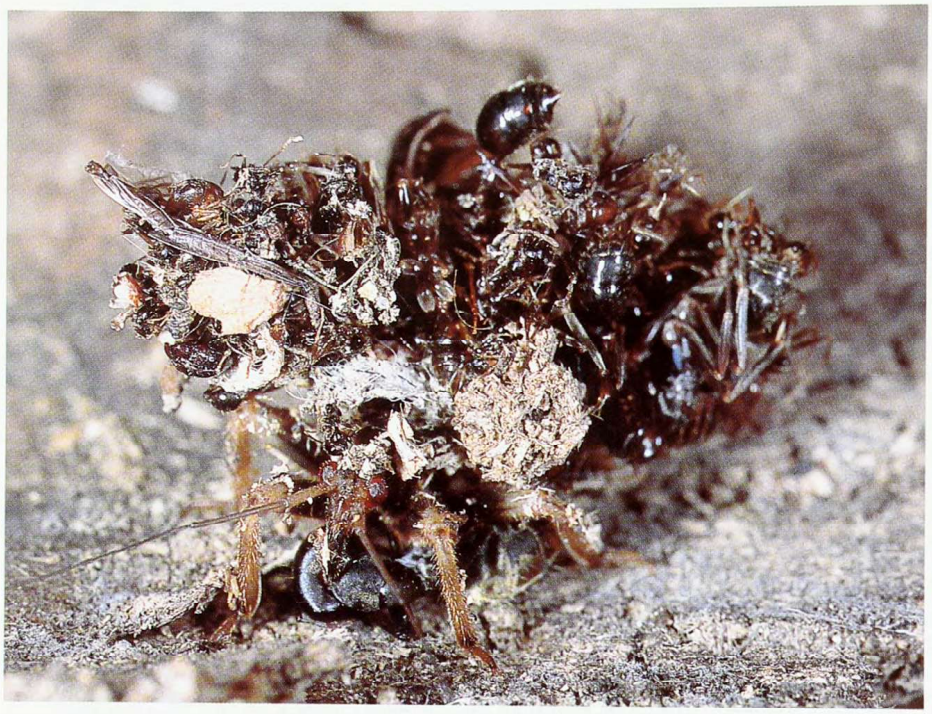
Melaleuca Billabong, Lakefield National Park, Cape York Peninsula, Queensland.

Eliot Falls, Heathland Reserve, Cape York Peninsula, Queensland.

Melaleuca Swamp, Daintree, Queensland.

# Assassins who live with the dead

*When the corpse has been sucked dry, the predator places the body onto its back.*



SIMON D. POLLARD

**An African assassin bug nymph, with its backpack of ant corpses, sucks the life out of another victim.**

AS THEIR COMMON NAME suggests, assassin bugs are not amiable vegetarians; they are predators, and the lives of three species from West Africa have all the ingredients of a dark gothic tale. It is a tale of corpses sucked dry, out-of-body experiences and naked undertakers mixing their shed skins with the dead.

Most assassin bugs (family Reduviidae) are predators of other arthropods, and the nymphs (immature stages) of many species have unusual camouflaging behaviour to deceive prey and confuse predators. Miriam Brandt and Dieter Mahsberg, from the Universities of Regensburg and Würzburg in Germany, studied the function of camouflage used by nymphs of West African *Paredocla* and *Acanthaspis* species in Comoe National Park, Ivory Coast.

While many animals have evolved camouflaged body shapes, these nymphs acquire their disguise from their surroundings. A naked nymph is not a happy nymph so they initially cover themselves with a layer of dust, sand or soil, which adheres to a matt of bristles, like dirt trapped on the furry side of a Velcro strip.

They mostly eat ants and, after grabbing one, the bug uses its syringe-like mouthparts to pierce through the body of the prey and inject paralysing saliva and digestive enzymes. In effect, the ant's hard cuticle becomes a container to hold its liquefied tissues as they are sucked up the syringe and into the bug's digestive system. When the corpse has been sucked dry, the predator puts on its undertaker's hat—literally—and places the ant's body onto its back on top of the layer of dirt. In a real out-of-body experience, with Hannibalesque overtones, the empty shell of the fresh victim rides above its contents now residing inside the body of the bug.

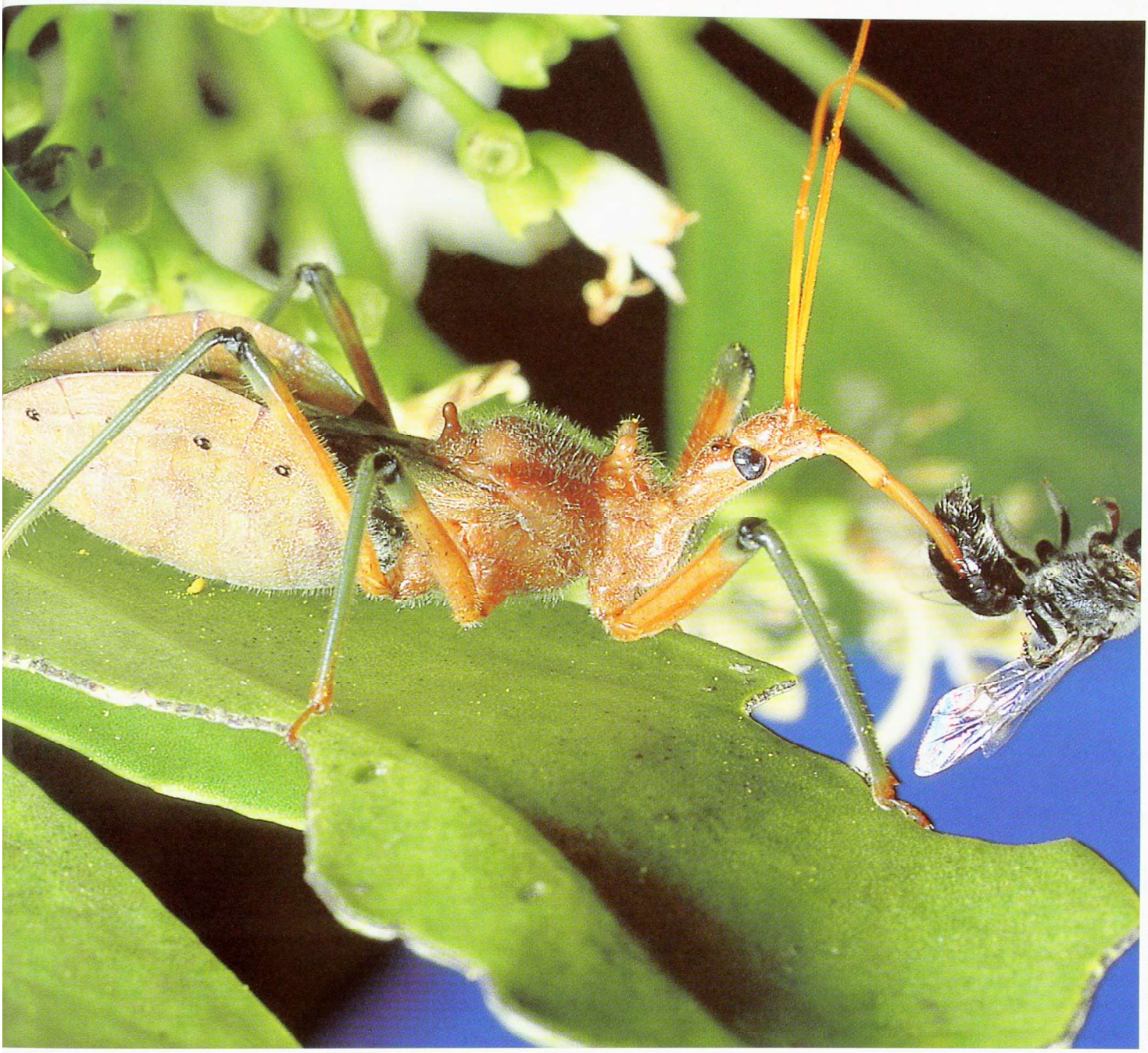
And while it may be a funeral without flowers, the bug often mixes plant remains with its victims' bodies. After each moult the bug is naked again and quickly acquires a new dust coat, before again shouldering its backpack of the deceased, which may even include the skin it has just shed. This pile of corpses is tethered together by fine elastic threads secreted from glands on the nymph's back.

Why do the nymphs acquire these macabre fashion accessories? Brandt and Mahsberg looked at how a variety of predators and prey reacted to naked, dusted and corpse-laden bugs. For nymphs naked as the day they moulted, the researchers had to keep them away from anything they could use to camouflage themselves. Some nymphs were allowed to have only a dust coat, while others a dust coat and a collection of plant and ant memorabilia.

In the arthropod-movie equivalent of hiding in the closet while the axe-wielding psychopath pulls at the clothes around you, predatory centipedes would tap on the bug's backpack in search of cues that would signal food, but were duped by the disguise. However, take all the clothes out of the closet and put in a naked nymph, or one with just a dust coat, and the palpating centipede soon finds a meal.

Large hunting spiders are extremely sensitive to vibrations and a naked nymph or one with a dust coat can do little to defend itself from a charging spider. This reminds me of Wile E. Coyote cartoons, when the coyote, faced with being flattened by a huge object from above, optimistically opens a small umbrella to protect itself. However, a bug with a backpack of bodies may escape because the spider gets a face full of ant bodies rather than the juicy nymph, which runs away while the spider figures out how dinner became a burial mound. The backpack acts as a distraction to the predator, in much the

**BY SIMON D. POLLARD**



WAYNE LAWLER/AUSCAPE

**Adult assassin bugs have no need for disguise. Here the Australian *Pristhesancus* species attacks a native bee.**

same way as a wriggling lizard's tail detached from its escaped owner.

But, are predators with good eyesight fooled by the backpack? The researchers found that geckos ignored nymphs with a backpack, while those with a dust coat had a fifty-fifty chance of surviving. Although the backpack makes the bug more conspicuous, visually oriented predators do not appear to recognise it as prey. As one bug researcher put it, "nothing looks less like a bug than a small heap of ants".

The researchers also looked at the effect of the dust coat and backpack on the nymphs' ability to hunt for their most common prey, ants. Army ants are extremely aggressive and attack anything animate. Naked nymphs had a rough time, but dust-coated and backpack nymphs were largely ignored. Ants have very poor eyesight, and it appears that the dust coat masks olfactory and tactile cues, allowing the nymphs to move unmolested among potentially dangerous prey. Because ants are not visual predators, the presence or absence of the backpack made little difference to the bug's hunting success.

After the nymphs moult into adults, they discard their strange collection of childhood possessions, and although adults still prey on ants, they no longer need to live with the dead. □

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# Hunters and collectors

*People like to stroke their collections. A few even talk to them as if they were lost lovers or friends.*

I RECENTLY READ THAT AUSTRALIAN Nobel prizewinner Peter Doherty keeps a collection of donkey figurines. They were sent by admirers when a colleague likened him to Eeyore—A.A. Milne's crotchety character who even apologises for bad weather ("...only don't blame me!"). Although we can't blame Doherty for putting this collection together, he did choose to keep it "in a drawer somewhere". Does this sound familiar? How many of us have a drawer somewhere full of personal treasures? I wonder if it is an essential human quality to collect things.

Collecting is more than simply accumulating things or gathering nuts for the winter. According to Russell Belk from the University of Utah, collecting is the "process of actively, selectively, and passionately acquiring and possessing things removed from ordinary use and perceived as part of a set of non-identical objects or experiences". Nearly everyone (if only as a child) has probably made some kind of collection, and many of these have ended up in museums.

We can track the beginnings of modern archaeology and museum collections to the Renaissance Period when the collection of antiquities was stimulated by rediscovery of classical civilisations. Italian dilettanti—those who delight in the arts—amassed extraordinary collections of art, manuscripts, fossils and relics. Belk sees the origins of collecting in the rise of consumer society that has its roots in early civilisations, with collecting really taking off during European voyages of discovery in the 15th century.

The thing about most collections is that the goods themselves are removed from their normal functions, although some items are made specifically as collectibles, such as commemorative plates or even snow domes whose purpose is to remind us of people, places or events. But it is the ultimate in a materialistic world to pay big money for such items as used bottle tops, (unused) toilet paper rolls or a disposable cup used once by John Lennon.

Psychoanalyst Otto Fenischel refers to the typical collector as the "anal retentive type who gains satisfaction from symbolic equivalents", seeing the origins of collecting in the "infantile attitude to faeces". Apparently, small children have little opportunity to exercise control over their lives but one way is to go, or not to go, to the toilet, when and where they want to—not just when it suits the parents. Collections are another way that children take control and create fantasy worlds—and they start at about four years old.

This idea is too simple, according to another psychoanalyst Werner Muensterberger. He has studied the entire lives and times of several collectors and argues that a collection is a substitute for something else or even another person. People like to stroke their collections. A few even talk to their collections as if they were lost lovers or friends (Sigmund Freud talked to his statues, and Prince Charles reportedly talks to his plants).

Don Juan 'collected' maidens; Frederick the Wise of Saxony collected 17,433 holy bones; and Thomas Phillipps (1792–1872) had to have a copy of every book in the world. In each of these cases, Muensterberger describes collecting as a thrilling hunt; a never-ending obsession that saps resources to satisfy a deep need for recognition. What looks like cupidity (an inordinate desire to possess something) and narcissism (admiration of oneself) is traced to phallic fantasies, childhood frustrations or an Oedipus complex. He attributes one obsessive patient's collection of cowrie shells to the repression of coprophilia (morbid interest in faeces)! How many of us collect cowrie shells?

Collections mean different things to different people. But what a collection means to the collector is particularly important. After all, you cannot really have an unintentional collection. Peter Doherty made a decision to keep his 'gift collection' of Eeyores—it obviously meant something to him. But how do we even recognise a collection unless the collector tells us that it is indeed a collection?

A prehistoric 'collection' of bricks might be the remains of a house, or a 'collection' of shells might be a midden (refuse heap)—hardly collections in the collectible sense. A horde of metal objects or stone axes, on the other hand, might be a real 'collection', but we would really need to know the intentions of the collector. The recent past is easier to tackle, and Pacific archaeologists have argued that certain shells, stones and bones were valuable collections because they are similar to items recently used in important ceremonies. Anthropologists have argued that a distinctive element of Papua New Guinean society is that people collect indebtedness; they accumulate obligations often in the form of objects that must be passed on and handled in specific ways. Debt collection means something else to most Westerners!

A deltiologist collects postcards. A tegestologist collects beer mats. Is there anything that is *not* collected by ordinary people (that is, people without serious psychological problems)? Aunt Clara (from the television series "Bewitched") collected doorknobs—ordinary objects but hardly an ordinary household! Imelda Marcos collected shoes. Certainly the ordinary object is making its way into museum exhibi-

**BY RICHARD FULLAGAR**


STUART HUMPHREYS NATURE FOCUS TATOO GUN COLLECTION COURTESY TONY COHEN

**Humans collect all manner things, even tattoo guns.**

tions—lunchboxes at the Museum of Victoria and washing machines in Sydney's Powerhouse Museum. But do our museums unwittingly promote the negative aspects of collecting, such as consumerism, colonialism, materialism and addictions to things?

Surveys suggest that almost all children collect things (an average of 12.7 collections for ten-year-old boys in one study). Belk suggests that men in the USA have tended to dominate collecting, while Susan Pearce (University of Leicester) claims there are slightly more female than male collectors in the UK. Collecting may be less popular than it used to be, but one in three adults probably have collections in the capitalist world, and an archaeological study of modern America suggested 60 per cent of households have at least one collection. Although many serious collectors love to hunt down particular items, collecting is no longer seen as an obsessive disorder, in today's consumer society.

So forget infantile neuroses; collecting is pretty normal. Nevertheless, what people collect can be pretty strange. I invite *Nature Australia* readers to let us know what they collect (see box). My own childhood collections sadly accord with the American average: coins, stamps, postcards, football cards, marbles; but I was once passionate about kites. These days I don't collect anything in particular. Nor do I throw much away. I like, and collect, junk. □

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Do you collect anything and, if so, what? Write to *Nature Australia* Collections, 6 College St, Sydney, 2010, or send an email, subject "Collections", to *georgieh@bigpond.com*

# Ghostly glows

*Some algae and fungi glow in the dark.*

THE INTERNET SALES-PITCH reads "incredibly easy to grow at home, requiring as little care as a houseplant...producing blue light when shaken at night". For a few American dollars, you too can own and enjoy bioluminescent algae. Or if you prefer your bioluminescence untamed, try your luck with a night-time swim or boat trip in the local sea.

The term bioluminescence is used for light-emission that originates from a chemical reaction within living organisms. We are most familiar with fireflies, glow-worms and, from television, bizarre deep-sea fishes. Plants in the narrowest sense don't luminesce naturally, although the glowing flower of a white bluebell (*Lisianthus* sp.)—apparently the result of transferring a jellyfish gene for fluorescence rather than luminescence—caused a stir at an Italian flower show last August. Nevertheless some algae and fungi, often considered part of the botanical world, glow in the dark without genetic manipulation.

The Ghost Fungus (*Omphalotus nidiformis*) is a relatively common luminescent fungus in the eucalypt forests of southern and middle-eastern Australia. This funnel-shaped, gilled toadstool is white by day, although becoming darker with age. It resembles the edible but non-luminescent Oyster Mushroom or Hiratake (*Pleurotus ostreatus*), but the Ghost Fungus is highly toxic if eaten, causing severe vomiting in humans. For the several days and nights that it lasts, the fruiting body emits enough of a whitish glow to read the time from your watch in the dark—in tropical Australia you might use the unrelated toadstool *Filoboletus manipularis*.

Only one other (so far undescribed) species of Australian fungus has luminescent fruiting bodies, but a few others bestow a faint greenish glow to decaying wood through a network of luminescing fungal threads. A night-time inspection by plant pathologists at the Royal Botanic Gardens and Domain Trust revealed that their laboratory cultures of the pest fungus *Armillaria* glow in the dark. Overseas these luminescent fungal threads have been called 'fairy sparks', 'touchwood' and 'foxfire', the latter a corruption of the French *faux fire*, meaning false fire.

The eerie glow attracts night insects such as moths and small flies, which may assist in the dispersal of the fungus. Many different insects are certainly attracted, and glowing fungi soon become moth-eaten and full of larvae. However specialist fungal gnats also eat their spores, offsetting the positive effects of larger insects that might transport the spores to new habitats. Because of the mixed blessings associated with being the one house with the light on, some mycologists (fungal experts) think it more likely that luminescence is merely a way of getting rid of excess oxygen, possibly even an artefact handed down from an ancient life form adapted to low-oxygen environments. Alternatively the light may be used to activate DNA repair, as happens in some luminescent bacteria.

Bioluminescence in all organisms results from the oxidation of 'luciferin', a generic name for a range of chemicals that bind with oxygen in the presence of an enzyme called luciferase. The products of this reaction are 'oxyluciferin' and light. It is interesting to compare this with what we call 'fluorescence' and 'phosphorescence', where the source of energy comes from the absorption of photons from incoming light rather than from a chemical reaction. There are many different sorts of luciferin, and bioluminescence has arisen in numerous unrelated taxonomic groups, including bacteria, insects, fungi and algae.

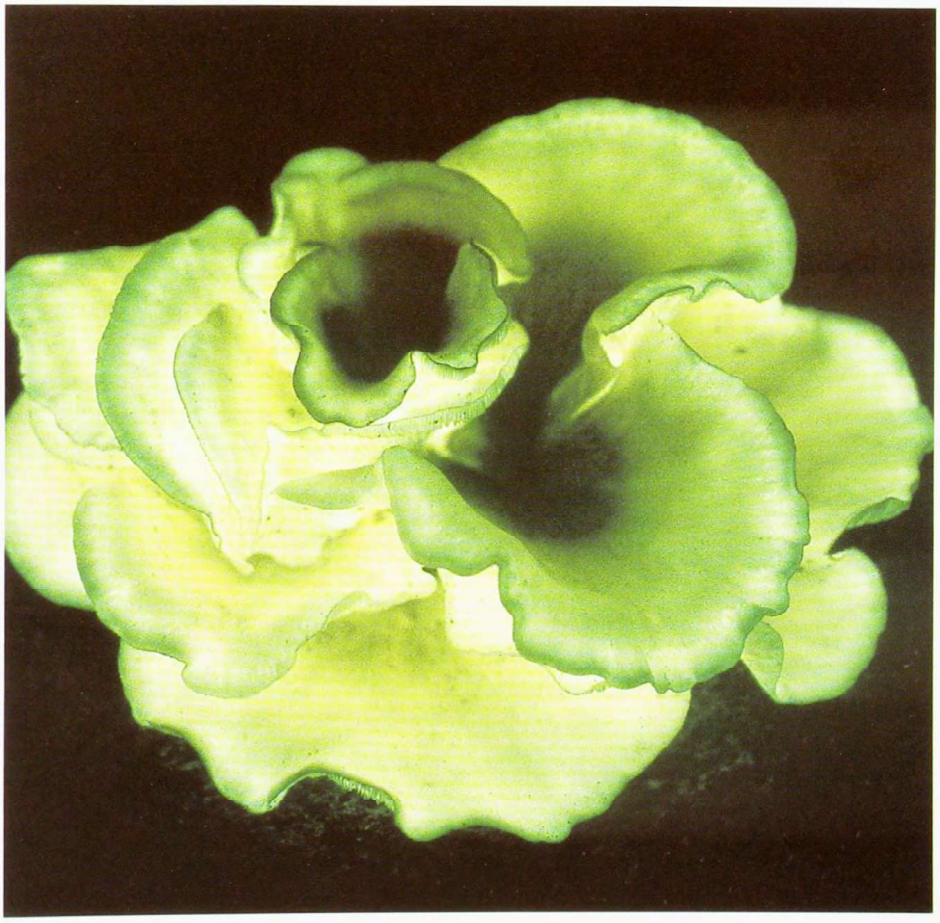
In the case of bioluminescent algae, whether in a fish bowl or the sea, luciferin remains inert until the algae are mechanically disturbed. Most of the time luciferin is tightly bound to a special protein, and then packaged up into aptly named scintillons. These scintillons become more abundant at the end of the day, and the potential for bioluminescence peaks about two hours after sunset. Somehow (the process is still poorly understood) stimulation of the cells results in acidification of cell contents and activation of the oxidation process within the scintillon. Most sailors have experienced the often brilliantly luminescent bow wave or wake of a ship in the early evening, caused by mechanical disturbance of algae in the water, but bioluminesence can just as easily be triggered by ultrasound or chemical stimulation (for example by increasing the acidity of the surrounding water).

The usual source of marine bioluminescence is a thick soup of dinoflagellates, the same group of single-celled microscopic algae responsible for red tides and the controversial flesh-eating *Pfiesteria* (see *Nature Aust.* Winter 2002 and Summer 2002–2003). Pink wafts of the non-toxic dinoflagellate *Noctiluca scintillaris* are common in eastern Australia, and they often add an extra sparkle to Sydney Harbour by night. In fact the dinoflagellates were once known as the Pyrrhophyta, the 'fire plants'—not particularly apt, however, as the glow produced by bioluminescence is often called 'cold light' because almost all the energy released from the chemical reaction is released as light rather than heat.

The flashes of light are thought to act

**BY TIM ENTWISLE**

**Daytime and night-time views of the bioluminescent fungus *Pleurotus nidifo rmis*.**



KATHIE ATKINSON

like a burglar alarm, protecting the dinoflagellates from being eaten (see *Nature Aust.* Spring 1997). It works like this. The 'burglar' is the animal trying to eat them. When a small fish or other grazing predator thrashes around nearby, the cells are stimulated to make flashes of light. This light attracts bigger predators, which then eat the grazers. The illuminated message is, don't mess with us or you'll end up in someone's stomach!

Interestingly, the US Navy has shown great interest in better understanding, and working out ways to avoid, bioluminescent algae. A concentration of only 100 dinoflagellates per litre of seawater is enough to highlight a moving object such as a ship, and the telltale glow may alert the enemy to its presence. Most coastal monitoring programs around the world record bioluminescent dinoflagellates at or above this level, but in the case of a red tide or other algal bloom, the concentrations can reach 30 million cells per litre. Under these conditions, breaking waves can trigger spectacular night-time displays.

Clearly bioluminescence can be an object of wonder or fear. While attempts to commercialise its extraordinary properties have so far failed, bioluminescence has had a role to play in modern history. For example, there are numerous stories of US troops during World War 2 attaching bioluminescent fungi to their helmets and guns while on patrol in the jungles of Pacific Islands, as a way of avoiding collisions with one another. And, more touchingly, one war correspondent began a letter home with "Darling, I am writing to you tonight by the light of five mushrooms." □

## FURTHER READING


*Haddock, S.H.D., McDougall, C.M., and Case, J.F. , 2000. The Bioluminescence Web Page.* http://lifesci.ucsb.edu/~biolum/.

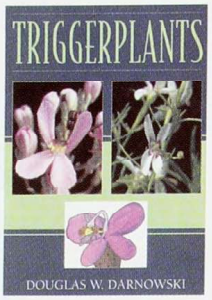
*Evans, G., 2002. Fungimap.* http://fungimap.rbg.vic.gov.au/.

*Rose, D., 1999. Notes from underground: bioluminescence and fungi.* Spores Illustrated *(Summer 1999) [reproduced at* http://www.comafungi.org/nfusum99.htm]



DR TIM ENTWISLE IS DIRECTOR OF PLANT SCIENCES AT THE ROYAL BOTANIC GARDENS AND DOMAIN TRUST, SYDNEY.

# reviews



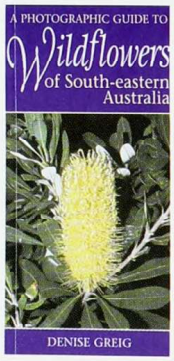

## Triggerplants

*By Douglas W. Darnowski. Rosenberg Publishing, NSW, 2002, 112pp. $29.95rrp.*

DARNOWSKI'S BOOK DELVES INTO THE WONDERFUL WORLD of the Australian triggerplant genus *Stylidium*, which is renowned for its unusual pollination method. In triggerplants, the fused male and female reproductive organs form a column in the centre of the flower, and when an insect fires the 'hinge' mechanism, the column rotates rapidly—whaaam!—and coats the insect with pollen. The book starts with an excitable introduction to the pollination mechanism, and follows with a discussion of triggerplant diversity and horticulture. Most importantly, Darnowski proposes for the first time that, in addition to an extraordinary pollination mechanism, triggerplants may also be carnivorous.

Darnowski's passion and enthusiasm for triggerplants is conveyed throughout the book, and he encourages children to learn more about the genus by suggesting ways to conduct simple triggerplant research. However, the use of this book as an introductory guide to triggerplants is compromised at times by factual errors, and supporting illustrations that are not always clear. Presently, the evidence for carnivory in triggerplants is unpersuasive, however I suspect this book will generate much discussion among carnivorous plant enthusiasts and scientists alike.

—ELISA RAULINGS
PARKS VICTORIA




## A Photographic Guide to the Wildflowers of South-eastern Australia

*By Denise Greig. New Holland, NSW, 2002, 144pp., $19.95rrp.*

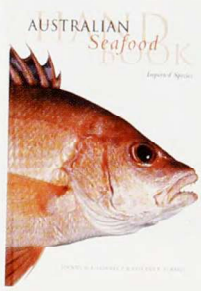
DENISE GREIG HAS BECOME THE THISTLE HARRIS OF OUR TIME. She has continued the excellent work of making the Australian flora more accessible to the general public. The book can be roughly broken up into three sections. The introductory section broadly describes the main vegetation types observed in south-eastern Australia, and how to use the book. All the obvious broad vegetation types are clearly described, including the common plant groups or families that might be encountered in these vegetation zones.

The larger, second section deals with the plants themselves. The plants are set out in alphabetical family order. Line drawings representing the families in the top outer corner of the page are a great visual-identification tool for locating species. The text describing the species, its preferred habitat and likely occurrence is concise and informative. Important field-identification characters are provided in bold. Overall the photography is of a high standard, and the line drawings of the leaves are an added plus.

The final section is a glossary and a thorough index of plant names. The glossary is excellent and contains clear, easy-to-understand definitions and occasional clear diagrams to supplement the definition. The index is extensive, so it is possible to find all the species names, synonyms, common names and vegetation types.

The book is a sensible size for carrying in the pocket of the backpack or the glove box of the car. For the holidaying traveller or the weekend bushwalker, this book is an ideal companion.

—PETER JOBSON
ROYAL BOTANIC GARDENS SYDNEY




## Australian Seafood Handbook: Imported Species

*Ed. by G.K. Yearsley, P.R. Last and R.D. Ward. CSIRO Marine Research, Hobart, 2003, 231 pp. $49.95 rrp.*

IN 2001, OVER 140,000 TONNES OF SEAFOOD WERE IMPORTED into Australia comprising over 225 species from 50 countries. In the past there has been enormous confusion over the identification and marketing names of these species.

The Imported Species Handbook is the culmination of four years of work by the same CSIRO scientists who wrote the very successful Domestic Species Handbook (1999). It follows the same easy-to-use format but covers imported seafood species, including fishes, crustaceans, molluscs and other invertebrates.

For each species, identification details, size and habitat are provided, as well as colour photographs of the species and fillet (for fishes). There is also a section on protein fingerprints for most species.

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death
*the last taboo*

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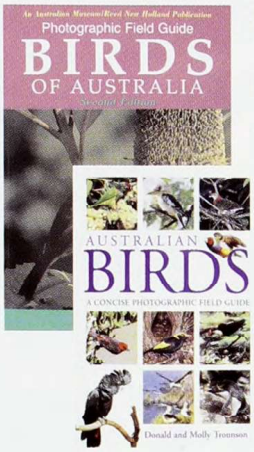
The authors state that, because of the dynamic nature of seafood importing, the book cannot be comprehensive. Despite this, they have made a huge contribution to clarifying the knowledge of imported seafood. This attractive book, together with the Domestic Species Handbook, will become an essential reference for anyone interested in Australian seafood.

—Mark McGrouther
Australian Museum




## Birds of Australia: Photographic Field Guide

*By Jim Flegg. Second edition. Reed New Holland, Sydney, 2002, 367 pp. $34.94 rrp.*

## Australian Birds: A Concise Photographic Field Guide

*By Donald and Molly Trounson. Cameron House, SA, 2002, 392 pp. $34.95 rrp.*

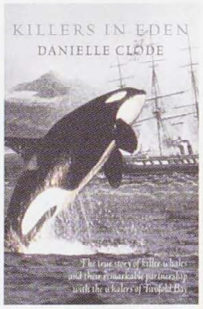
Unlike most traditional bird field guides, which use paintings to illustrate each species, these guides use photographs. This is useful to show natural poses, in contrast to drawings, which aim to show every feature typical of a species. As most birdwatchers know, a bird spotted in the wild rarely exhibits all of these 'typical' features, and doesn't always look exactly as the book says it should. However, the individual nature of a bird's appearance is also problematic for a photographic guide, as one individual is called upon to represent an entire species. The quality of the photographs is excellent in both guides; indeed, some are identical, and have obviously been sourced from the same photographic agency.

The text of both guides is interesting and easy to follow, but the Trounsons' species descriptions include many more behavioural observations than Flegg's, which is mainly limited to physical features and habitat preferences. Flegg's guide also includes general sections on bird biology, habitats, birdwatching and conservation, and a useful system of habitat symbols, indicating quickly where each species is likely to be found.

It is in layout that the guides really differ. Flegg has structured his guide in the 'traditional' way—photographs facing species descriptions on a double page, and with the birds presented in the usual scientific order. The Trounsons' layout is a new concept, in which text and illustrations are entirely separate and linked using a numeric system. The system is quite simple once it has been used a few times, but is baffling at first glance. The need to flick between sections may also hamper its use in the field. However, the simple grouping of birds into sections ('Land Birds' and 'Water Birds') will assist novice birdwatchers, but may confuse those used to the 'accepted' scientific order.

Both guides are valuable new additions to the range of bird books available in Australia.

—Emma Gray
Australian Museum




## Killers in Eden: The True Story of Killer Whales and their Remarkable Partnership with the Whalers of Twofold Bay

*By Danielle Clode. Allen & Unwin, NSW, 2002, 190pp., $24.95rrp.*

Mutualistic relationships between humans and animals in natural populations are relatively rare, which is perhaps remarkable given the abundance of such relationships more generally. Among the most thoroughly quantified is that between the Boran honey-collectors of Kenya and their avian honey guides. Sadly, the extraordinary relationship between the whalers and Killer Whales of Eden can only be inferred from historical records and oral narrative.

During the comparatively short history of near-shore whaling at Eden, Killer Whales assisted the whalers to locate and harpoon their prey, eventually drowning the huge baleen whales by dragging them to the depths of the bay. The Killer Whales fed on the tongue and lips of the whales, which would eventually surface and then be processed by the whalers.

In this fascinating book, Danielle Clode provides a compelling account of the veracity of this partnership, while dispelling some of the more fanciful claims. A true appreciation of the nature of this relationship requires some detailed knowledge about Killer Whales, which is provided in a highly accessible manner. As top predators, Killer Whales are unusual because they are highly social animals, engaging in cooperative behaviour to hunt particular prey. Learning how to hunt takes time, and younger individuals are apparently 'trained' by older members of their family. It took the Eden Killer Whales less than 15 years to learn to hunt cooperatively with the European whale boats, but as Clode wryly observes, "The remarkable feature of the Eden killer whales is not so much that they learnt to cooperate with humans, but that this is the only instance where humans learnt to cooperate with them".

—Mark A. Elgar
University of Melbourne

# SOCIETY PAGE

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. Whether your special interest is conservation, birds, science, national parks, bushwalking or a particular group of animals, there's a society for you.

## ANIMAL WELFARE

**Native Animal Network Association (NANA)**
PO Box 2191
TOMERONG NSW 2540
Ph: 02 4443 4877
Web: *www.nana.asn*
Contact: Shirley Lack
Membership: $15.00

**Wildlife Victoria Inc.**
247–251 Flinders Street
MELBOURNE VIC. 3000
Contact: Nadia Angeli
Membership: $25.00 Single
$40.00 Family $50.00 Corporate

**Wildlife Welfare Organisation (SA) Inc.**
PO Box 688
GOOLWA SA 5214
Web: *www.chariot.net.au/~wwo*
Contact: Debbie Robinson
Membership: $15.00

**WIRES NSW Wildlife Information & Rescue Service**
PO Box 260
FORESTVILLE NSW 2087
Ph: 02 8977 3333 & 1800 641 188
Web: *www.wires.org.au*
Contact: Carol MacDougall
Membership: Varies branch to branch

**WRIN**
30 Collins Street
KANGAROO FLAT
VIC. 3555
Contact: Rob Schrieber

## BIRDS

**Bird Observers Club of Australia**
183–185 Springvale Road
NUNAWADING VIC. 3131
Ph: 03 9877 5342
Web: *www.birdobservers.org.au*
Contact: Trish Teesdale
Membership: On Application

## CONSERVATION

**Australian Bush Heritage Fund**
GPO Box 101
HOBART TAS. 7001
Ph: 03 6223 2670 or 1800 677 101
Web: *www.bushheritage.org*
Contact: Julie Marshall

**Gilbert's Potoroo Action Group**
PO Box 654
ALBANY WA 6331
Ph: 08 9841 3096
Web: *www.potoroo.org*
Contact: Val Hack
Membership: $10.00

**The Wetlands Centre**
PO Box 292
WALLSEND NSW 2287
Ph: 02 4951 6466
Web: *www.wetlands.org.au*
Contact: B Burgess
Membership: $250.00 Corporate
$55.00 Family $33.00 Individual
$16.50 Concession

## EDUCATION

**CSIRO's Double Helix Science Club**
PO Box 225
DICKSON ACT 2602
Ph: 02 6276 6643
Web: *www.csiro.au/helix*
Contact: Jo-Anne McRae
Membership: $27.00 or $24.00

## ENVIRONMENTAL

**Australian Plants Society NSW Ltd**
PO Box 744
BLACKTOWN NSW 2148
Ph: 02 9621 3437
Web: *www.austplants.nsw.org.au*
Contact: Michelle Wilson
Membership: $40.00 Single
$46.00 Joint

**Society for Growing Australian Plants**
PO Box 586
FORTITUDE VALLEY
QLD 4006
Ph: 07 3376 1125
Web: *www.sgapqld.org.au*
Contact: Lorna Murray
Membership: $35.00 + $5.00 (joining fee) + $1.00 per additional member in household

## MUSEUMS

**TAMS—The Australian Museum Society**
6 College Street
SYDNEY NSW 2010
Ph: 02 9320 6225
Web: *www.amonline.net.au/tams/*
Contact: Alison Byrne
Annual Meetings
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$70.00 Single $52.00 Concession

**The Waterhouse Club**
SA Museum
North Terrace
ADELAIDE SA 5000
Ph: 08 8203 9802
Web: *www.waterhouseclub.org.au/whc*
Contact: Mary Lou Simpson
Membership: $90.00 Family
$70.00 Single

## NATURAL HISTORY

**Dinosaur Club**
Australian Museum Education
6 College Street
SYDNEY NSW 2010
Ph: 02 9320 6223
Contact: Cathy Lamond
Membership: $15.00

**Launceston Field Naturalists Club Inc.**
PO Box 1072
LAUNCESTON TAS. 7250
Ph: 03 6344 3989
Contact: Elizabeth Montgomery
Membership: $27.00 Family
$27.00 Associate $20.00 Single

## REPTILES & AMPHIBIANS

**WA Society of Amateur Herpetologists Inc.**
9 Birch Place
STONEVILLE WA 6081
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Web: *www.iinet.net.au/~bush/index.html*
Contact: Brian Bush
Membership: $20.00

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# q&a

## Ear Pockets

**Q:** *Why do Cats (and Dogs) have those pockets or folds in their ears? Is it something to do with acoustics? The reason would have to be good because they also attract heaps of ticks.*

—Priscilla Park
Roches Beach, Tas.

**A:** I have no idea about the functions (if any) of the fold or pocket in the ears of Dogs and Cats. Yes, they do house mites and other parasites, but whether they have evolved for a specific purpose (such as acoustics) or are simply accidental by-products of the growth and development of other supporting structures, I cannot say. However, I *do* know an Aboriginal explanation for them.

Although Australian Aborigines did not have Dogs until relatively recently, perhaps 4,000 years ago, Dogs quickly became central to Aboriginal society, as evidenced by Dog burials in south-eastern Australia. Dogs enjoy/suffer a unique and somewhat bizarre position in human society. In mythology and folk wisdom, the Dog is the highest and the lowest, the bringer of law and the camp scavenger, sacred and profane.

According to Aboriginal people in the Top End of Australia, the Dog came from over the sea. With him he brought fire, and also knowledge and law of the circumcision ceremony—an important initiation into manhood. The Dog brought the small stone knife used for cutting in the ceremony, and he kept it in the pocket at the back of his ear.

—Colin Pardoe
Gilberton, SA

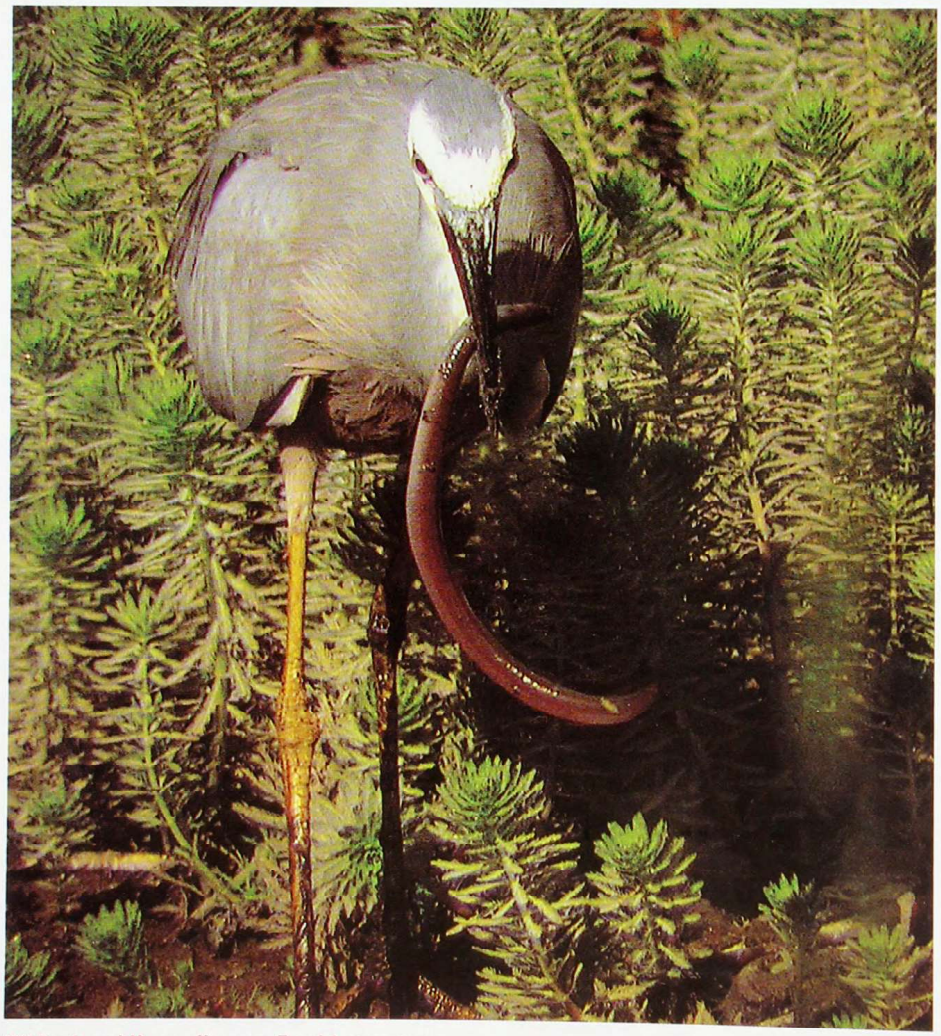
## Frankfurter Worms

**Q:** *I photographed a White-faced Heron pulling out a worm from the Warriewood Wetlands, Northern Beaches, Sydney in February. It is the biggest worm I've ever seen and I was wondering if you could identify it for me.*

—Neil Fifer
Collaroy Plateau, NSW

**A:** This is a Frankfurter or Squirter Worm (most likely *Didymogaster sylvaticus*). It is the most widespread of two very similar species found in the Sydney Basin and it gets its first common name from its appearance. The specimen in the photo is extended, as it's trying to get free, but relaxed they look very much like a frankfurter. They are usually about the length and thickness of a middle finger, but the one shown here is particularly large. They get their second common name from the rather dramatic way some of them, when attacked, squirt fluid from pores on top of their bodies, like those perforated hoses that are used to water the lawn. Frankfurter Worms are one of the few native annelid (segmented) worms that turn up in people's gardens —usually those with lots of leaf litter (their food) and wood mulch. They are showing some promise as a composting worm for leaf litter and other garden waste, which is what I'm currently investigating.

—Martyn Robinson
Australian Museum



COURTESY NEIL FIFER

White-faced Heron dines on Frankfurter worm.

**Answers to Quiz in Nature Strips (page 19)**

**1.** *Gecko* **2.** *In a Sperm Whale's head* **3.** *Prestige* **4.** *Bonobo* **5.** *Koala* **6.** *Fitzroy* **7.** *Eels* **8.** *Troposphere* **9.** *Eating bones* **10.** *Their hides*

COURTESY EILEEN COLLINS

**One of Australia's larger robber-fly species: *Phellus olgae*.**

### Robber Fly By

**Q:** *While working in the Chiltern Box–Ironbark National Park in north-eastern Victoria, on a 31° C overcast day, I came across this magnificent insect (see photo). It was about 4.5 centimetres long and flew in short, fast bursts, buzzing loudly as it moved from tree trunk to tree trunk. Could it be some sort of robber fly?*

—Eileen Collins
Friends of Chiltern Park, Vic.

**A:** It is indeed a robber fly (family Asilidae), and it happens to be one of Australia's larger species, *Phellus olgae*.

Robber flies are voracious predators that capture other insects on the wing. They hold their prey with their strong legs and pierce it with their sclerotised proboscis (hardened feeding organ). The face and mouthparts of robber flies are covered with a strong bristly 'beard' (clearly seen in the photograph) to protect the head from struggling victims. Adults can be quite large (with wing spans up to seven centimetres) and they often perch on twigs or tree trunks from which they swoop to capture prey in midair. The larvae are also predacious and usually occur in sandy soil.

Australia has a diverse and varied robber-fly fauna of over 600 described species, but many more species await description.

—Dan Bickel
Australian Museum

HOWARD HUGHES/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 *When the wild comes leaping up.* Autumn's Pic Teaser was a havestman.

# The problem with wilderness

*Most national parks emphasise wilderness and tourism, rather than being part of a system of reserves planned for conserving Australia's flora and fauna.*

EXTINCTION, DRYLAND SALINITY and water shortages are symptoms of population growth, excessive resource consumption and incorrect land management. We can establish parks and reserves, create conservation agreements on private lands, plant trees on degraded farms and breed endangered species in captivity, but these are reactions to a problem, not solutions. Unfortunately such activities absorb too many of our conservation dollars.

As long as we have an economic system dedicated to growth, the benefits of treating the symptoms of environmental degradation will be short-lived. Australia was never a vast empty land waiting to be developed; it has ancient and fragile soils and only a thin belt of forest. Now it is a tired land degraded by 200 years of settlement based on the English model. Australians consume more than their share of the world's resources and, although much of our consumption is unsustainable, there is little evidence that this will change.

Historically, Australians have conserved nature by simple measures, such as regulating the taking of wildlife and setting aside national parks. Recently, considerable resources have been put into saving endangered species. Such efforts are necessary, and there have been gains for nature conservation, but these efforts alone cannot save the continent's biota unless the economic paradigm changes. Not only will we fail to conserve nature, but the emphasis on reserving national parks on non-arable land and re-dedicating existing conservation areas as wilderness can be thought of as a 'threatening process', one that deploys scarce conservation dollars into areas that are not the most effective for biodiversity conservation.

By casting national parks and wilderness as threats, we are being provocative. Obviously, a national park does not threaten the survival of species in the same way as the clearing of native vegetation or the spread of exotic predators. What is threatening about national parks and wilderness is the belief that they will prevent the loss of biodiversity. It is this belief, and particularly the emphasis on wilderness, that pushes governments to create a system of reserves without significant long-term benefits for nature conservation. Further, changing land use within the Crown's conservation estate, say from a nature reserve to a wilderness, has arguably no added benefit for conserving nature.

Australia's national parks are too small to sample the full range of continental biodiversity. A system of conservation reserves must embrace large areas of land across the entire landscape and be flexible enough for evolutionary processes to proceed, for organisms to disperse and migrate, and for entire ecosystems to adapt to climate change. An ecologically sustainable park system must be integrated with ecologically based off-reserve management. Unfortunately, most national parks emphasise wilderness and tourism, rather than being part of a system of reserves planned for conserving Australia's flora and fauna. Off-reserve management, and the research and education necessary to achieve it, is sustained by a small band of dedicated workers, but compared with estimates necessary to conserve our national biodiversity in the long term, the scale of this effort is miniscule.

Many national parks are lands for which no other use could be found. Thus, places of little commercial value are usually the ones protected, while places important for conserving biodiversity, or which are under threat from development, are sacrificed to economic interests.

More would be gained by ending the clearing of native vegetation, retiring a proportion of agricultural land from production so it could be restored, and utilising native plants and animals in place of introduced species. However, as long as proponents of changing land use on public land to national parks and wilderness dominate the debate, governments will not act on these more difficult and costly initiatives.

With regularity across Australia, the latest wilderness designations and a new list of postage-stamp-sized parks are put on display at local, State and federal elections to the applause of a vocal minority, while the nation's wildlife withers and conservation education and research are starved of support. When you think about Australia's future, don't simply accept what has been done in the name of conservation. Ask instead what really has been achieved to conserve biodiversity and create an ecologically sustainable Australia. □

**BY HARRY RECHER & DANIEL LUNNEY**

HARRY RECHER IS PROFESSOR OF ENVIRONMENTAL MANAGEMENT AT EDITH COWAN UNIVERSITY IN PERTH AND EDITOR OF *PACIFIC CONSERVATION BIOLOGY*. DANIEL LUNNEY IS EDITOR OF *AUSTRALIAN ZOOLOGIST*.

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| 25/5 | • St Kilda Penguins • Fox Control • Clash of the Carnivores |
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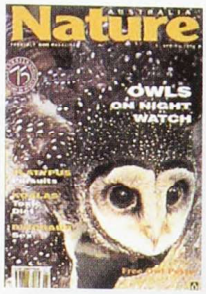


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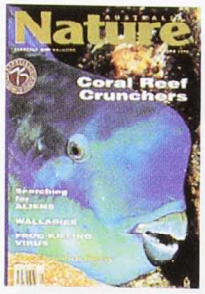


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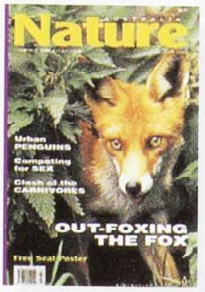


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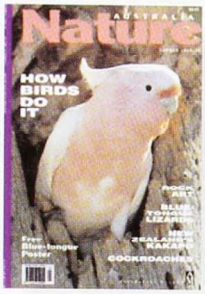


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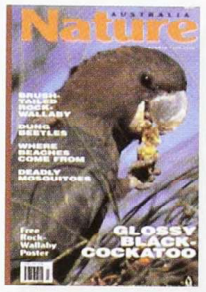


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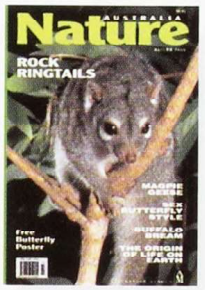


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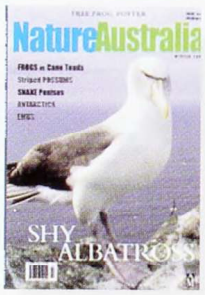


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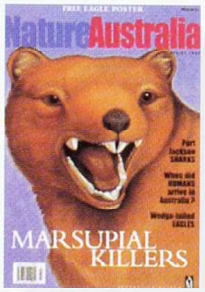


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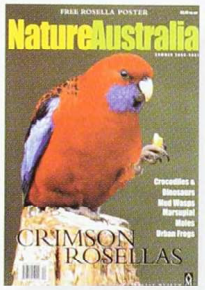


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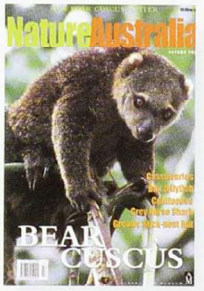


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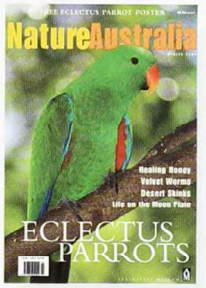


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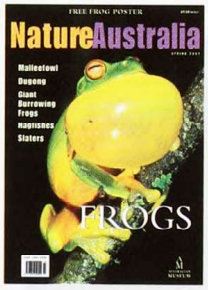


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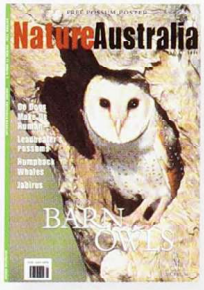


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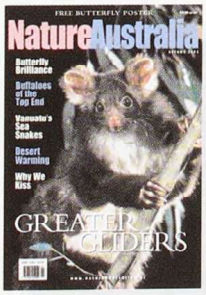


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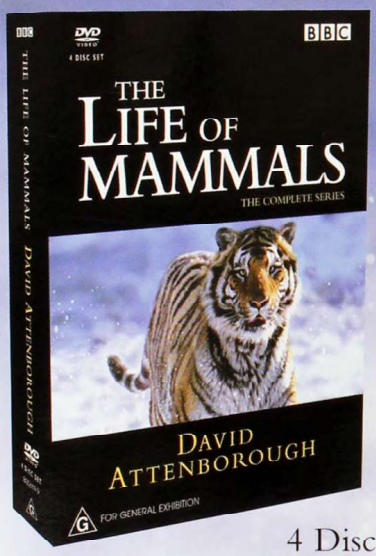


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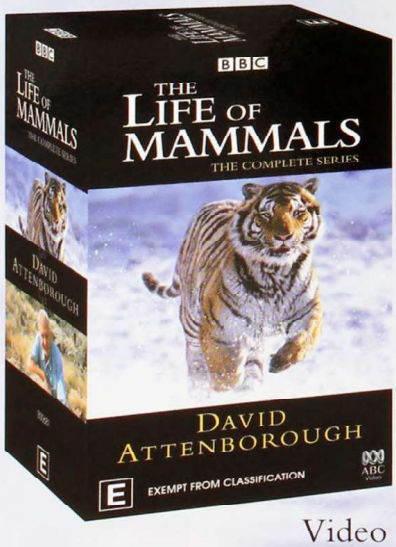


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