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Bogongs & Arsenic

BEAUTIFUL NATURE

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death
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FRONT COVER
The spectacular beauty of nature is captured in this photo of Peron's Tree Frog (*Litoria peroni*). Photo by Brent Wilson/Nature Focus.

up front

It's wonderful to be able to announce that *Nature Australia* has just won the 2003 Whitley Award for Best Zoological Periodical from the Royal Zoological Society of New South Wales.

First presented in 1979, these awards recognise outstanding publications that contain significant amounts of information relating to the fauna of the Australasian Region. Each year a committee consisting of both academics and non-academics reviews all the entries and recommends the assignment of awards in the various categories. For a publication to be successful in the Whitley Awards, it must either make a significant contribution of new information, or present a new synthesis of existing information. Evidence of excellence is sought mainly in the text but illustrations are taken into consideration as well as standard of design, presentation and production. This year marks our 11th such award since 1987 and represents a recognition of our ongoing commitment to provide you with the best nature magazine in Australia.

In this issue we have some great articles for you. David Lindenmayer and Ross Cunningham (along with more than 4,500 volunteers) have spent the last 20 years collecting information on the possums and gliders that live in the Mountain Ash forests of Victoria. In their efforts to understand how so many species from the one broad group can coexist in the same forest they have discovered some important differences in the habitat requirements of each species. This information should prove invaluable in attempts to conserve these wonderful animals.

Steve Salisbury takes us on a mind-bending tour of the evolution of feathers and tries to unravel the research currently being undertaken to understand when, why and how feathers evolved. Ken Green has been

© ANDREW HENLEY LABS

A Feathertail Glider.

interested in Bogong Moths for the last 25 years. He has discovered a disturbing link between arsenic and the moths, but what impact will this have on the many animals that rely on Bogongs for food and where is the arsenic coming from? Gisela Kaplan believes that, when it comes to accurate mimics, the Australian Magpie cannot be beaten. She presents her case, and explains why these birds do it, in her article on page 60. With the Cane Toad marching across the Top End, Jon Altman, Tony Griffiths and Peter Whitehead focus on the issues facing the Indigenous land managers of the region as they try to solve a problem that non-Indigenous Australians seem to have put in the too-hard basket.

We also take a look at how poisonous plants have actually helped to protect many native animals, discover a living fossil, follow the life of a Wollemi Pine by reading its rings, explore how humans communicate with their facial expressions, and present a case for removing shark nets from Sydney's beaches. Just in time for the warmer weather. Enjoy.

— JENNIFER SAUNDERS
Publishing Manager

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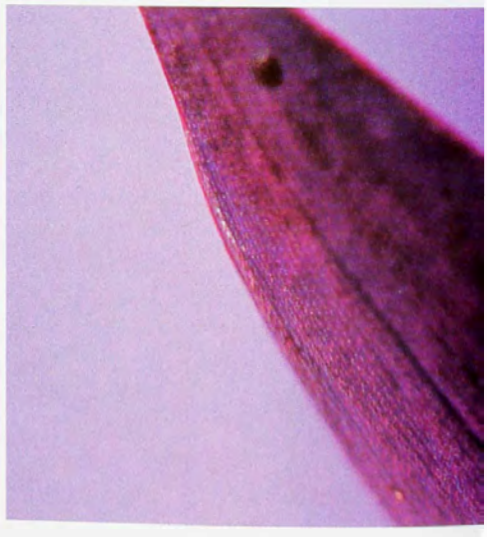

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Buffalo Bull

So, David Bowman wants us to embrace Water Buffaloes as Australian wildlife (*Nature Aust.* Autumn 2003). He does so partly by exploiting our sense of shame about the treatment of Aborigines, stressing the value that some of them now place on buffaloes. He enlists support from Banjo Patterson. He plays down the ecological destruction buffaloes cause (see, for example, "Pandanus: Then and Now", *Nature Aust.* Summer 1994–1995). He wrongly argues that Australia's feral buffaloes, which are domesticated stock gone wild, are equivalent to the endangered native buffaloes of Asia. He makes the outrageous claim that Australia has a "duty of care" towards these destructive feral beasts. This is remarkable stuff coming from a university biologist. Why does he do it? He begins his article by telling us he was "exhilarated by some primeval force" he didn't understand. I think I understand. It is the romance of the big animal. It is the same voice that wants Horses, Goats, Camels and deer trampling through our national parks. Like Bowman, I like big animals. But when I want to see them I save up and go to Africa, or Asia. He is right in saying we will never eradicate our feral buffaloes. But that is not a reason for celebrating them, for allowing emotion to dictate conservation policy.

—Tim Low

Urban Currawongs

I think it is highly unlikely that the prevalence of European garden plants has caused the increase in Sydney's currawong populations (*Nature Aust.* Winter 2003). Consider the following. Between 150 and 30 years ago, privet, lantana and blackberries flourished, as did introduced bird species. Few currawongs or other native birds were found in the suburbs. Then, about 30 years ago, patriotism appeared. Experts urged the planting of Australian 'natives'. Gardeners obliged by planting mainly hybrids or plants alien to the region. Since then there has been a spectacular increase in parrots, cockatoos, honeyeaters and their predators, including currawongs. Some of these species have joined introduced species as pests.

I suspect that the reduction of urban pest populations, both native and introduced, will only be achieved through the revegetation of large areas with local plants (that is, those endemic to the Sydney region) and the replacement of lawns with native grasses. Councils, plant nurseries and particularly naturalists should do everything possible to promote this, but then again it's so much easier to scapegoat a 'sinister-looking' and unpopular bird than it is to effect changes in human behaviour.

—Dave McConnachie
Sanctuary Point, NSW

Humans—One of a Kind

Tim Low contends that, in terms of altering the environment, humans are different from other animals only in degree, not in kind (*Nature Aust.* Autumn 2003). I disagree. First, in some cases the degree of difference is so great that to imply human destructiveness is just part of a continuum in the biological world is pedantic at best and disingenuous at worst. No herd of elephants would do in a month what the same number of cockies with dozers and chains will do before lunch. No group of beavers could ever make the Three Gorges Dam. Second, there are absolute differences. No other species destroys the place with fire; none unleashes herds of dependent animals onto the landscape; none releases lethal novel molecules into the surrounds; and none attempts to kill every single individual of another species in order that it vanishes from the Earth. Conservation is ultimately about politics, and I leave it to readers to figure out who benefits from the view that humans just modify the environment like any other species.

—Allen E. Greer
Australian Museum

TOM & PAM GARDNER/NATURE FOCUS

Pied Currawong (*Strepera graculina*) are on the rise in urban areas. But why?

Allen Greer says "No other species destroys the place with fire". But our fires burn so fiercely only because flammable vegetation evolved. Charcoal mixed with myrtaceous pollen can be dated back to Miocene times. Fire-tolerant eucalypts, shedding flammable foliage and bark, were displacing rainforests and she-oaks millions of years before humans came along. Our fires merely extended a natural process.

Many species besides humans have evolved novel lethal molecules, and there are other predators that cause extinctions. Crown of Thorns Starfish wreck coral landscapes on a comparable scale to most human landscape destruction (and starfish plagues appear to pre-date human influence). I agree with Greer that we are (almost) unique in herding other animals (except for ants that herd aphids).

I highlighted the conservation problems inherent in denying that we are animals; and the benefits for conservation of deciding that we are. I did not say and don't believe that 'humans just modify the environment like any other species'. We will keep ruining the world unless we can develop new relationships with nature. Greer thinks my approach is wrong; but I think the greater danger lies in not embracing new ways of thinking.

—Tim Low

A Handful of Collectibles

I liked your story about collectors (*Nature Aust.* Winter 2003). My husband is a book collector so every room bar two in the house is overflowing with books, as are the two sheds. It could be worse. He also started collecting M 'n' M dispensers—really ugly and garish plastic things—but fortunately this has slowed. My now-grown-up son, as a child, collected those roundish sawn bones from chump chops, which he kept under the bed. And when I was a child, both my friend and I collected fluff. We used to pick it off our blankets at night and off our fuzzy wuzzy boleros.

—Margaret Owen, WA

I am a stamp collector. I started when I was a child and continued until my mid-twenties. Then things like study, marriage, mortgage and fatherhood intervened. I have now taken it up again but, instead of the preoccupation with the accumulation, I now collect with more specific objectives in mind. I've always collected from Australia, because it is my home, but I am also interested in Germany and other countries. It took me nearly 15 years before I could deal with the Third Reich. During that time, if I handled this material, I always felt the need to go and wash my hands. (Freud would have loved that!) Eventually, I told myself to stop being stupid and get on with it. Through my hobby, I have learnt so much about the countries whose stamps I collect. It has become an important part of my life, and I would be lost without it.

—Frank Gericevich Como, WA

I am a museum zoologist in Tasmania, specialising in the taxonomy of snails. For a collection at home I have over 300 snail ornaments—of no great value, just a collection of interest to me. It also provides my friends and relatives with an infallible item to buy me for birthday and Christmas presents. Even a small snail ornament worth a couple of dollars will please me. I loved your article on collectors.

—Brian J. Smith Queen Victoria Museum, Tas.

Most of the people I know have collected a variety of things, from ornamental to downright odd, and so I agree with the premise that "it is an essential human quality to collect things". My husband and I have a large collection of cigarette lighters, ashtrays, cigarette dispensers and boxes. We have collected them over a long period of time. I also have a small group of beautiful Chokin plates that are on display all the time. Our collections don't rule our lives, but they certainly enrich them.

—Marilyn Statham, Tas.

As a child I collected the usual—coins, erasers and sheets of stationary. My grandparents also started a collection for me of dolls from around the world, which I have added to since I started travelling. As an adult I collect eggs. My friends buy me eggs as souvenirs when they go overseas, and I've now learnt a lot about their meanings in different cultures.

—Emma Elliott

***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 *Voyage to the end of the world*. The winner this issue is Margaret Owen.**

Spring

Compiled by Geordie Torr and Martyn Robinson

Blue Swimmer Crab in defensive posture.

Crab Meet

If you're brave enough to risk a nip on the ankle, now's the time to grab a torch and head down to the ocean. Prowl the shallows on a late-spring or early-summer night and you might just come across large numbers of Blue Swimmer Crabs (*Portunus pelagicus*) getting together to mate.

In Australia, Blue Swimmers are found all around the continent in a wide range of habitats including bays, estuaries and intertidal areas. Although they're strong swimmers, they spend most of their time buried just below the sand, only their eyes, antennae and gill-chamber openings exposed, waiting to ambush prey. They sometimes eat poisonous toadfish, which also come in to spawn in the shallows at this time. Mating takes place as soon as the female has moulted. Not wanting to miss his chance, a male grabs hold of a female prior to moulting and carries her around, clasped beneath him for four to ten days, waiting for her to 'slip into something more comfortable'.

The outcome of this liaison is anything up to two million eggs, which take about 15 days to hatch. The baby crabs then go through a series of very uncrab-like larval stages, sometimes drifting as far as 80 kilometres out to sea. By late spring they're ready to settle and head back inshore. At this time you might see things that look like steel-blue peas zooming around in the shallows. These are larval crabs just prior to taking the more familiar crab form and settling down on the seafloor.

For more on Blue Swimmers, visit **www.sea-ex.com/fishphotos/crab,.htm**

Flying Duck Orchid (*Paracaleana nigrita*).

Sneaky Orchids

Everywhere you look at springtime, plants are advertising for help ferrying their genes to a suitable partner. Most use bright flowers or the offer of a reward such as nectar to catch the eye of a go-between, but there's one group that relies on that age-old advertising adage—sex sells.

Certain types of orchids attract male insects by pretending to be a female. Not only do they often resemble the insect in question—usually a bee or wasp—but many are hairy in all the right places and produce a scent very

similar to the pheromones produced by the female. In some cases, the male insect tries to fly off with the fake female, in others he will actually try to mate with it. (Last century, a group of orchid researchers found wasp sperm in the flowers but were initially too embarrassed to publish their unseemly discovery.) Either way, the result is the same—they get lumbered with a packet of pollen known as a pollinia.

Many orchid species specialise in their own insect species, which reduces cross-pollination, not to mention even more confused insects. In order to be ready as soon as they are, the male wasps mature before the females. Raring to go, they investigate anything so long as it looks, smells and feels like a female. But no matter how good the disguise, an orchid is still not as good as the real thing, which is why the plants time the maturation of their flowers to coincide with that of the male wasps. But even if most flowers aren't pollinated, all is not lost. A single successful pollination can yield millions of seeds.

For more on sexually deceptive orchids, visit **http://online.anu.edu.au/BoZo/peakall-_group/Florian/**

Fighters, not Lovers

This is the time of year when you might see something resembling the staff of Aesculapius—the rod with two entwined snakes that forms one of the official symbols of medicine.

The two snakes will be males testing each other to see which is the strongest, longest, or otherwise better individual. Once entwined, each snake tries to get his head above that of his rival and force the other's head down. Eventually one snake topples over once too often or can't keep up the twining, and admits defeat by slithering from the scene.

Interestingly, this behaviour has only been observed in a limited number of species including black snakes (*Pseudechis* spp.), copperheads (*Austrelaps* spp.) and some pythons. Although these combats are usually very civilised, some captive pythons bite their opponents and gouge at them with the spur-like remnants of their hind legs.

Excellent sources of information on snake ecology and behaviour are Rick Shine's *Australian snakes: a natural history* (1991) and Allen Greer's *The biology and evolution of Australian snakes* (1998).

FROM THE COLLECTION

On 28 September 1969, something unusual fell from the sky onto farmland at Murchison, Victoria (near Shepparton). More than 100 kilograms of small rock fragments (the largest weighing just seven kilograms) showered over an area of about 13 square kilometres. Together these became known as the Murchison Meteorite.

It proved to be a very rare type of stony meteorite, called a carbonaceous chondrite, thought to originate from comets. But it was particularly interesting because some of the chemicals it was found to contain were very similar to amino acids, the building blocks of proteins and DNA. Although later proven to be of non-biological origin, the mysterious chemicals generated so much interest that researchers from two major US museums came over and collected most of the meteorite. Luckily, several other institutions, including the Australian Museum, managed to secure many fragments.

One interesting feature of this meteorite that hasn't received as much attention is its distinctive odour, which resembles that of camphor or bitumen.

You can read more about the Murchison Meteorite at **www.ast.cam.ac.uk/AAO/local/www/jab/astrobiology/murchison.html**

Two male Carpet Pythons (***Morelia spilota mcdowelli***) in combat.

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**.

Buzz Off Big Ears

Having problems with the local elephant herd? Put away the elephant gun and bring on the bees.

African Savanna Elephants (*Loxodonta africana*) consume on average 110 tonnes of foliage a year, some of this unavoidably coming from local farms. For numbers to increase, elephants must be able to live in harmony with the local people. African Honey Bees (*Apis mellifera scutellata*), which are notoriously aggressive especially near their hives, could be the secret to keeping elephants away from the trees and crops of local farmers, and provide extra income through sales in honey.

Fritz Vollrath (Oxford University) and Iain Douglas-Hamilton (Save the Elephants) hung six occupied and 30 unoccupied hives on fever trees (*Acacia xanthophloea*) at a favourite elephant foraging spot. Elephants damaged over 90 per cent of the trees without hives, while none of those trees that had 'live' hives were touched. Even empty hives provided some protection.

Elephants have an excellent sense of smell and the smell of a hive may deter them from feeding in the vicinity. However, they also have great hearing, and a long memory. The researchers played back angry bee humming to wild elephants and got mixed reactions. While some elephants ignored the sound, many others, including a tame elephant that had been stung four years earlier, were visibly startled and backed away. Perhaps being stung by a swarm of African Honey Bees is not something an elephant is likely to forget.

—V.W.

If the Shoe Fits . . .

Most men are obsessed with the size of their penis. No doubt this stems

MARTYN COLBECK/OSF/AUSCAPE

Bees may be just the ticket to stem some of the damage caused by African Savanna Elephants.

from the view that a longer penis signifies increased masculinity. Yet distinguishing phallic fact from fantasy can be hard when the subject matter is so sensitive.

Take foot size, for example. Many people say you can tell the size of a man's penis from the size of his feet. Urologists Jyoti Shah (St Mary's Hospital) and Nim Christopher (University College Hospital) set out to test this 'myth' by measuring the stretched penises of 104 patients, while taking note of their shoe size and age. Measured immediately after disrobing (to minimise any effects of temperature), stretched penis length has been shown to be a valid estimate of erect length.

The men, aged between 17 and 84, had penis lengths ranging from 6–18 centimetres (median 13 centimetres) and UK shoe sizes 5.5–13 (median 9), but the researchers could find no statistically significant correlation between the two sets of measurements. In other words, large feet don't indicate a large penis, and vice versa.

These results support the findings of Washington-based Richard "Dickie" Edwards. For the past eight years he has conducted an online penis-size survey, in which 3,100 men measured their own erect penises and provided various other measurements, including foot size. However, just as anglers are known to exaggerate the size of the fish they catch, males tend to up the length of their penis when self-reporting, so the results were somewhat suspect. (Edwards is now conducting another survey in which he is offering to do the measuring himself.)

—G.H.

Can Fox-hunters justify their sport?

JOHN SHAW/AUSCAPE

Does Hunting Control Foxes?

When arguing the case for their sport, Fox-hunters often say that hunting Foxes helps keep Fox numbers down. Unlike their compatriots in Australia, Foxes (*Vulpes vulpes*) in the UK don't cause economic damage and loss of biodiversity, but could do if their numbers were to increase significantly.

Philip Baker and colleagues from the University of Bristol took advantage of the 2001 outbreak of foot-and-mouth disease to test this claim. Fox-hunting was banned for ten months during the outbreak and restricted for a further two months, providing the perfect opportunity to investigate the real impact of hunting on Fox numbers.

The researchers had already surveyed 160 square-kilometre sites in 1999 and 2000 (before foot-and-mouth), estimating Fox numbers by counting faeces. They then surveyed these same sites again in 2002 (after foot-and-mouth), enabling them to compare Fox numbers before and after the year's ban on hunting. Overall, they found no significant change in Fox numbers during the ban. If anything, there was a slight decline in Fox numbers in most sites, although the reasons are not clear.

The authors say their results support the Committee of Inquiry into Hunting with Dogs, that banning hunting is unlikely to increase Fox numbers. Fox-hunters might have to come up with a better reason to justify their sport.

—A.T.

The Fall of Darwin's Finches?

The finches of the Galapagos Islands became evolutionary icons as a result of Charles Darwin's 19th-century observations. This group of 13 species descended directly from just one ancestral species and remains among the most celebrated examples of natural selection at work.

Now these legendary little birds could be facing their biggest evolutionary challenge yet—blood-sucking maggots.

The larvae of introduced flies were first discovered infesting hatchlings in Galapagos finch nests by ornithologists Birgit Fessl and Sabine Tebbich, from Vienna's Konrad Lorenz Institute, in 1997. They've since identified three species

A Small Ground Finch (*Geospiza fuliginosa*) picks ticks from a Land Iguana (*Conolophus subcristatus*). Will these Galapagos Island finches be able to survive the onslaught of blood-sucking maggots?

infecting the birds, the most common of which is *Philornis downsi*.

Although larval *Philornis downsi* survive on fresh blood, adults feed on fruit which is how they may have accidentally been introduced to the Galapagos. But whichever way they arrived, the issue is now whether Darwin's finches can survive the alien blood-suckers.

Such parasites can literally sap the life from their hosts by causing anaemia. Fessl and Tebbich also found maggots burrowed into the flesh and organs of finch nestlings. Normally, hosts would eventually evolve defences. But Darwin's finches have not yet had time to adapt and it's believed maggot infestations may already be killing more than a quarter of nestlings on some islands.

The researchers documented that *Philornis downsi* alone infected an enormous 97 per cent of finch nests on the island of Santa Cruz and were present on all the archipelago's inhabited islands including Isabela. This is home to the rarest of Darwin's finches, the critically endangered Mangrove Finch (*Cactospiza heliobates*). Parasitic fly larvae could propel the species towards extinction.

—K.McG.

Dare You to Eat Me!

Next time you think you've found aphids munching on a plant in your garden, take a closer look. It could be the plant has fooled you.

Some plants actively imitate insects in order to attract them, such as certain orchids that mimic female bees so that the males are encouraged to visit, and pollinate, the plants. But now Simcha Lev-Yadun and Moshe Inbar (University of Haifa-Oranim in Israel) argue it can work both ways. Some plants, they say, mimic insects to keep them at bay.

The stems, branches and leafstalks of the burr plant *Xanthium trumarium* are covered in dots that look remarkably like an infestation of ants. Similarly, the dark-coloured anthers of

The stem of *Xanthium trumarium*. Would you eat a plant that looked like it was swarming with ants?

Paspalum grass dangle from green flowers, looking all the world like a cluster of aphids. And the immature seed pods of three wild legume species (*Pisum fulvum*, *Lathyrus ochrus* and *Vicia peregrina*) resemble big fat caterpillars.

What purpose could this mimicry serve? The authors argue these adaptations protect plants from plant-eating predators. While ants are well known for their aggressive and protective traits, another study showed that the root fly *Delia radicum* was less likely to lay its eggs on plants with aphid infestations (why risk laying eggs on a plant that looks like it may already be eaten by the time the larvae emerge?).

And what about looking like a caterpillar? Each of the three different legumes had immature pods dotted with conspicuous red spots. This spot pattern is typical of moth and butterfly caterpillars and warns that the grubs may be poisonous. The plants cunningly cash in on this strategy, putting potential predators off grazing on their pods.

—A.T.

A female hunting spider (*Pisaura mirabilis*) clutches her egg sac (and sometimes anything that looks like an egg sac).

Wrapped with Love

The most important thing about a gift is the wrapping, or so recent research on hunting spiders shows.

As a courtship gift, the male *Pisaura mirabilis* will wrap his prey in silk, transforming it into a white round parcel. When he meets a female, he presents this gift to her and, if she accepts it, he starts mating with her almost immediately.

Pia Stålhandske from Göteborg University in Sweden were curious about why the spider first wraps his prey in silk. Could it be so that it resembles the female's egg sac? To find out, she used watercolours to paint the silk-wrapped prey brown, or extra white, while leaving others as they were (naturally white). She found that the gifts painted white, which had the same brightness as egg sacs, were the ones the females grabbed most quickly.

The female has a very strong instinct to care for her

COURTESY ANDERS HANGELBY

NICHOLAS BIRKS/ WILDFLIGHT

Humans have only been throwing things around for 19,000 years.

Thrust, not Thrown

Humans are good at throwing. Take a look at the *Guiness world records*: a haggis was hurled 55 metres; 98 metres for javelin gets an Olympic gold; and with the aid of an atlatl (or spear-throwing device that fits onto the end of a spear) the record is over 258 metres. When did humans start chucking things, and why?

The earliest (400,000-year-old) spears, from Schöningen in Germany, were initially thought to be thrown because of their aerodynamic design. Moreover, spear throwing was inferred from the high degree of asymmetry seen between the left and right upper limb bones of Neanderthals and early modern humans found around this time. This asymmetry was assumed to have been produced from the uneven forces experienced through one-handed throwing, with the dominant (right) arm becoming stronger and more robust than the left. However, as Daniel Schmitt and colleagues (Duke University) argue, two-handed thrusting could also have produced this right-dominant pattern.

To test this idea, the researchers set up an experimental design to measure forces acting on an aluminium spear thrust using two hands into a gymnastics cushion. They discovered that the force imparted to the main (rear) thrusting arm can be 6.6 times that acting on the leading (guiding) arm. This would result in corresponding differences in strength and bone morphology in the two arms.

The researchers also noted that the upper arm bones of Neanderthals and early modern humans were oval in cross-section, while those of modern humans less than about 19,000 years old were circular. A shift from thrusting to throwing might explain this situation, as the forces applied along the bone during throwing are evenly distributed, as opposed to those applied during stabbing, which are not.

These findings suggest that big-game hunting with thrown spears only became an important hunting tactic in the last 19,000 years, which also happens to be when the first atlatls appear in the archaeological record.

—R.F.

egg sac, which would get eaten if left unattended. She clings tenaciously to it for up to three weeks when her spiderlings hatch. If the egg sac is experimentally removed, the female searches frantically for it. Stalhandske believes the males are exploiting the female's maternal instinct to clutch at an egg sac.

Occasionally a male will silk-wrap small flowers or a useless exoskeleton. But as long as it looks good, the female will accept it, proving that it's not the present that counts, but the wrapping.

—V.W.

Through Ancient Eyes

Could dinosaurs see in the dark? With the last of these ancient reptiles having died out some 65 million years ago, this will surely remain a rhetorical question. But perhaps not.

A team led by Belinda Chang (Yale University) has managed to 'recreate' one of the visual pigments of a 240-million-year-old archosaur, a member of the group of reptiles that gave rise to the dinosaurs. The pigment, called rhodopsin, plays a vital role in vision at low light levels.

The scientists' first step was to reconstruct an evolutionary tree, linking the ancestral reptiles to a variety of other vertebrates including alligators, pigeons, toads, goldfish and eels. Placing each animal's rhodopsin gene sequence on the tree, they then worked back to calculate what the archosaur's sequence would have looked like.

Once they had what they thought was the most accurate version, they set

Although fully female now, as a youngster this Fossa would have masqueraded as a male.

about reconstructing it, synthesising large fragments of DNA, amplifying them into numerous copies, and then sticking them together in the right order. The resulting gene was then inserted into a culture of monkey cells, which began manufacturing the ancient archosaur rhodopsin.

When they analysed the pigment's properties, the researchers found that it was most sensitive to light towards the red end of the spectrum. In this respect it is similar to that of a modern bird, which is probably not surprising given that birds are the direct descendants of dinosaurs. However, the results also suggested that the archosaur's night vision was at least as good as a modern-day mammal's, giving rise to the intriguing notion that they, and hence the dinosaurs, were nocturnal.

—G.T.

Butch Fossa

Most adolescents go through a difficult period, but life for a young female Fossa must be particularly confusing.

The Fossa (*Cryptoprocta ferox*) is a large predator related to civets found only on the island of Madagascar. Early last century, it was noticed that some female Fossas possessed male-like features, including an

enlarged spiny clitoris that resembled a penis. This so-called masculinisation is seen in a number of other mammals including Spotted Hyenas (*Crocuta crocuta*).

A team led by Clare Hawkins (University of Aberdeen, UK) travelled to the world's fourth largest island to investigate the nature of these gender benders. The eight juvenile females they caught did indeed have a number of masculine features, but strangely (and uniquely among mammals) these features were transient, being most noticeable in Fossas between one and two years of age.

Masculinisation in other animals has been put down to either a need to be more aggressive—achieved through increased levels of testosterone, which in turn cause the development of masculine features—or social reasons, with male-like genitalia being important for determining status in a group and allowing females to control which males mate with them.

But female Fossas aren't particularly aggressive and don't have increased levels of testosterone. Females are also typically solitary, so masculinisation wouldn't offer any direct social benefits.

The researchers believe that it's this desire to be left alone that has led to the development of masculine features. Because females are solitary and only have a brief period when they are sexually receptive, males may attempt to mate with any female they encounter. Resembling a male could stop the young females being harassed by suitors, which can lead to injury. Masculinisation also coincides with the time when young female Fossas are dispersing, so looking like a male may stop them from being attacked by territorial females.

—G.T.

The Big Die Young

One of the downsides of being male is that you tend to die younger. Perhaps this is because males take more risks than females as they slog it out with one another to take control of a territory or mate. However, new research by Sarah Moore and Kenneth Wilson (University of Stirling, UK) has found that most males are also more susceptible than females to parasites, and this may be hastening their demise.

Moore and Wilson compared the parasitic infection rates, relative sizes and life spans of 106 mammal species and found that the larger the male is relative to the female, the more parasites he has. When they looked at the relatively few species where the female is larger than the male, they found the same thing happening in reverse: the girls have more parasites than the boys. This would appear to rule out the idea that higher levels of testosterone in males—thought to lower immunity—is responsible for increased mortality.

So perhaps there's nothing special about blokes: it's just that males tend to be bigger and eat more, and so offer a larger target to parasites.

—A.T.

NICK GALES LOCHMAN TRANSPARENCIES

A mating pair of Southern Elephant Seals (*Mirounga leonina*). Being big is good, but it has its downside.

Roses Are Red, Violets Are...?

In some parts of the world, the sky isn't blue. That is to say, the people who live there don't call it blue, and may not even perceive it as being blue.

Many languages don't split the visible spectrum up in the same way that English does. In some, there is no distinction between green and blue, and in others no distinction between blue and dark. More than a century of study has failed to produce an adequate explanation for this peculiar state of affairs, but now Delwin Lindsey and Angela Brown (Ohio State University) think they may

JEAN-MARC LA ROQUE, MISCAPE

Tropical paradox? People who are surrounded in blue can end up being blind to it.

have found the answer.

After reviewing 203 languages, the researchers found that those people who lacked a term for blue tended to come from regions where the level of UV in sunlight was high—typically areas close to the equator. Speakers of these languages also tended to have a higher prevalence of blue-yellow colour deficiency. Lindsey and Brown suggest that both of these effects are the result of damage to the eye caused by UV light.

As we age, yellow pigments build up in the lenses of our eyes, causing the density of the lens to increase and light at the blue end of the spectrum to be absorbed. Exposure to UVB accelerates this process. The researchers asked young English-speaking volunteers to name a variety of colours as viewed through clear and yellowed lenses of varying densities. They found that as older, UVB-damaged lenses were simulated, the subjects were less likely to use blue to describe a colour and more likely to use green.

—G.T.

Killers from the Deep

Every winter, one of the world's largest animal aggregations forms in Norway. Packed tightly together in dense layers in the deep, dark fjords, schools of herring (*Clupea harengus*) contain up to 40 billion individuals. Ten million tonnes of fish is hard to overlook if you are a hungry Killer Whale (*Orcinus orca*). But the challenge for daylight-hunting whales lies in bringing these great balls of fish to the surface for easy pickings.

PERRY VAN DUIJNHOVEN

Large groups of Killer Whales work together to raise enormous schools of herring to the surface.

Leif Nottestad (Institute of Marine Research in Norway) and colleagues observed deep-water hunting on four occasions. By monitoring the school size of herring using sonar, and tracking the whales and herring with an echosounder, the scientists were able to piece together the attacks.

Between 22 and 46 Killer Whales gather together at the surface before diving 160–180 metres through the dense layer of herring. Throughout the hunt the whales vocalise to one

It's the leaves, not the flowers, of the European Dwarf Palm that bring on the pollinators.

another, coordinating their actions as a group. The whales drive enormous groups of herring upwards, herding over 25 tonnes (75,000 individuals) to the surface. Once they are in shallower waters, the whales steer the herring into ever-tighter balls by flashing their white bellies, and kill and stun them using tail slaps. Then it's simply a matter of gorging repeatedly.

—K.H.

Say it with Leaves

Plants have been using floral fragrances to attract insect pollinators for millions of years. According to recent research, however, it's not only flowers that can produce these scents.

Mathilde Dufaÿ and colleagues, from the CNRS in France, made the discovery while studying the European Dwarf Palm (*Chamaerops humilis*), a Mediterranean coastal native pollinated by just one insect species—the weevil *Derelomus chamaeropsis*.

The researchers found that, although the palm emits a strong fragrance when 'advertising' for pollinators, it doesn't actually come from the plant's flowers. Most is produced by unusual and previously undescribed leaf structures, which appear, so far, to be unique among flowering plants.

The palm's flowers do produce a weak odour but the weevils are not interested in this. They are instead drawn from relatively long distances to the leaf fragrance.

Chemical investigations found that the feeble scent produced by the flowers contains none of the compounds normally characteristic of floral aromas. In contrast, the perfume produced by the leaves contains mainly monoterpenes and sesquiterpenes, compounds that are common in the floral scents of other plants.

Although the discovery explains how the palm attracts pollinators, the cues it then uses to steer the weevils from its leaves to its flowers where they are needed remain unexplained.

Why the palm developed this unusual system may be due, the researchers believe, to the discrete placement of the flowers. These are enclosed tightly within bracts at the base of the leaf stalks and are often hidden by older leaves. It's possible the aroma-producing leaf organs evolved because the

palm's leaves were in a better position to broadcast scent.

—K.McG.

Frog Hollows

As anyone who's spent a night in the jungle can tell you, it's a noisy place. Now scientists have discovered that one small Bornean frog has developed a novel approach to making itself heard: by exploiting the acoustics of its water-filled hollow.

Male Bornean Tree-hole Frogs (*Metaphrynella sundana*) live in partially filled tree trunk cavities, which act as both egg deposition site and sound stage for their amorous broadcasts. One might imagine that singing in a hole should dampen the call, but Björn Lardner (Field Museum of Natural History, Chicago) and Maklarin bin Lakim (Sabah Parks, Malaysia) noticed that the calls of the two-centimetre-long frogs could be heard up to 50 metres away in dense forest.

Intrigued, they placed a calling male in a part-filled plastic tube, and analysed the pitch of the frog's call as the water level was slowly reduced. Initially the frog changed pitch erratically until it hit the note that matched the resonant properties of the container and amplified the call. Gradually over the next several minutes, the frog lowered its pitch by 115 Hertz, to keep in tune with the falling water levels. Eventually it lost track, and started singing erratically in search of the acoustic sweet spot again.

Although several species of crickets and burrowing frogs are known to use their

COURTESY BJÖRN LARDNER

The Bornean Tree-hole Frog broadcasts its call from its hollow.

burrows to amplify calls, the researchers say this is the first evidence of an animal not only sampling resonance properties, but also adaptively adjusting its call pitch to suit the ambient conditions.

—R.S.

Giant Sperm Wars

Several years ago, the longest sperm known to science was discovered and it belonged to one of the smallest animals, the vinegar fly *Drosophila bifurca*. It was nearly six centimetres long, about 20 times the male's body length. Not all vinegar flies have long sperm, however; some species produce lots of short sperm (rather than few long). But what is the driving force behind the evolution of few long or many short sperm? Female choice, say Syracuse University's Gary Miller and Scott Pitnick.

The longest sperm known to science was discovered and it belonged to one of the smallest animals.

Just as males vary in sperm length, so too do females vary in the size of their sperm-storage organs. In a series of experiments using the closely related vinegar fly *Drosophila melanogaster*, successive generations of females with either long or short storage organs were each mated several times with males with either long or short sperm, and the paternity of their progeny identified. (Sperm length and storage-organ length in these populations had been manipulated using laboratory-breeding techniques.)

Miller and Pitnick found that the sperm of all males competed equally inside females with short sperm-storage organs, but the larger the female's storage organ, the greater the advantage of males with longer sperm. According to the researchers, it is the length of the female's sperm-storage organ that drives the evolution of sperm length. What drives the evolution of female sperm-storage length is unknown.

That female choice can rapidly drive sperm into outrageous variations of size and shape has significant implications for biodiversity. This is because sperm from one population can quickly become mismatched and reproductively incompatible with females of other populations.

—R.S.

It's the female vinegar fly (*Drosophila*) that determines the size of the male's sperm.

Ancient hand-held weights or 'halteres': the real things and as depicted on Greco-Roman vases.

Performance-enhancing Slugs

Hand-held weights (halteres) were first used in the 18th Olympic Games of 708 BC. Greek vases clearly show athletes gripping slugs of stone and lead during the long jump, thrusting them forward at takeoff and back again before landing. But were these slugs introduced to enhance performance, or to increase the challenge of the event?

Alberto Minetti and Luca Ardigó (Manchester Metropolitan University) argued theoretically that a weight-loaded jump would be longer than an unloaded jump if the takeoff speeds were the same. Thrusting the weights backwards before landing would also propel the jumper farther forward. But in a real-life situation, can takeoff speeds be the same with the added weights? Surely the extra weight would reduce the speed?

Trials on four volunteers showed that lead slugs do indeed increase both takeoff speed and maximum vertical height, resulting in a greater leap forward for all long jumpers. However, mathematical models predict that there are no advantages when the halteres are heavier than ten kilograms. Allowing for extra muscle mass in the upper limbs and other effects, best performances were predicted with weights in the two-to-nine-kilogram range—just what the archaeological record has uncovered.

No-one knows how the ancient Olympians worked out that extra weights are performance enhancing. Following World Cup cricketer Shane Warne's explanation for taking illegal diuretics, perhaps one of the Greek athlete's mums thought it would be a good idea.

—R.F.

FURTHER READING
References for the stories that have appeared in this edition of Nature Strips are available online:
www.natureaustralia.net

QUICK QUIZ

1. *What is the predominant colour of an Ulysses Swallowtail Butterfly?*
2. *Which famous four-legged animal was euthanised on Valentine's Day 2003?*
3. *What does SARS stand for?*
4. *Which Australian mammalogist wrote the Quarterly Essay "Beautiful Lies" (2003)?*
5. *What do plants called 'ornithocoprophiles' thrive on?*
6. *Where is the only known population of Gilbert's Potoroos?*
7. *What is another name for the introduced Brown Rat?*
8. *Does a person weigh more on carpet or on hard floor?*
9. *What is the world's largest living penguin?*
10. *How do archerfish obtain their prey?*

(Answers on page 83)

Diamond drill for sore gums

For all their fragile appearance Spotted Pardalotes are surprisingly fearless.

BY STEVE VAN DYCK

WHEN IT COMES TO SERIOUS experimentation with meat, I flop spinelessly into the chicken and yellow-belly bag. Some exotic dishes, marinated and cremated, I can handle, and in this category I can confess to Camel, Donkey, Giant White-tailed Rat and Palm Cockatoo. But uncooked, the story is a different kettle of fish. Oysters and sashimi can't even make it half way down the pitch without getting bowled out for a duck. And, generally speaking, any animal secretions other than milk and honey are strictly *verboten*.

Some people with more intrepid taste buds, however, are able to enjoy the full spectrum of things secreted and discharged, from the bile of Asian Black Bears to the spittle-made nests of cave swiftlets. Connoisseurs of these types of food are, however, not limited to the human species. The diet of the tiny native Spotted Pardalote (*Pardalotus punctatus*) consists mostly of a chunky slurry of nests. But not bird nests, psyllid nests. Psyllids (pronounced 'sillids') are small sap-sucking bugs. Some species are found only on eucalypt leaves and live under crusty scales called lerps. Lerps, in turn, are dry, waxy, lentil-sized, cockle-shelled umbrellas built from sugary secretions that ooze from a psyllid's anus. The psyllid nymph hides under the frame of the protective lerp and the two grow together as the bug sucks away at the leaf under its feet.

Constant bullying lies at the root of why Spotted Pardalotes nest in the relative safety of an underground tunnel.

As astonishing as it sounds for these plastic-looking lids, lerps are remarkably good to eat, being composed of dextrin, amylose, amylopectin and complex polymers of glucose. Whenever I come across lerpy leaves within reach, I pull off a spray and nibble on the waxy sequins. Most of the time the flavour evokes smouldering memories of communion bread and church candles, but sometimes the image gets muddied when I recall what part of the psyllid produced the lerp.

Quite apart from keeping the sun, rain and most predators off a sucking psyllid's back, the lerp, as any gardener knows, keeps insecticide sprays out as well. With this degree of protection, lerp-producing psyllids, when they occur in large numbers, can cause extensive defoliation and even death of trees. But relief for sore gums is in the air. Listen, and a persistent ticking of busy beaks up in the canopy will betray the presence of Spotted Pardalotes, lerp lovers on a break-and-enter mission mopping up the scales and the psyllid nymphs underneath.

A Spotted Pardalote, also once called Spotted Diamondbird, is one of the most miniscule and beautiful of Australian birds, being a plump, nine-centimetre, nine-gram ball of yellows, reds, blacks and greys, the top of which has been spangled in a shower of diamond-like spots. For a tiny bird, its beak is stout and powerful and, if you look carefully at the upper mandible, there's a very sharp hawk-like 'tooth' that forms at the tip, presumably from all the lerp-prizing.

For all their fragile, moth-like appearance, Spotted Pardalotes are surprisingly fearless and will approach humans to within an arm's length. I remember as a ten-year-old the first good look I ever had of one was when I simply grabbed a female that was hovering inquisitively in front of my face.

Unfortunately for Spotted Pardalotes, the value of lerps as a food resource has not escaped the attention of many other (larger) birds, namely honeyeaters, and more specifically that rubbernecked paragon of impudence and aggression,

Spotted Pardalote

Pardalotus punctatus

Classification
Family Pardalotidae. Smallest of 4-5 species.

Identification
Tiny, dumpy and 'finch-like'. Black head, wings and tail, all spotted white. White eyebrow, grey cheeks, fawn belly, chestnut-red rump, yellow under tail. Male with yellow throat, female's throat cream.

Distribution
Forests and woodlands of eastern and southern Aust. from Cairns to Adelaide. Also in Tas. and south-west corner of WA.

Biology
Eats insects (mostly lerps/psyllids) and spiders. Breeds mid-winter to mid-summer. Lays 3–7 pearly white eggs, incubates for 14 days.

the Noisy Miner (*Manorina melanocephala*). Pardalote researcher and ecologist John Woinarski (Northern Territory Department of Infrastructure, Planning and Environment) has calculated that between five and ten per cent of a Spotted Pardalote's day is wasted escaping from the attacks of bigger and more covetous lerp-lords like the Noisy Miner. He has suggested that this constant bullying lies at the root of why Spotted Pardalotes nest in the relative safety of an underground tunnel.

This burrow is drilled up to a metre into the side of a creek bank, compost heap or road cutting. And how well the tips of my fingers recall that cosy ball of shredded bark at the end of the tunnel! Spotted Pardalotes are incredibly forgiving. As a young teenager I used to find their nesting holes down in the creek bank irresistible. By tunnelling in a few feet from the hole and at a different angle, you could converge in on the nesting chamber and with a torch watch the daily progress of the spotty family. A few clay plugs pushed into the observation tunnel after each visit and the pardalotes never twigged to the intrusion.

But they don't always nest in the ground. Pairs have regularly and successfully used a hanging basket of ferns under our pergola, and I have read of people having successfully encouraged Spotted Pardalotes to nest in drainage pipes hung horizontally under the eaves.

During the nesting season from midwinter to summer, the male defends an area as large as four hectares around his and his partner's burrow. But after raising up to three broods, they put mining and parenting behind them and join large quiet flocks that can be seen fluttering in a slow dribbling procession from treetop to treetop. Normally flocks number between 10 and 12 birds, but up to 1,000 individuals have been recorded in late-summer aggregations (interestingly, these are composed mostly of females and juveniles).

The flocks drift and wander, often over long distances (one individual was banded in Adelaide then recorded nesting in Melbourne nine months later). They search for warm lowlands in winter, cool highlands in summer and, of course, outbreaks of psyllids that are probably detected from the air by the drooping, brown canopy shown by suffering trees.

It could be said that a pardalote's life is divided between treating disease of the gums and drilling tunnels among the roots. Smack of another profession? (No wonder they wear diamonds!) But no, these little gum doctors are really just humble gleaners. □

KATHIE ATKINSON

A male Spotted Pardalote brings nesting material to his burrow.

FURTHER READING

Higgins, P.J. & Peter, J.M. (eds), 2002. Handbook of Australian, New Zealand and Antarctic birds. Vol. 6. Pardalotes to shrike-thrushes. *Oxford University Press: Melbourne.*

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

Colonial Spider

The Colonial Spider is known from only four populations across a small area of south-eastern New South Wales.

BY GRANT HOSE

In New South Wales, over 750 plant and animal species have been listed as threatened. The threatened-species list includes many mammals, fishes, reptiles, frogs and birds, but only two species of invertebrates. It is a similar story nationally. Invertebrates such as insects, spiders and crustaceans are poorly represented on such lists, which is surprising given that they comprise the most diverse and abundant group of animals on the planet. Their poor representation on threatened-species lists does not reflect the healthy status of invertebrate communities in Australia, but merely our lack of knowledge about most species.

The Colonial Spider (*Badumna socialis*) is just one of over 2,000 spider species described in Australia. It is currently known from only four populations across a small area of south-eastern New South Wales in the Jenolan, Abercrombie, Wombeyan and Colong Caves region, where it inhabits limestone arches or cave entrances. In these few locations it is generally present in large numbers, but while the spider is not currently listed as threatened, it may be considered rare because of its very limited distribution and specialised habitat. Cave entrances and arches are biologically diverse habitats where cave and surface faunas mix. The entrance and arches provide spiders with protection from the extremes of weather and an abundant supply of insect prey.

Unlike most spiders, which are solitary, the Colonial Spider lives in groups. It is one of only around 20 spiders worldwide that displays communal or social traits. The degree of interaction among individual Colonial Spiders remains unknown, but they take their name from their colonial or communal web-building behaviour. The webs are untidy, woolly sheets of silk with funnel openings. The webs of individual spiders are built alongside each other so that they overlap and create a continuous sheet that may cover several square metres of the cave roof. The webs are a particularly prominent feature in the roofs of the Grand Arch at Jenolan Caves and the Abercrombie Arch at Abercrombie Caves, and often have a blue-green sheen that results from light reflecting off the many fine silk fibres that make up each web.

The Colonial Spider is closely related to the Black House Spider (*Badumna insignis*) that adorns window corners, door frames and eaves in houses throughout southern Australia. It is likely that the Colonial Spider diverged from its relatives and developed its communal lifestyle to make efficient use of the specialised habitat. Colonial and Black House Spiders belong to a group known as cribellate spiders, which is in reference to the silk used in their webs. Cribellate silk is made from many matted microscopic silk fibrils. Webs made of cribellate silk function without sticky glue and rely on the dense woolly network of silk fibres and other poorly understood properties (such as electrostatic charge effects) to entangle prey.

Just as spider webs catch airborne prey, they are also efficient in capturing airborne particles of dust and pollutants. Because spiders groom themselves regularly by drawing their legs through their mouthparts and also eat their silk webbing, they are likely to ingest pollutants that may accumulate on their webs. My colleagues and I analysed webs from populations at Jenolan, Abercrombie and Wombeyan Caves to assess and identify possible threats to the populations. Webs from the Abercrombie Arch, for example, were found to be high in phosphate, which could be attributed to the guano of Welcome Swallows (*Hirundo neoxena*) that also share the arch. High concentrations of sulphate were detected in webs from the Grand Arch at Jenolan Caves, which reflects the presence of the mineral gypsum (calcium sulphate) in the limestone. Levels of lead and zinc were also particularly high in webs from Jenolan Caves, an effect potentially attributable to emissions from motor vehicles that travel through the Grand Arch. Whether this and other factors, like wind turbulence and high dust loads in the webs, are contributing significantly to the patchy distribution of Colonial Spiders seen in the Arch remains uncertain, but it does suggest the need for continued monitoring of this spider population.

Research on the Colonial Spider, besides highlighting potential threats and assisting management of the species, has provided a tool that can be applied more broadly to environmental monitoring in habitats beyond the caves investigated here. Further research is needed to explore the distribution of the species and social interaction among individuals. No doubt there are many more rare invertebrates out there that need to be identified, researched and managed. □

FURTHER READING

Foelix, R.F., 1982. Biology of spiders. *Harvard University Press: Cambridge.*

Hose, G.C., James, J.M. & Gray, M.R., 2002. Spider webs as environmental indicators. Environ. Pollution *120: 725–733.*

Dr Grant Hose is a Research Fellow in the Institute of Water and Environmental Resource Management at the University of Technology, Sydney. His research interests include cave ecology and ecotoxicology.

1080 plants

1080 plants may have saved many marsupials from doom.

PHOTOS: TIM LOW

Sandplain Poison is the plant to which Numbats in Dryandra Woodland may owe their survival. It grows there prolifically but otherwise is not a widespread plant.

BY TIM LOW

CONQUEST OF THE WORLD BY *Homo sapiens* has been impeded in many regions of the globe by other species, notably those that harm people, their crops and livestock. In a striking example from the 19th century, expansion of the English into Western Australia was stymied by poisonous plants. When settlers led their herds and flocks into woodlands east of Perth, their stock often died. The mystery fatalities proved a worse blight than droughts, fires, floods and the spears of affronted Aborigines. In 1840 amateur botanist James Drummond showed that the deaths were due to certain pea-bushes (*Gastrolobium* species). These plants were later found to contain one of the most toxic substances known, compound 1080 (pronounced 'ten eighty') or sodium monofluoroacetate, the active ingredient in Dingo, Fox and Rabbit baits. These 1080 or poison plants had to be uprooted from pastures before settlement could proceed.

The Western Australian wheat belt, over-cleared and blighted by salinity today, is acknowledged as a dire example of over-development. Undoubtedly, many unique plants were bulldozed into oblivion before they were discovered and named. But the situation would be even worse today were it not for 1080 plants. Some of the major nature reserves survived only because they were too rugged for wheat and rendered unsafe for grazing by the poison plants.

1080 plants may also have saved many marsupials from doom. Australia has the world's worst record of mammal extinctions and, although we don't know the exact reasons why, Foxes no doubt played a key role. Extinctions were most dramatic in the south-eastern third of mainland Australia where Foxes reached peak numbers, lowest in Tasmania where Foxes did not establish, and low in northern Australia where Foxes remain sparse.

The conquest of south-western Australia by Foxes, like conquest by the English, was evidently slowed down by poison plants. Many native animals in the south-west have evolved a high tolerance for 1080 by feeding upon these plants. As legumes with nitrogen-fixing roots, the poison plants are highly nutritious. Western Grey Kangaroos (*Macropus fuliginosus*) rely on them for up to a quarter of their diet. Toxicity trials have shown that Common Brushtail Possums (*Trichosurus vulpecula*) in the south-west can endure 150 times as much fluoroacetate as Common Brushtails from the east. 1080 tolerance is widespread among mammals, birds and reptiles in the south-west. Predators such as Rosenberg's Monitors (*Varanus rosenbergi*) presumably evolved immunity by feeding on insects and other prey that browse these plants. Ingested fluoroacetate may take a day or two to be eliminated, which means that a Fox or Cat dining on possum in south-western Australia runs a risk of being poisoned (or if the dose is low, a carnivore's fertility may suffer). Biologists believe this

toxic effect has suppressed Fox numbers in south-western Australia, which helps explain why Numbats (*Myrmecobius fasciatus*), Red-tailed Phascogales (*Phascogale calura*), Brush-tailed Bettongs (*Bettongia penicillata*) and Western Quolls (*Dasyurus geoffroii*) survived here and nowhere else. (Density of woodland understorey and habitat fragmentation may be factors too.) These mammals once ranged as far east as inland New South Wales, but survive today only in the broad region where 1080 plants grow.

In Dryandra Woodland, famed for its Numbats, the dominant shrub is Sandplain Poison (*Gastrolobium microcarpum*). Most of the Numbats I've seen at Dryandra were foraging near the shelter of these plants. Today, under Operation Western Shield, national parks and other south-western reserves are regularly baited with 1080, greatly complementing the aid conferred by the toxic plants. 1080 baits are safe for feral-animal control in this region because the native fauna is so tolerant—quolls do not die if they swallow a bait. Thanks to baiting, Numbat, bettong and quoll numbers are rising, and authorities are returning them to reserves where they vanished long ago. Western Australia is now a world leader in animal reintroductions.

1080 plants are by no means confined to south-western Australia. Fluoroacetate was first isolated from a toxic African legume, and was later detected in a South American species. It also occurs in one *Gastrolobium* (Desert Poison Bush, *G. grandiflorum*) that ranges across northern Australia (the others are confined to the south-west). It is sometimes produced by Georgina Gidgee (*Acacia georginae*), a wattle found in the Northern Territory and north-western Queensland that occasionally poisons Cattle. But the centre for 1080-producing shrubs remains south-western Australia, home to more than 40 species.

The irony today is that more than a dozen *Gastrolobium* species are now rare, mainly due to persecution by farmers. Hook-point Poison (*G. hamulosum*) is known from only 230 plants, and Granite Poison (*G. graniticum*) has a global population below 850. In the eyes of many, poison bushes have gone from plants people despise to plants worthy of conservation. Given their special role in conserving Australia's biodiversity, the least we can do for these plants is afford them a promising future. □

Crinkle-leaf Poison (*Gastrolobium villosum*) was one of the first poison bushes encountered by Sheep because it grows freely in the Darling Range on the outskirts of Perth.

FURTHER READING

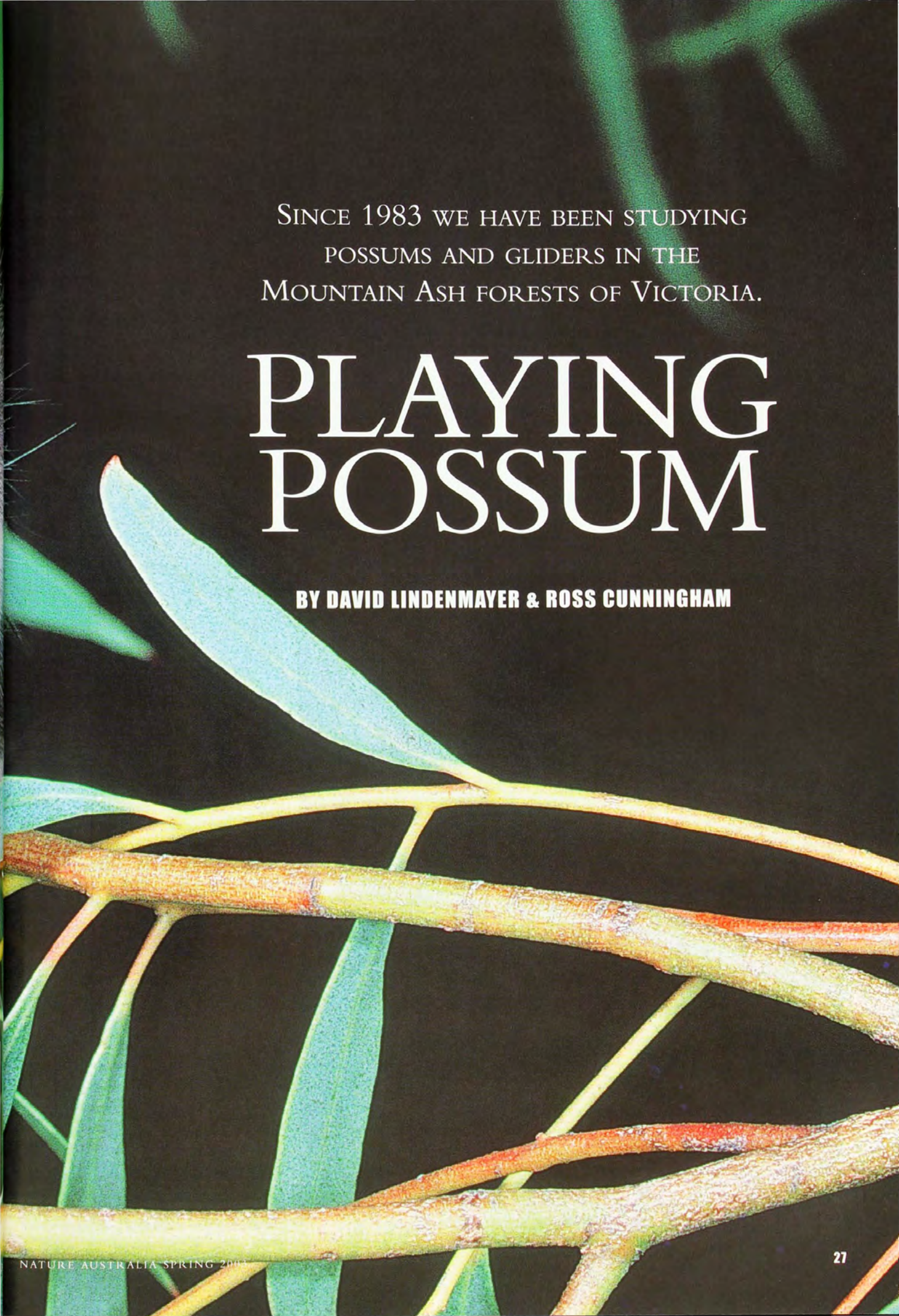
Everist, S.L., 1974. Poisonous plants of Australia. *Angus & Robertson: Sydney.*

Hopper, S., 1991. Poison peas: deadly protectors. Landscope *6(4): 44–50.*

Twigg, L.E. & King, D.R., 1991. The impact of fluoroacetate-bearing vegetation on native Australian fauna: a review. Oikos *61: 412–430.*

TIM LOW IS A BRISBANE-BASED BIOLOGIST AND WRITER. HIS MOST RECENT BOOK, *THE NEW NATURE* (PENGUIN, 2002), WON THE 2002 WESTFIELD/WAVERLEY AWARD FOR EXCELLENCE IN RESEARCH.

Weighing less than 15 grams, the Feathertail Glider is the smallest of Australia's six marsupial gliding species. When it glides (distances of up to 20 metres) it resembles a leaf falling from a tree.



SINCE 1983 WE HAVE BEEN STUDYING POSSUMS AND GLIDERS IN THE MOUNTAIN ASH FORESTS OF VICTORIA.

PLAYING POSSUM

BY DAVID LINDENMAYER & ROSS CUNNINGHAM

JEAN-PAUL FERRERO/AUSCAPE

Leadbeater's Possum is a highly agile and rapidly moving arboreal marsupial. Here it is climbing on small branches to collect pollen and nectar from flowers.

IT IS DUSK IN A PATCH OF OLD-growth Mountain Ash forest in the Central Highlands of Victoria. The calls of the daytime birds begin to wane, signalling the changeover to the animal night shift—owls, nightjars and an extraordinary diversity of possums and gliders. Half an hour later a large possum emerges from a hollow halfway up a trunk. There's a rain of scats as the animal relieves itself after a long day asleep in its nest tree. It is the recently recognised and renamed Mountain Brushtail Possum (*Trichosurus cunninghamii*), and one of eight different species of possums and gliders that live in the area. From smallest to largest, they are the Feathertail Glider, Eastern-Pygmy-possum, Sugar Glider, Leadbeater's Possum, Yellow-bellied Glider, Common Ringtail Possum, Greater Glider and Mountain Brushtail Possum. But how can so many species from the one broad group coexist in the same forest?

SINCE 1983, AND WITH THE HELP OF more than 4,500 volunteer observers, we have been collecting data on possum and glider ecology and behaviour in the Mountain Ash forests of Victoria. These data show important differences in the habitat requirements of each species of possum and glider. For example, less than eight per cent of Mountain Ash forests are currently suitable for Leadbeater's Possum (*Gymnobelideus leadbeateri*)—one of the faunal emblems of Victoria and an endangered species that sends foresters and conservationists alike into apoplexy. The species typically occurs in both old-growth forest and young regrowth forests where there are many hollow trees for nesting and numerous understorey wattles for food (see "Stirring the Possum", *Nature Aust.* Autumn 2002). In contrast, the Greater Glider (*Petauroides volans*) is most likely to be found in old-growth stands. The Yellow-bellied Glider (*Petaurus australis*) also shows a preference for old-growth forest and in this region it occurs almost exclusively in Mountain Ash landscapes within closed catchments set aside for water production, where such stands are extensive and largely unfragmented.

Most Greater Gliders in Mountain Ash forests are black with a white underbelly. Predominately white-coloured animals are uncommon, although nearly all the animals in a small population near the town of Healesville are white.

We believe such differences are important for the coexistence of these animals.

Despite the different habitat preferences, there is one feature that almost all the species have in common—an abundance of trees with hollows, without which the majority of possums and gliders simply cannot survive. The one exception is the Common Ringtail Possum (*Pseudocheirus peregrinus*), which builds a nest (or drey) in dense foliage, although many individuals still prefer to use hollows in the cool, wet environments of Mountain Ash forest.

Possums and gliders do not occupy just any hollow. They can be very selective in what they choose, perhaps because they spend up to 75 per cent of their lives living inside them. Not only do animals vary in their choice of hol-

Like almost all species of possums and gliders in the Mountain Ash forests of Victoria the Yellow-bellied Glider is dependent on large trees with hollows in which to nest and shelter.

low tree species, but also the tree height, diameter and levels of tree decay, including number and types of cavities. For example, Leadbeater's Possums prefer short but large-diameter hollow trees that are well decayed. In contrast, closely related Sugar Gliders (*Petaurus breviceps*) opt for trees with numerous long slits or fissures. Greater Gliders most often use very tall trees in the early stages of decay. Perhaps these tall trees give Greater Gliders (the least agile of Australian marsupial gliders) the best 'flying start' to the night—allowing them to move long distances away from their nest sites. Staying close to a nest tree (for feeding or socialising) is not a good strategy because it might attract predators like owls.

Differences in the preferred types of nesting trees allow possums and gliders to 'divvy up' a key resource in the forest. Sharing of the same nest tree by different species is rare (less than two per cent of cases) and, when it occurs, is typically between a large species (such as a Greater Glider) and a small one (such as Leadbeater's Possum). However, as always in ecology, some of the 'general rules' are there to be broken and we did record one case of Leadbeater's Possums and Sugar Gliders sharing not only the same nest tree but also the same hollow.

Other differences in tree-hollow usage among the different species of possums and gliders involve the timing of emergence after dusk. Typically, the smallest species (the Feathertail Glider, *Acrobates pygmaeus*) is the first to emerge, then the intermediate-sized Sugar Glider, Leadbeater's Possum and Yellow-bellied Glider. The largest species (the Greater Glider and Mountain Brushtail Possum) are usually the last to emerge from their nest trees—sometimes up to 40 minutes after dusk. The reasons for the differences in emergence times could be related to metabolism and diet. Small possums and glid-

A.H. TOLHURST

The Common Ringtail Possum is the only species of possum or glider that is not totally dependent on tree hollows in Mountain Ash forests. Nevertheless, the cold and wet conditions of these forests mean that most animals use hollows instead of constructing nests (called dreys).

A.H. TOVHURST

The rippled skin of the Sugar Glider's gliding membranes helps distinguish it from the very similar-looking and closely related Leabeater's Possum.

ers are 'high-energy' animals and probably need to begin feeding as soon as possible after dusk, seeking out insects, pollen and nectar. Larger species have greater stores of energy and can afford a more leisurely start to the night's feeding proceedings.

A BETTER UNDERSTANDING OF THE diverse fauna of Mountain Ash forests is critical for finding effective conservation strategies. Extensive areas of the forests are clearfelled each year to produce paper and timber. Intensive clearfelling operations are not ecologically sustainable and are known to have detrimental impacts on many forest animals, particularly the suite of species that depend on tree hollows, which take hundreds of years to form.

Part of the solution to the problem is to set aside large areas of forest from logging, such as in nature reserves and national parks. The Yarra Ranges National Park, for example, has become a prominent part of the Central Highlands region in recent years. The park is particularly important for the Yellow-bellied Glider, which is strongly associated with large unfragmented areas of

(Right) The Mountain Brushtail Possum is the largest species of possum in the Mountain Ash forests. Its longer ears and feet and shorter tail distinguish it from the recently recognised Short-eared Possum (*Trichosurus caninus*) that occurs in northern New South Wales and Queensland.

old-growth Mountain Ash forest (not found in surrounding wood-production forests).

However, because of the potential impacts of wildfires and possible climate change, nature-conservation strategies are also needed outside the Yarra Ranges National Park. Our work on the habitat preferences of possums and gliders can help reduce the risks when it comes to logging. For example, one 'popular' idea in forest management is to identify particular species that indicate the presence of other species. The concept has great currency in the USA, although it has rarely been put through its paces with rigorous scientific scrutiny. Our data show that no single species of possum or glider (or group of species) was a good indicator of the presence of any other species. This result highlights the need to focus on the management of *all* the species of possums and gliders and not just the ones considered to be 'indicators'.

With the possible exception of the Yellow-bellied Glider, it should be possible to log forest and still retain suitable habitat for most species of possums and gliders—but *only* if new and more ecologically appropriate harvesting methods (alternative to clearfelling) are widely used. Because different possum and glider species rarely share the same nest tree, logging methods must aim to retain many more hollow trees, and other trees that will eventually develop hollows, on logged sites.

Developing these ecologically sensitive logging methods will be a real challenge for forest managers. However, forest-management agencies must adopt such measures if they wish to ensure the Mountain Ash forests remain biologically diverse and a key part of Australia's natural heritage. To this end, and in partnership with the Victorian Government, in December 2002 we started a new field experiment to test the biodiversity value of improved logging practices. With the help of dedicated volunteers, we will assess whether 'islands' of forest retained within logged coupes are useful for possums and gliders (as well as other groups such as birds and reptiles) and whether modified forestry practices can indeed create the sorts of habitats these animals need to survive. □

The Eastern Pygmy-possum (*Cercartetus nanus*) is rarely seen in Mountain Ash forests. Most of the animals we have observed there have been in pitfall traps dug for surveys of reptiles, particularly in areas with abundant tree ferns.

FURTHER READING

Lindenmayer, D.B., 1997. Differences in the biology and ecology of arboreal marsupials in southeastern Australian forest. J. Mammal. *78: 1117–1127.*

Lindenmayer, D.B., 2002. Gliders of Australia: a natural history. *University of New South Wales Press: Sydney.*

Lindenmayer, D.B. & Beaton, E., 2000. Life in the tall eucalypt forests. *New Holland Publishers: Sydney.*

Lindenmayer, D.B. & Cunningham, R.B., 1997. Patterns of co-occurrence among arboreal marsupials in the forest of central Victoria, south-eastern Australia. Aust. J. Ecol. *22: 340–346.*

Lindenmayer, D.B. & Franklin, J.F., 2002. Conserving forest biodiversity: a comprehensive multiscaled approach. *Island Press: Washington, DC.*

DAVID LINDENMAYER AND ROSS CUNNINGHAM ARE ASSOCIATE PROFESSORS OF ECOLOGY AND STATISTICS, RESPECTIVELY, AT THE CENTRE FOR RESOURCE & ENVIRONMENTAL STUDIES AT THE AUSTRALIAN NATIONAL UNIVERSITY IN CANBERRA. THEIR WORK IN THE MOUNTAIN ASH FOREST OF THE CENTRAL HIGHLANDS OF VICTORIA HAS BEEN UNDERWAY SINCE 1983. VOLUNTEERS INTERESTED IN JOINING THEM ON FIELD RESEARCH CAMPS SHOULD CALL THE EARTHWATCH INSTITUTE IN MELBOURNE ON (03) 9682 6828.

THE STORY OF HOW FEATHERS EVOLVED IS FAR FROM OVER

THE FUZZY FRONTIER

BY STEVE SALISBURY

ILLUSTRATION BY JAMES REECE

(Previous page) *Confuciusornis* is one of the oldest birds known after *Archaeopteryx*. Literally hundreds of specimens of this magpie-sized bird have now been found in Liaoning Province, suggesting it may have lived in large colonies around the forested lake margins. It is much more bird-like than *Archaeopteryx*, with a considerably larger breastbone, reduced bony tail and no teeth. *Confuciusornis* was apparently sexually dimorphic, with many of the larger specimens—presumably the males—possessing a pair of exceptionally long, scale-like tail feathers.

In 1868, Thomas Huxley declared that dinosaurs gave rise to birds. He based his claim on *Compsognathus*, a 150-million-year-old dinosaur fossil from Solnhofen, Germany, whose delicate hind legs were remarkably similar to those of table fowl. The discovery seven years earlier of *Archaeopteryx*, a fossil bird with a long bony tail, toothed jaws and clawed fingers, had convinced many people that birds were somehow related to reptiles. But *Compsognathus* was the fossil that placed dinosaurs firmly in the middle of this complex evolutionary equation. Wings, claimed Huxley, must have grown out of rudimentary forelimbs. And feathers? Whether *Compsognathus* had them, Huxley could only guess. Nevertheless, his theory clearly required that scales had somehow transformed into feathers. The question was not just how, but why?

LIAONING PROVINCE *seemed to be transforming theropods into a motley crew of fuzzy feathered freaks overnight.*

In October 1996, Chinese and Canadian palaeontologists revealed sensational photographs of a new theropod dinosaur from China. The scientific world stood with its jaws agape. This was *Sinosauropteryx* ('Chinese dragon feather'). About a metre long, the 125-million-year-old fossils from Liaoning Province, north of Beijing, looked very similar to those of *Compsognathus*, except for one, very striking difference: each *Sinosauropteryx* specimen was surrounded by a halo of dark, fuzzy fibres (see "Feathered Dinosaur", *Nature Aust.* Spring 1997).

As news of these dinosaurs spread, palaeontologists began arguing over what the strange fibres represented. To many, the best explanation was that they were long filamentous integuments, not unlike mammalian hair, only much thicker. As such, they could be considered proto-feathers, the long-sort-after transitional structure between elongate reptilian scales and simple down-like feathers. Others, however, were quick to dismiss these fibres as frayed bits of decaying flesh, most likely collagen, a protein found in connective tissue. But before any kind of consensus could be reached, Liaoning produced another two, even more amazing fossils: *Protoarchaeopteryx* and *Caudipteryx*.

While there may have been doubts about the body covering of *Sinosauropteryx*, this wasn't the case with *Protoarchaeopteryx* and *Caudipteryx*. Both these dinosaurs were covered in structures that clearly resembled bird feathers. So much so, in fact, that many critics of the theropod–bird link believe they aren't dinosaurs at all, but belong to a group of archaic flightless birds.

Protoarchaeopteryx and *Caudipteryx* are each about the size of a turkey, but with much longer legs and a bony tail. *Protoarchaeopteryx* has both contour and down-like feathers on its body and a bizarre, fan-like arrangement of larger, 'true' feathers sprouting from the end of its tail. The tail fan is even more pronounced on *Caudipteryx*, hence its name, which means 'tail feather'. *Caudipteryx* also has a tuft of 'true' feathers attached to its second, clawed finger.

In palaeontology it's usually a long wait between major discoveries. In the case of feathers and fuzz, for example, we had to wait 135 years between the first *Archaeopteryx* specimen and *Sinosauropteryx*. In the late 1990s, however, Liaoning Province seemed to be transforming theropods into a motley crew of fuzzy feathered freaks overnight. In 1999, hot on the heels of *Protoarchaeopteryx* and *Caudipteryx* came

LUIS V REY

Beipiaosaurus. Estimated to have been over two metres long, *Beipiaosaurus* is the largest fuzzy dinosaur yet found. It is also one of only a few dinosaurs that belong to Therizinosauridae, an unusual group of theropods endemic to eastern Asia and North America. The discovery of feather-like filaments in a therizinosaurid signalled to palaeontologists that fuzz may have been much more ubiquitous among theropods than was initially thought.

And they were right. A few months later, Liaoning turned up the 'Chinese bird dragon' *Sinornithosaurus*, the theropod everyone had been waiting for. This is because it is a 'feathered' dromaeosaurid, or 'raptor' (see "Dinosaurs of a Feather...", *Nature Aust.* Spring 2000), and of all the dinosaurs, it is the dromaeosaurids that are most similar to birds anatomically. At first glance, the turkey-sized *Sinornithosaurus* looks like it was covered in shaggy black hair. However, detailed analysis of these structures has revealed that they are in fact multiple branching filaments, as opposed to the simple, fibre-like struc-

A reconstructed scene from the heart of the fuzzy frontier—Liaoning Province, north-eastern China, 125 million years ago. In the right foreground, two 'proto-feathered' *Sinosauropteryx* approach a pair of *Psittacosaurus*, a beaked ceratopsian dinosaur with quill-like structures along the upper surface of its tail. Behind them, two *Beipiaosaurus* browse the lower branches of lakeside trees for insects. At two metres in length these unusual-looking therizinosaurids were the largest of the fuzzy dinosaurs of their day. To the right of the *Psittacosaurus*, feathered dromaeosaurids ('raptors') display to each other to assert dominance. Two male *Confuciusornis*, one of the world's first flying birds, play out a similar game in the trees.

COURTESY WALTEL BOLEN

ILLUSTRATION BY JAMES REECE

The turkey-sized *Caudipteryx* (left) must rank as one of the most unusual dinosaurs ever discovered. Articulated skeletons (above) of several individuals have now been found in Liaoning Province, north-eastern China. Attached to each of its short, clawed forelimbs was a tuft of long, symmetrical feathers. In combination with the jaunty fan of feathers sprouting from the tip of its tail, they may have been used for threat and mating displays in a manner similar to many modern-day ground birds.

tures adorning *Sinosauropteryx* and *Beipiaosaurus*.

Both fuzzy and feathered theropods continue to be discovered. The flock now includes four more dromaeosaurids: two species of *Microraptor* and another two that are yet to be named, including one that is clothed in feathers almost identical to the down feathers of modern birds. Amazingly,

JAMES KING, AUSTRALIAN MUSEUM

Down (top left), contour or body (middle left) and flight (right) feathers of a Masked Owl (*Tyto novaehollandiae*), and a contour feather (bottom left) of a Powerful Owl (*Ninox strenua*).

FEATHER FACTS

Like hair or scales, feathers are formed from the outer layer of skin and are made of a substance called keratin. Contour (body) and flight feathers have a hollow central shaft (the quill) that divides the feather into two vanes, each of which comprises a series of barbs. Adjacent barbs are hooked together by tiny structures called barbules. Consequently, each vane acts as a single interlocking sheet rather than a series of separate hairs. Contour feathers only have barbules on the barbs towards the tip. The barbs at the base are therefore separate, and often take on a ruffled, almost hair-like appearance. Barbs on down feathers lack barbules altogether. Some down feathers even lack a quill.

The feathers of modern birds come in many shapes and sizes, each type serving multiple purposes. For instance, primary and tail feathers are used for flight and display, whereas down feathers help maintain body heat.

A bird's flight feathers are anchored tightly to its wing bones. The primary flight feathers are attached to the wrist and hand, forming the outer half of the wing, whereas the secondary flight feathers are attached to the forearm. A small tuft of secondaries, known as the alula, is also attached to remnants of the thumb.

If a bird's secondaries are clipped, it can still fly, but remove no more than the tips of its primaries and it will be grounded. The reasons for this seem to relate to the shape of each type of feather, specifically its vanes. The primaries of flying birds have asymmetrical vanes. The leading edge is thinner than the trailing edge, so that each feather has an airfoil-like cross-section. With the wing fully spread, it is thought that the outer half of each primary acts as a small, independent airfoil or winglet, helping to increase the lift generated by the rest of the wing during takeoff and to prevent stalling at low flying speeds. If these winglets are taken out of the equation, the total amount of lift generated by the wing is reduced considerably, making flapping flight almost impossible to maintain. In flightless birds, however, the vanes on the feathers that are attached to the wrist and hand are symmetrical, similar to the secondaries of flying birds. Lacking an aerodynamic profile, these symmetrical feathers do not generate very much lift when the wing is extended and flapped. Combined with the smaller size of their wings, this is probably one of the main reasons why birds with fully symmetrical wing feathers can't fly.

ILLUSTRATION BY JAMES REECE

Still considered the world's oldest bird, *Archaeopteryx* was first discovered in 1859 in the lithographic limestones of Solnhofen, southern Germany. It is similar to many theropod dinosaurs in possessing a toothed beak, claws on its fingers and a long, bony tail. Its wings, on the other hand, are very avian, with the same number of primary and secondary flight feathers as those of modern-day flying birds. Although incapable of sustained flapping flight (as indicated by its small wishbone), *Archaeopteryx* probably partook in rudimentary aerial excursions, if only for short distances.

sensus among palaeontologists is a long way off.

In light of the shortcomings associated with both the flight and insulation hypotheses, many palaeontologists have opted for a slightly 'sexier' idea, suggesting that the symmetrical feathers of *Protoarchaeopteryx* and *Caudipteryx* evolved for use in mating and threat displays. Another idea for the origin of feathers relates to biomechanical support. It's now known that feathers and feather-like structures in the skin can help brace the body against mechanical loads such as torque during fast running. Lacking the fused skeletal elements seen in modern birds, particularly the speedy ratites, some theropods may have evolved proto-feathers in order to 'tighten up' their running style. The same principle was used by Nike to develop the body-hugging suit that helped Cathy Freeman win gold in the 2000 Olympics.

DESPITE THE RECENT FLURRY OF fuzzy fossil finds and new evolutionary scenarios for the origin of birds, the story of how feathers evolved is far from over, and a number of fossils are causing palaeontologists to rethink their ideas. One such fossil is *Longisquama*. This 220-million-year-old, mouse-size reptile from Kyrgyzstan, central Asia, had received little attention since it was first described in 1970. But after seeing the specimen in 1999, Terry Jones (Oregon State University) and colleagues decided it was far more bird-like than previously thought. What got their attention was *Longisquama*'s 'plumage': sprouting from the midline of its back is a series of paired, vane-like integumentary appendages up to 12 centimetres long.

FEATHERS AND *feather-like structures in the skin can help brace the body against mechanical loads during fast running.*

When it was first discovered, *Longisquama*'s integumentary appendages were considered to be elongate scales, possibly used for gliding or sexual display. But Jones *et al.* interpreted them as feathers, thrusting *Longisquama* from relative obscurity into the centre of a bitter evolutionary debate. For not only does *Longisquama* pre-date *Archaeopteryx* by 70 million years, it's also not a dinosaur, let alone a theropod.

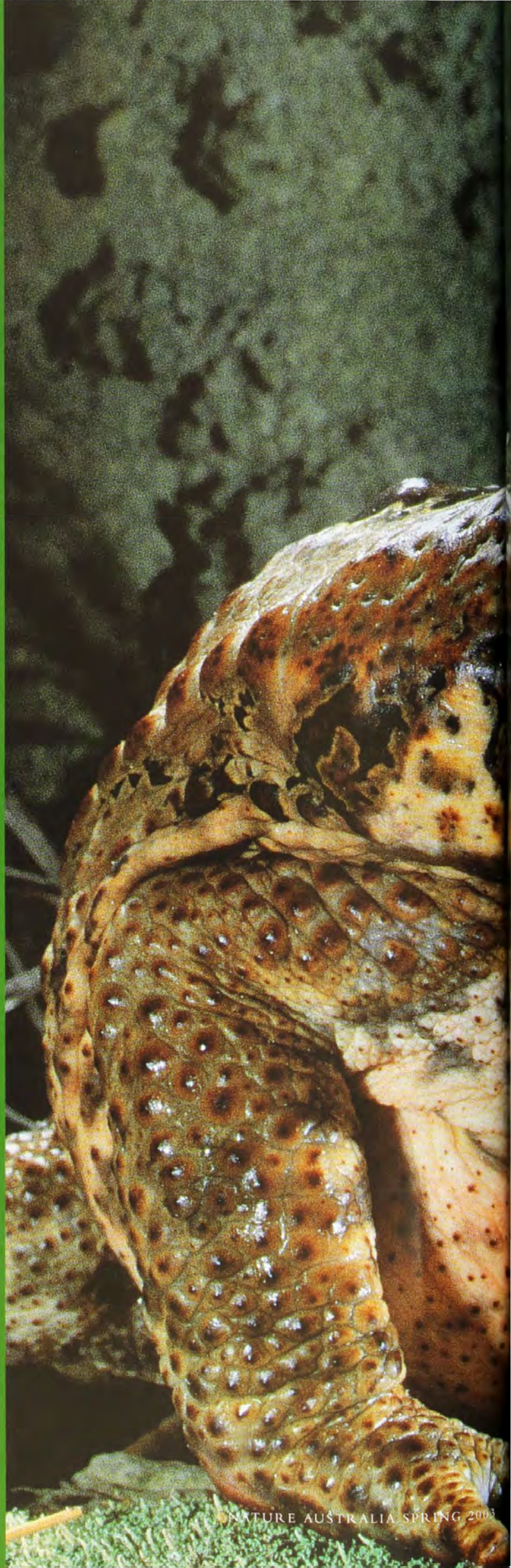
Most palaeontologists are not convinced. Interestingly though, Jones *et al.* came up with their idea *prior* to the discovery of scale-like tail feathers in two early birds, *Protopteryx* and *Confuciusornis*. So maybe their interpretation isn't so far off, and the origin of feathers, or feather-like integumentary appendages at least, is more complicated than at first thought.

As most proponents of the dinosaurian origin of birds (and thus feathers) are quick to point out, all the fuzzy dinosaurs discovered so far are fleet-

CANE TOADS HAVE ENCIRCLED AND ENTERED ARNHEM LAND, ONE OF THE STRONGHOLDS OF ABORIGINAL CULTURES IN NORTHERN AUSTRALIA.

INVASION *of the* RUBBISH FROGS

BY JON ALTMAN, TONY GRIFFITHS & PETER WHITEHEAD



MICHAEL CERMAK

A large Cane Toad showing the short squat body and comparatively short legs. The prominent ridge between nostril and eye is not seen in any native Australian frog.

AUSTRALIANS HAVE MUCH TO celebrate about our country's unique heritage: its wildlife, its people and its landscapes. We applaud actions that sustain our heritage and agonise over potential losses. But we have all but ignored an invasion of suicidal adventurers that threatens people, wildlife and the delicate balance between the two.

No, we are not promoting hysteria about human refugees in leaky boats. We have had more than enough of that. We are talking about the introduced Cane Toad (*Bufo marinus*) and its march across the Top End. Cane Toads are rampant in Kakadu National Park, and moving rapidly through some of Australia's most biodiverse landscapes. They have encircled and entered Arnhem Land, one of the strongholds of Aboriginal cultures in northern Australia.

The advance guard of Cane Toads is thinning out the ranks of naive native predators that attack them. Even frog-eating predators can't slow the advance, because they cannot cope with the suite of toxins in the toads' skin and glands. Goannas, quolls, snakes, crocodiles and turtles are dying quickly—poisoned. We know definitively that many animals will die—from laboratory studies, reports from skilled lay observers, and scientific studies now underway in Kakadu. But what proportion of the predator populations will die? Will those populations ever recover to anything like former levels? And if they do, how long will it take?

AUSTRALIA FREQUENTLY CASTIGATES others failing to meet good conservation standards, yet surrendered to Cane Toads with barely a whimper. In stark contrast to the leaky boats, the Cane Toad invasion was never a decisive election issue, it did not attract funding in the hundreds of millions, nor did it lead to mobilisation of armed forces. The best response we can point to was a short-term research program in the early 1990s, backed by limited funding, that stopped prematurely, and a current small-scale feasibility study looking at control by a genetically modified virus. Why didn't we get serious about this threat?

Objective science was used to justify our wimpiness. Control is difficult because Cane Toads are hard to kill. The things that kill them also kill native frogs and even fishes. Because there is no "proof" that extinction is caused by toads, we didn't feel obliged to act. Costs would be high, risks substantial, and benefits in preventing extinctions questionable. All seems logical and objective, but there is one critical flaw. Why was the risk of extinction the only or best criterion for justifying intervention, and who decided that this was all that Australians cared about?

TONY GRIFFITHS

Many Kuninjku people still depend on native animals and plants for food. Although Magpie Geese (*Anseranas semipalmata*) appear not to be directly threatened by Cane Toads, other dietary species are likely to decline significantly.

Far from being objective, the science that justified resigned passivity was loaded down with values. In our view, they were mostly the values of boutique conservation—concern for the pretty, the rare and the endangered. Proposals made by one of us (Peter Whitehead) for studies of the Cane Toad's social and cultural impacts in the early 1990s were regarded as ineligible for funding because the Cane Toad had not been listed as a threatening process under endangered species legislation. In the world of boutique conservation, the animals most affected by Cane Toads were too commonplace or uncharismatic to warrant serious concern. Such decisions effectively denied the relevance of all but these boutique perspectives.

One perspective denied was that of

A Keelback (*Tropidonophis mairii*) consuming a Cane Toad. This snake is one of the few native predators able to eat toads without succumbing to their toxins.

the eastern Kuninjku people of central Arnhem Land. One of us (Jon Altman) lived and worked with this Aboriginal population more than 20 years ago, recording the way they used landscapes and interacted with animals. The Kuninjku way of life, how they viewed their place in the world, and the way they interacted with other societies, all depended fundamentally on a relationship with wildlife. More than half their income and food came from common, 'boring' species. Their existence as a people depended on continued abundance of some of the sorts of animals that contemporary science had apparently decided were unimportant.

Fieldwork recently completed indicates that, over the intervening two decades, relationships of the same people with wildlife have, if anything, strengthened. This strength does not derive from isolation from the rest of society or the market economy. Indeed, many Kuninjku engage creatively with the wider Australian and global communities, producing artworks representing wildlife, landscape and ancestral knowledge now displayed in galleries around the world. One Kuninjku man, John Mawurndjul, was recently described as the foremost living Aboriginal artist. Such recognition has not alienated him from his cultural obligations. He uses income from art to strengthen Kuninjku contact with their country by providing the means (vehicles and fuel) for others to access and maintain their ancestral lands.

What will the Cane Toad do to relationships between people and land? We cannot predict with certainty, as there have been next to no quantitative studies of the effects of Cane Toads on native wildlife. But there *will* be change. Several species of goannas and short-necked turtles are likely to be affected. Frilled Lizards (*Chlamydosaurus kingii*) will probably eat young toads and die. Crocodiles, both Freshwater (*Crocodylus johnstonii*) and Saltwater (*C. porosus*), will perish. The abundance of a substantial proportion of the 25+ species that Kuninjku people depend on for their livelihood may be reduced.

The survival of Aboriginal people as

STEVE WILSON

Young Cane Toads that have recently completed metamorphosis. Even these small toads are toxic.

Cane Toad

Bufo marinus

Classification
Family Bufonidae ('true' toads).

Identification
Stocky amphibian up to 15 cm long with warty skin. Females larger and smoother-skinned than males. Olive- to reddish-brown on top, with paler belly. Bony ridges over each eye, and a pair of enlarged poison glands on each shoulder.

Distribution and Habitat
Native to Central and South America. Deliberately introduced to Aust. in 1930s. Since spread through eastern and northern Qld, parts of NSW, and presently westwards across NT. Occupies many habitats, from tropical rainforest to semi-arid sandstone ranges.

Biology
Mostly active in cool of late evening and early morning. Eats mostly ants, termites and beetles, but also other frogs, small reptiles, mammals and even small birds. Females produce 10,000–20,000 eggs, sometimes twice a season. Tadpoles emerge in a few days, metamorphose in around 3 weeks, and reach adult size (7–8 cm) within a year.

hunter-gatherers has also depended on treating toxic species with great circumspection. How should they react to new animals that exude poison or even squirt toxins when harassed? Should they stop eating fish or turtles that eat tadpoles or toads, even if these predators survive the experience? Should they stop harvesting animals that are badly affected by the toads so that the vulnerable aren't put at further risk? How will reduced availability of toad-affected species influence demand on other species?

Effects on wildlife will probably be worst at the margins of the affected species' ranges. Where wildlife is barely hanging on, Cane Toads may upset an uneasy equilibrium and tip marginal populations into oblivion. Genetically and ecologically distinct subpopulations, like the Dwarf Freshwater Crocodiles of the upper Liverpool River, will be especially vulnerable. These crocodiles occur at low densities

in creeks high up in infertile sandstone gorges, where even unappetising prey is snapped up eagerly. Being small, they will be killed by smaller doses of toad toxin than their downstream cousins. Should Aboriginal harvesters avoid these places altogether? And if they do, who will look after the land, maintain fire regimes and manage wildlife?

QUESTIONS OF THIS SORT STRIKE AT the heart of Kuninjku lives. This invasion challenges Kuninjku culture and their capacity to live off the land much more fundamentally than the impact of a few refugees on the status of urban Australians. The Kuninjku situation demands a response, albeit less extravagant than reactions to leaky boats.

These issues came into sharp focus in July 2002, when some Kuninjku had their first interaction with a Cane Toad entering Nandel, a camp on a floodplain near the Tomkinson River. They had heard a lot about these animals, so the arrival caused a commotion. The camp was alive with people yelling, throwing burning logs at the toad, and grabbing children. A *balanda* (white fella) scientist (Tony Griffiths) quickly dispatched the toad, much to the relief of others. Everyone was upset that this *djati narwarreh* (rubbish frog) had turned up. There was much concern for the children's safety, as well as for the Dogs.

THE CAMP *was alive with people yelling, throwing burning logs at the toad, and grabbing children.*

The *balanda* scientist was in camp studying use of wildlife. One objective of the work, done jointly with the Kuninjku, is to understand how customary practices interact with new challenges posed by feral animals. Looking at the frequency with which skilled hunters encounter and take wildlife in the absence of toads, and then seeing how this changes after toad invasion, could provide a measure of the toads' impact on other animals' abundance. Using more conventional methods of wildlife survey, scientists have found it difficult to measure changes in abundance of highly mobile animals like goannas. Although knowing the impact of toads will be cold comfort to Kuninjku people, it might help other Aboriginal groups plan for the invasion and take steps to reduce the impact on their lives.

The Australian constitution provides that loss of private rights should be compensated by governments, a principle extended to Indigenous customary rights by the *Native Title Act* in 1993. The courts have established that actions by governments affecting private property, even indirectly, can attract liability. One example followed creation of a conservation reserve in Victoria, where failure to control wild Dogs should have been anticipated as a problem for neighbours, and action taken to prevent damage. Because they failed to act, managers of the reserve (the State) were held

The Frillneck Lizard is a conspicuous member of the north Australian reptile fauna, popular with tourists and also used for food by Aboriginal people. It is particularly susceptible to Cane Toad toxins.

A dead Cane Toad being consumed by ants. Many more ants are eaten by toads, with huge numbers ants and other invertebrates being snapped up.

to be financially liable for losses of Sheep on an adjoining property.

We are not suggesting that Kuninjku people mount a legal case against those who introduced Cane Toads or failed to do anything about their spread. However, we do suggest that the Australian Government has a moral obligation to treat seriously the impacts on Kuninjku harvesters and other Native Title interests.

Rather than direct compensation, a better way will be to celebrate and actively support expansion of the role that the Kuninjku and others already play in caring for large areas of land. In northern Australia, many wildlife species are declining, probably due to the combined effects of grazing by introduced species and changed fire regimes. Our most difficult conservation problems in the north stem from loss of human presence, rather than too many people. Unoccupied country invites other biological invaders, including Swamp Buffaloes, Horses, ants, bees, invasive woody weeds and aggressive African grasses. The typically passive Australian approach of relying on reserves to maintain wildlife is failing. Reserve management does not mimic the effects of people moving through the country in the quest for food—skilfully using fire to foster abundance of the wildlife they value, reducing risks of larger and intense fires, and intercepting invaders before they are beyond conventional control.

WE AVERTED OUR GAZES *from the effects of the Cane Toad, leaving the victims to find solutions.*

Some view the paltry Government support received by Kuninjku people as a demeaning form of welfare. A better perspective will value what they already do for land management and take the opportunity to build on it. This can be done relatively cheaply, mainly by better supporting existing organisations by properly recognising their national conservation role. Associations like the Bawinanga Aboriginal Corporation, an outstation resource agency that helps Kuninjku people stay active on their country, presently struggle to find creative ways to secure support. Bawinanga has, for example, worked with traditional owners to collect specimens of the Liverpool River Dwarf Freshwater Crocodile for rearing in captivity away from Cane Toads, with no financial support from any government. But they

cannot deal with a growing array of entirely new conservation problems imposed by decisions taken elsewhere (weeds, feral stock, exotic insects, and more) unless realistically funded.

Non-Indigenous Australians have bequeathed Indigenous land managers a suite of difficult problems, some of which require specialised equipment or funding to reach remote areas. For decades we averted our gazes from the pernicious effects of the Cane Toad, leaving the victims to find solutions. We should do much better than turn our backs on the new challenges. Aboriginal people deserve support to apply their customary skills, not as remote curiosities but as full partners and critical contributors to Australia's conservation goals.

FURTHER READING

Freeland, W.J., 1984. Cane toads: a review of their biology and impact on Australia. *Technical Report No. 19: 1–67.*

Freeland, W.J., 1986. Invasion north: successful conquest by the Cane Toad. *Aust. Nat. Hist. 22(2): 69–72.*

Jacklyn, P., 1992. The status of cane toads in the Northern Territory. *Environment Centre: Northern Territory.*

van Dam, R.A., Walden, D.J. & Begg, G.W., 2002. A preliminary risk assessment of cane toads in Kakadu National Park. *Supervising Scientist Report 164, Environmental Research Institute of the Supervising Scientist, Darwin.*

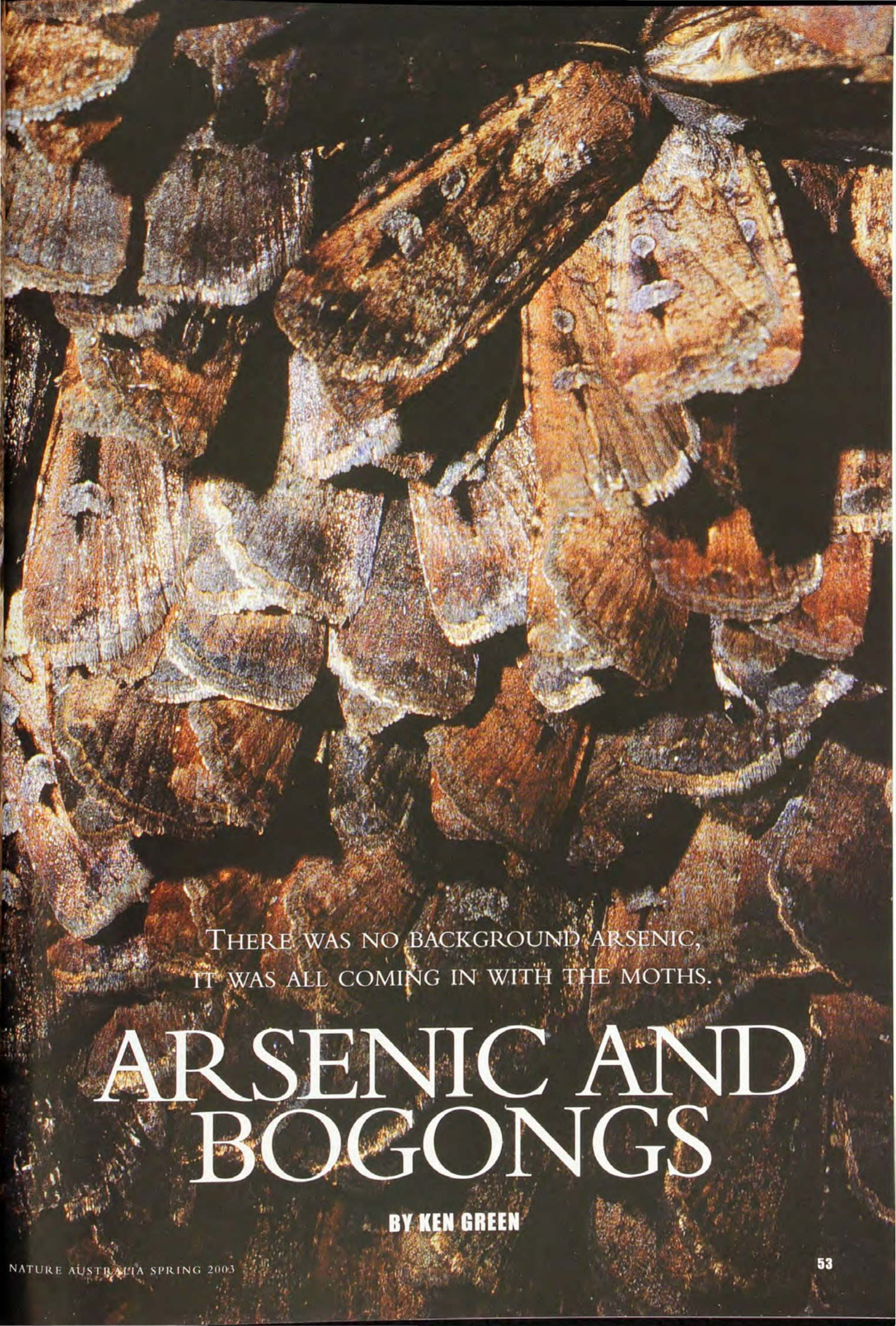
PROFESSOR JON ALTMAN IS DIRECTOR OF THE CENTRE FOR ABORIGINAL ECONOMIC POLICY RESEARCH AT THE AUSTRALIAN NATIONAL UNIVERSITY. HE HAS A DISCIPLINARY BACKGROUND IN ECONOMICS AND ANTHROPOLOGY, AND HIS RESEARCH INTERESTS INCLUDE THE ROLE OF CUSTOMARY PRACTICES AS A SUSTAINABLE COMPONENT OF MODERN INDIGENOUS HYBRID ECONOMIES IN NORTHERN AUSTRALIA. TONY GRIFFITHS AND PETER WHITEHEAD WORK AT THE ARC KEY CENTRE FOR TROPICAL WILDLIFE MANAGEMENT AT THE NORTHERN TERRITORY UNIVERSITY. BOTH ARE WILDLIFE BIOLOGISTS WITH AN INTEREST IN MANAGEMENT OF WILDLIFE HABITATS AND POPULATIONS SUBJECT TO HARVEST.

TONY GRIFFITHS

Aboriginal children from central Arnhem Land whose lives and experience of their homelands will be changed by the arrival of the Cane Toad. The relatively few toads encountered in the advance are presently a source of interest and some amusement, but the full effects have yet to be felt.

GLEN CUTHRUTHERS

Aestivating Bogong Moths are sensitive to light and line up with their heads barred beneath the wings of the moth in front, resulting in a tiling pattern on the rock face.



There was no background arsenic, it was all coming in with the moths.

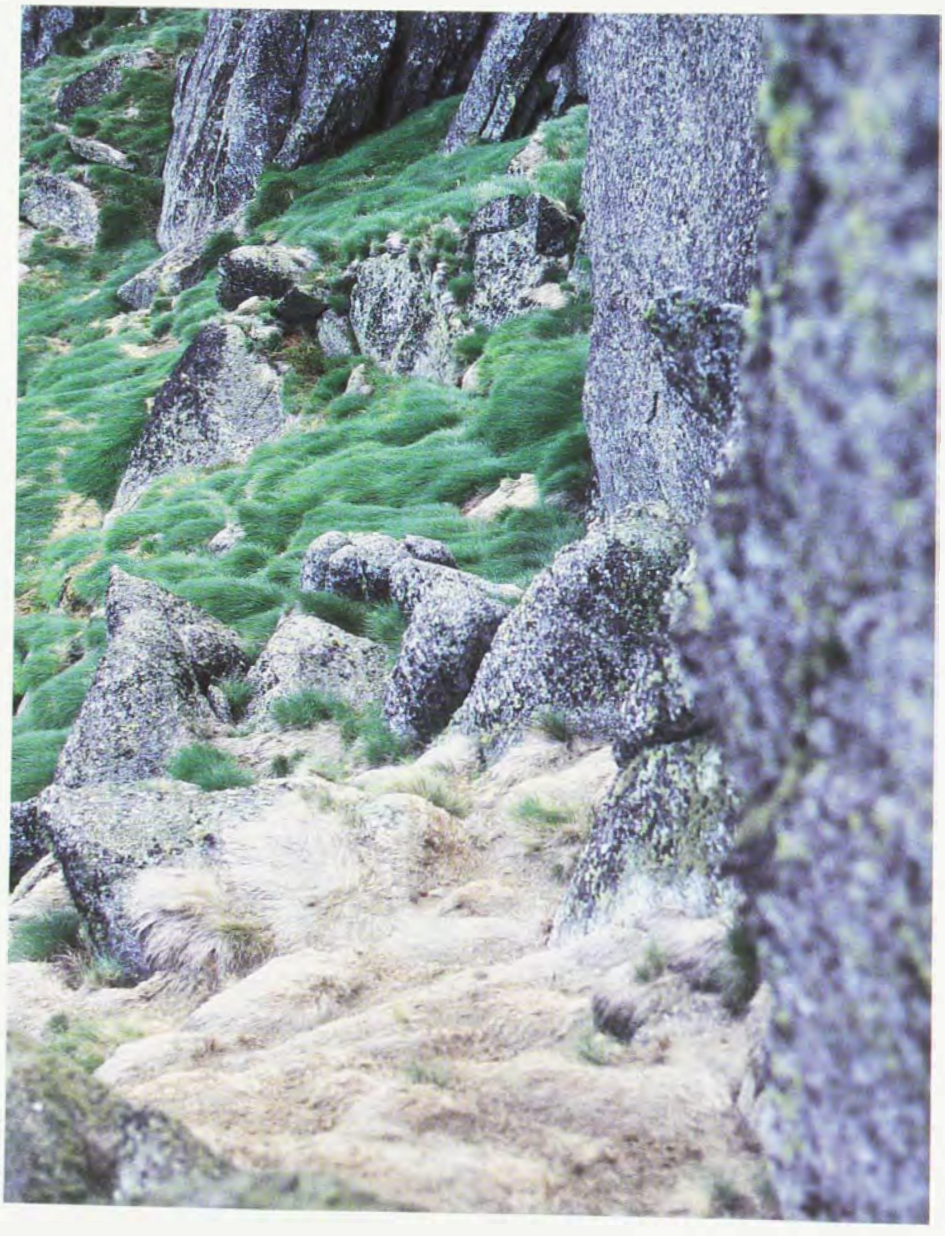
ARSENIC AND BOGONGS

BY KEN GREEN

THERE'S BEEN A BOOK AND a television documentary on Bogong Moths, but they made their first real splash to a worldwide audience of a billion or more when they dropped in on the opening ceremony of the Sydney Olympic Games. Although they had made the news in previous years by invading Parliament House, this was the big time!

I had just returned from a conference in Switzerland, and had not even made it back to the office in Jindabyne, when SOCOG called. Could this be my last-minute invitation to join the synchronised swimming team? I had missed the Olympic coverage up until then, save for a few snatched viewings at various airport lounges, and so was unaware of the moth problem. The question from SOCOG was simple: how do you stop the moths coming to the brightly lit Olympic Stadium? My tongue-in-cheek response, "Have you thought of postponing the Olympics?", was quickly brushed aside. What could *not* be brushed aside was the migrating horde of Bogong Moths whose ancestors had been migrating at about this time of year for millennia. We decided the best solution was to shut the lights off after the evening events so the moths would continue on their way for the rest of the night. The moths can fly up to 300 kilometres in a night, so even half a night should see them well on their way.

The world soon forgot about Bogong Moths, but only temporarily. In October the following year they were back in the news, this time as carriers of arsenic: "Havoc in the air as mischief flies south for summer", as *The Sydney Morning Herald* put it.



KEN GREEN

FOR THE PAST 25 YEARS, I HAD BEEN taking a passing interest in Bogong Moths (*Agrotis infusa*). There seemed to be little more that could be said about them. Ian Common (CSIRO), in his work in the early 1950s at Mt Gingera near Canberra, had documented their basic biology, and their annual migration and aestivation (a summer dormancy similar to winter hibernation). Later Rob Blakers, an Honours student at the Australian National University (ANU), expanded studies to the Snowy Mountains. Josephine Flood had written *The moth hunters* about the Aboriginal prehistory and their annual treks to the mountains to feed on the moths. My interest in the moths was also as a food source, but for the many animals, native and feral, that today feed on them

Dead grass littered with the remains of Bogong Moths rang immediate alarm bells.

During summer the moths rely on the cool, dark spaces found among boulders on the rocky summits.

everything from Foxes to fishes, ravens to robins, and skinks to small mammals, including the endangered Mountain Pygmy-possum (*Burramys parvus*). I was also keeping tabs on how moth numbers varied from year to year by revisiting the same aestivating moth site at South Ramshead, south-west of Mt Kosciuszko, that I first visited in 1980.

This is what I was doing in January 2001 when I came across swathes of freshly killed grass, confined to the area where unusually heavy November rains had washed moth debris out from among the rocks and down the grassy slope. A metre or so on either side of the outwash, the grass was alive and vibrant green. Bogong Moths were obviously the key to the problem.

I sent moths off to be analysed for organic herbicide residues but the results came back negative. In the meantime, I contacted Stuart Johnston (ANU), who had earlier documented the lethal effects on alpine plants of the zinc from galvanised wire used to stabilise mulch during the revegetation of the mountains in the 1950s and '60s. He told me to collect soil samples from inside the cave, outside where the outwash had flowed, and just a metre or so to the side where the grass was still alive. When he analysed the samples, he found arsenic in the soils from the caves and under the dead grass, but not in the soil from under the live grass. Now that we knew what to look for, we went back together and sampled further soils and the live and dead grass, and of course the moths themselves. Bingo! Arsenic was right through the chain from moth to soil to grass.

I began ringing around. Who could be using arsenic sprays in this day and

age? The major use of arsenic, I found, is still in agriculture in various forms including monosodium methylarsonate (MSMA). To my surprise, I found that there are five MSMA herbicide sprays still licensed for use in agriculture in New South Wales, but their current use is so limited that they didn't appear to be the source. At this stage I was thinking that the arsenic appearance was a one-off.

I was also interested in the place of Bogong Moths in the food chain. Could the arsenic have also travelled that route? Over the years, Linda Broome (National Parks & Wildlife Service) had collected droppings of the Mountain Pygmy-possum for dietary analysis and there had been an unsettling decrease in possum numbers that summer. We subsampled the droppings and sent them off to pathology for analysis. This wasn't a one-off case: there was arsenic present in samples from every year! To check whether it was right through the food chain and to try and set some sort of background level, I sampled three further small mammal species from the area: another omnivore (Bush Rat, *Rattus fuscipes*) whose numbers had also decreased, an insectivore (Dusky Antechinus, *Antechinus swainsonii*) whose population had crashed, and a herbivore (Broad-toothed Rat, *Mastacomys fuscus*). The first two had arsenic in their droppings, while the last (the herbivore) had effectively none. In other words, there was no background arsenic; it was all coming in with the moths.

But were the animals excreting all the arsenic, or were they accumulating some in their tissues? I asked a pathologist whether the amount of arsenic accumulated in the tissues could be determined from blood samples. He said yes, and that he'd need only five millilitres of blood to test for it. Still, for a 40-gram mammal, this was plainly impossible. Foxes, on the other hand, were a bigger, better possibility, because up to 70 per cent of their summer diet near Mt Kosciuszko is composed of Bogong Moths. Unfortunately, the Fox-baiting we had done over the previous winter to protect the Mountain Pygmy-possum had been too effective and no Foxes were to be seen.

Bogong Moth

Agrotis infusa

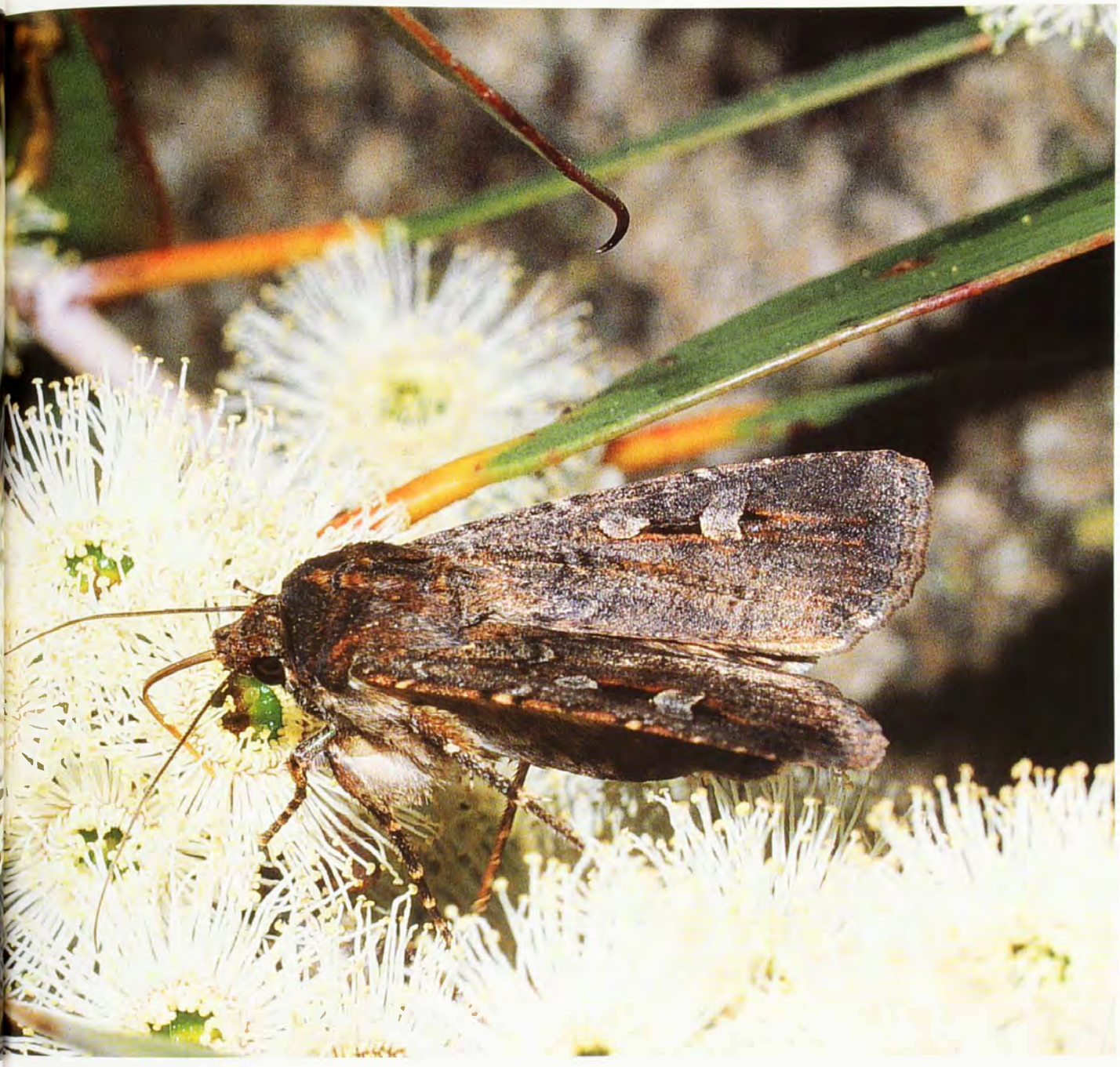
Classification
Order Lepidoptera, family Noctuidae.

Identification
Small brown moth, 2.5 cm long with 4-cm wingspan, 0.3 g.

Distribution
Most important breeding grounds are areas of self-mulching soils (grey, cracking clays) from southern Qld through western NSW to Vic. Summer aestivation sites range from Mt Gingera (ACT) through Snowy Mountains and Victorian Alps to Grampians.

Biology
The moths migrate *en masse* from larval sites to the mountains in spring where they undergo gregarious aestivation in rock crevices and caves. Become sexually mature after the summer's aestivation and their return to the plains. Here each female lays about 2,000 eggs. Adults live for up to 9 months. Larvae (cutworms) feed on annual dicotyledons. Adults feed on nectar on their migratory flights but do not feed once aestivation commences, although they will drink water.

TWO QUESTIONS REMAINED: HOW geographically widespread was the effect of the arsenic, and where was it coming from? It was getting late in the season and the moths were emigrating, but I managed to get moths and soil samples from a number of sites in the Snowy Mountains and Mt Gingera, and moths from Mt Hotham and Mt Buffalo in Victoria. While these were being analysed I walked the high tops examining every large rocky protuberance finding widespread evidence of moths and large areas of dead grass. Over two summers I collected samples in New South Wales from Mt Tingaringy (the summit of which is in Victo-



Bogong Moths feed on the way to the mountains but once there they survive the summer on their fat reserves.

ria) through the Snowy Mountains (including the summit of Mt Kosciuszko), the Bogong Peaks and outliers such as Mt Morgan.

The moths require cool moist conditions to get them through a long summer of fasting while they live on the fat that makes up 65 per cent of their dry body weight. There may be more than one generation of moths each year but the spring generation must migrate to the mountains because their annual food plants are not available during summer for the larvae to feed on. They fly by night and feed on nectar from eucalypt and other blossoms. Moths that we caught early in the season on Mt Tingaringy had a sweet honey smell (unlike moths that do not feed during aestivation in the caves). The moths may arrive too early to find a way into the traditional high-altitude camps, which might still be choked with snow. They will often then sit it out at lower-altitude sites, where they try to hide from ravens, which patrol the grasslands at this time of the year. The number of moths builds up from September to a maximum in December, with the lower-altitude sites slowly emptying in favour of the higher rocky outcrops and boulder fields. There they cling to the rock walls, heads tucked under the wings of the moths in front like overlapping tiles, in concentrations of up to 17,000 per square metre.

Eventually the moths return to the lowlands to lay their eggs in April–May when the autumn rains bring on new growth, and food is available for their offspring. Even if the moths go back exactly to where they originated, the trouble with locating the source of the arsenic is the large area over which the emigrating moths disperse. The moths favour the grey, cracking, clay soils that extend from the Darling Downs in Queensland, south to Victoria. Would

PETER MARSACK/LOCHMAN TRANSPARENCIES

At only about two centimetres in length, Bogongs are not the large moths that some people think.

it be possible to track down an arsenic source over such an extensive area?

We discussed the possibility that the moths collected the arsenic in nectar on the way to the mountains but this was quickly discounted. Alec Costin, whose studies of Snowy Mountain soils go back over 50 years, agreed that, if the arsenic was of natural origin then, over the thousands of years that moths have been coming to the mountains, the arsenic would have mixed more thoroughly with the soil and would occur away from just the present-day drainage lines from the rocky tops. An agricultural source seemed the most logical answer, particularly as the larval homesite areas have historically been used for grazing and cropping, and the Bogong Moth cutworm larvae have sometimes been considered agricultural pests.

One question was of fundamental importance though. Do Bogong Moths mingle during their migration, or do moths from a particular larval site favour a certain aestivation site? We inadvertently stumbled on the answer in the results that came back for arsenic levels in moths. At the two sites where we had both soil and moth samples (Mt Gingera and South Ramshead), arsenic levels in the soil reflected those found in the moths. Moths from Mt Gingera contained very little or no arsenic and the soil, which was a result of many years' accumulation, also had little or none. South Ramshead, on the other hand, had a high level of arsenic in the year's crop of moths and in the many years' accumulation in the soil. This seemed to indicate that the moths were migrating from particular larval sites to traditional aestivation sites.

Now all we would have to do was backtrack to where the arsenic-loaded moths came from. But easier said than done. The moths could hardly be radio-tracked across their migration route. What we needed was something like a genetic or chemical marker. So, from the last week in July to the end of August in 2001, Stuart Johnston started the laborious job of sampling larvae every 100 kilometres from Goondiwin-

di and Dirranbandi in southern Queensland through New South Wales to Mildura and Echuca in northern Victoria.

Tracking the origin of the arsenic-loaded moths will involve either finding some marker common to both the soil and adult moths, or the adults and larvae. If arsenic is contributing towards the decline of the Mountain Pygmy-possum, we will need to know where the arsenic is coming from. Unfortunately my application for further funding was unsuccessful. So for now I have soil samples sitting underneath my table-tennis table, vials of preserved larvae under my desk, and a freezer at home full of Bogong Moths labelled with the names of mountain tops. I did get a sample of South Ramshead moths from the 2001/2002 season analysed for free at the University of Canberra. Arsenic was still there. Before the early winter snowfalls, I walked up to South Ramshead to find there had been another washout of moth debris; and where it had flowed, the grass had died in a thin strip. So the problem continues. □

FURTHER READING

Common, I.F.B., 1954. A study of the ecology of the adult bogong moth Agrotis infusa *(Boisd.) (Lepidoptera: Noctuidae), with special reference to its behaviour during migration and aestivation.* Aust. J. Zool. *2: 223–263.*

Flood, J.M., 1980. The moth hunters. *Australian Institute of Aboriginal Studies: Canberra.*

Green, K., Broome, L., Heinze, D. & Johnston, S., 2001. Long distance transport of arsenic by migrating Bogong Moths from agricultural lowlands to mountain ecosystems. Vic. Nat. *118: 112–116.*

DR KEN GREEN IS THE ALPINE ECOLOGIST WITH THE NSW NATIONAL PARKS & WILDLIFE SERVICE IN THE SNOWY MOUNTAINS REGION. HIS INTERESTS ARE IN COLD-CLIMATE BIOLOGY, PARTICULARLY THE FAUNA OF ALPINE REGIONS OF THE WORLD.

NICHOLAS BIRKS/WILDLIGHT

Foxes are now the major predator of Bogong Moths in their summer aestivation sites.

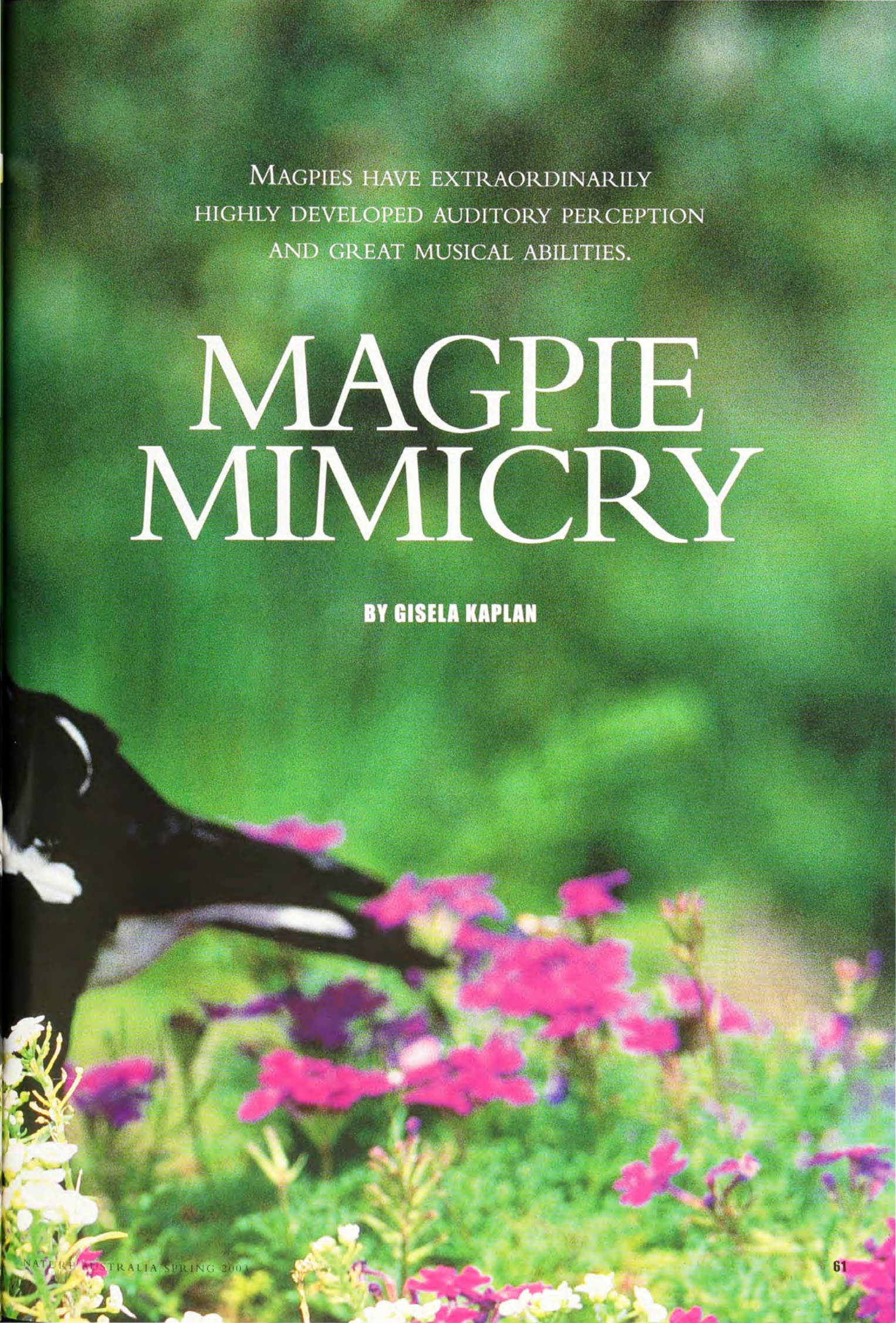
Magpies feed on many things and may be partial even to the occasional flower bud. Such items are also sometimes used as decoration for the nest.

DENNEY CLYNE

MAGPIES HAVE EXTRAORDINARILY HIGHLY DEVELOPED AUDITORY PERCEPTION AND GREAT MUSICAL ABILITIES.

MAGPIE MIMICRY

BY GISELA KAPLAN



LISTEN TO THE GULPING sounds of a currawong, the laughs of a kookaburra, or the deafening screeches of a cockatoo and, even with your eyes closed, you would know you are in Australia. We live in a bird-rich continent and, while some of our birds may be unusual to look at, it is their vocalisations that really set them apart.

Compared to birds from the northern hemisphere, Australian birds are generally much louder, use a far greater range of notes, and have a propensity to mimic other sounds. This last point is not widely known, even though Alec Chisholm claimed in his book *Bird wonders of Australia* (1948) that more than 50 Australian bird species can mimic. At least half of the ones he named have since been confirmed (including bowerbirds, butcherbirds, the Australian Magpie and Noisy Miner). Europe may boast its starlings, and North America its mocking birds but, as far as we know, no continent can quite match Australia's record for bird mimics.

But what do we mean by mimicry? Sounds, such as alarm calls, are easily shared by many bird species, and birds might have overlapping vocal ranges that make it appear as if one species is mimicking another. Some birds may even incorporate the odd small snippet from another bird's song into their own. But this is not what I mean. By mimicry I am referring to sustained, repeated and unmistakable sounds that are recognisably specific to another species rather than the one using them.

Currently, the most famous Australian mimics are the lyrebirds. The Superb Lyrebird (*Menura novaehollandiae*), in particular, has one of the most powerful and spectacular songs of any bird. Not only does the male incorporate many distinct bird calls into his repertoire but he may also include sounds of other animals or even of inanimate objects, and he strings these together in a symphony of sounds designed to win the favours of a female. Female lyrebirds usually do not mimic, although they can sing very well. (It is indeed another unusual quality of many Australian songbirds that both males and females sing, unlike their northern hemisphere counterparts in which singing is often the sole domain of the male.)

At the risk of rocking the boat, I propose that the Superb Lyrebird shares first prize as a mimic with the Australian Magpie (*Gymnorhina tibicen*). Most Australians are so familiar with the warbling tunes of these birds that they hardly notice them. However, my own research has found that Australian Magpies are capable of traversing four octaves with ease, use elegant crescendos and descend in one sweeping line reminiscent of Maria Callas in her best opera performances. Instead of pure notes, their songs (both male and female) have as many rich overtones as the human voice and, like the lyrebirds, Magpies are able to vary the tension of each of the two separate membranes of their vocal organ (the syrinx) to strike two different tunes at the same time.

Magpie song falls into several distinct categories. There are the pre-dawn/nocturnal calls. These tend to be a little more monotonous than, and sometimes different from, the day songs. At this stage, we are not sure whether these calls have any specific functions. Another category is the territorial song.

GISELA KAPLAN

A rare photo (late afternoon) of a Magpie encountering one of its archenemies, the Lace Monitor, which preys on nestlings. Not long after this photo was taken, the Magpie jabbed the lizard in the back of the neck with its beak. On the ground, the Lace Monitor will usually give way to the Magpie, but not necessarily at the Magpie's nest.

NICHOLAS BIRKS/SCHEDIGHT

A Magpie pair (male left, female right) with their young. Nestlings may emit very faint, high-pitched vocalisations.

which includes loud individual calls, carolling of two or more Magpies, and duetting between males and females. Then there are the alarm calls. So far I have classified eight distinctly different types of alarm calls for the Magpie, an unusually large range compared to other avian species. The fourth category is the subsong, which can be thought of as singing to oneself. This belongs to the individual and includes the typical warbling sounds that fill the summer's air. Mimicry is found only within this category.

THE EXCITING PART OF MIMICRY in Australian birds is its widespread use in the wild. We all know that parrots can mimic and learn to speak human words, but these behaviours are usually seen as artefacts of captivity. So far there have only been two reported cases of parrots mimicking in the wild: one of the African Grey Parrot (*Psittacus erithacus*), and another of young Galahs (*Cacatua roseicapilla*) raised by Major Mitchell Cockatoos (*C. leadbeateri*) adopting Major Mitchell vocalisations. However, the liberal use of mimicry by Magpies and other Australian birds is especially interesting because, unlike the mimicry of pet parrots, it is independent of human intervention or training.

To date I have identified 15 types of mimicry used by Magpies throughout Australia, in all States except the Northern Territory. These sounds include the calls of the Red Wattlebird, Noisy Miner, Masked Lapwing, Southern Boobook, Barking Owl, Pied Currawong and Laughing Kookaburra, a Horse neighing, Cat mewing and Dog

barking, to name just the most familiar sounds. Magpies use the new sounds freely and in any part of their song. By contrast, male lyrebirds add each new sound to their repertoire as if it were a bead on a necklace; that is, all sounds remain in a fixed sequence and new sounds get added to make the sequences longer (see "Lyrebirds: Veiled in Secrecy", *Nature Aust*. Winter 1998).

My recordings represent the vocalisations of 22 Magpies, including only two that I hand-raised. One of the hand-raised Magpies even developed the ability to learn human language sounds, words and phrases. As all my samples of Magpie mimicry are derived from different geographical areas, I assume them to be of unrelated individuals with non-overlapping territories. Except for the two hand-raised birds, only one was tame enough to take food directly from humans. All the others were wild but lived near humans and had been in their respective territories for some years.

There have been many stories about Magpie mimicry of human speech. One early myth was that Magpies needed their tongues split in order to talk. Of course, there is no basis to this because the sounds that Magpies (and any birds) make do not involve the tongue. Instead, sound is produced when air from the lungs passes across and vibrates the membranes of the syrinx, which is situated at the bottom of the windpipe (trachea). If the Magpies really did talk after the poor victims had had their tongues cut, it would have been because they had problems feeding themselves and needed to stay close to humans to be fed.

Unlike lyrebird mimicry, that of Magpies is fleeting, sporadic and not tied to time of year or specific occasions and, for this reason, has remained difficult to document. Although a few people had heard that Magpies could mimic, many remained sceptical. Occasionally, this even led to family arguments. In desperation, those wishing to prove their

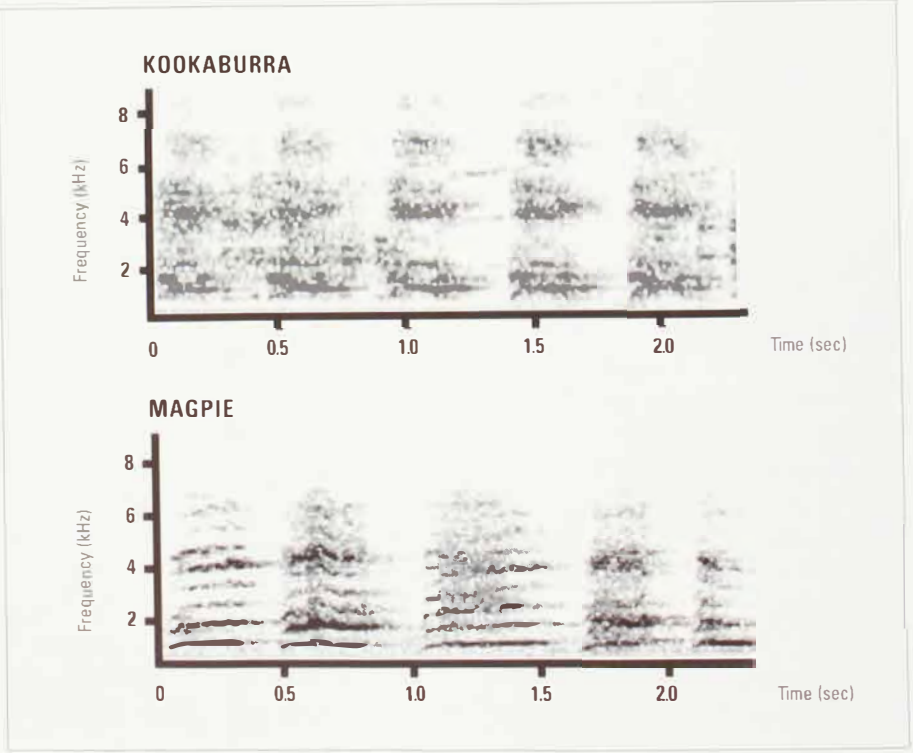
This pair of Magpies is carolling as a form of pair bonding and confirmation of territorial rights. The male, on the right, started the tune and the female joined him a few seconds later. Note the upright position of the head, which is typical for carolling but not for mimicry.

GISELA KAPLAN

Magpies are always alert and aware of their environment. Tilting of the head to the right means that the left eye is facing upwards and scanning the sky.

point went out and made recordings of the mimicking birds and then played them back to their incredulous families. This is how I have been able to collect examples of mimicry from across Australia. Several of these tapes were sent to me for verification and some of the mimicry sections have become part of my own analysis.

BECAUSE THERE ARE SO MANY published samples of lyrebird mimicry, I used lyrebirds as a kind of yardstick for the mimicry performance of the Magpie. However, I am not so sure anymore whether the Magpie should not be the yardstick against which lyrebirds ought to be measured. The most impressive feature of Magpie mimicry is the extremely accurate rendering of the



A sonagram (top) of the laugh of a Laughing Kookaburra, showing frequency (in kilohertz) against time (in seconds). The sonagram at the bottom is of a Magpie mimicking this Kookaburra's call. Note the similarity in structure.

KATHIE ATKINSON

A wide-open beak is typical of carolling. Carolling can be used as a call to announce a food source and, in those cases, the call may just be issued by a single Magpie on its own.

Australian Magpie

Gymnorhina tibicen

Classification

Family Artamidae, subfamily Cracticinae.

Identification

Large (40–44 cm, 330–440 g), black-and-white bird with robust bill (about 52 mm long). Sexes similar, except for female's greyish (as opposed to white) nape (area at back of neck).

Distribution and Habitat

Throughout Aust. and also southern NG. Introduced to NZ. Open eucalypt woodlands, farmlands, urban parks and gardens.

Biology

Sedentary, territorial. Largely insectivorous, but also eats seeds and some meat. Breeds mainly Aug.–Nov. but possibly up to Feb. Usually lays 2–4 eggs in stick nest. Incubation 24 days by female, 30–36 days to fledging. Parents continue to feed fledglings for 3 months. Lifespan 20–25 years.

structure of each sound. By contrast and on close analysis, the Superb Lyrebird glosses over specific sound structures and, before you know it, he is already onto the next bout of sounds. The Magpie is very different—not as quick in the rendering as the lyrebird, but methodical and precise as if each part of the harmonic structure really mattered.

The same attention to detail is evident in all cases of Magpie mimicry, be it performed in the wild or in captivity. In one example, I managed to record the duetting call of a pair of Laughing Kookaburras (*Dacelo novaeguineae*) housed in the cage next to my hand-raised female Magpie. The two kookaburras were recovering from fractures and had not vocalised for weeks. One morning they burst out into a song that lasted just six seconds. And then they were silent again. The next day, I heard (and recorded) the Magpie copying the entire phrase flawlessly, as confirmed by comparison of the two sonagrams. There were no other kookaburras in the region and there had been no opportunity for her to learn these sounds before. Only a few humans have such complete auditory recall. Mozart was one of them. It is certainly a most unusual talent.

As mentioned before, Magpies are capable of mimicking human speech. However, if the bird regards someone as a parent figure (and that is often the case when a Magpie is hand-raised, which now requires a licence), it will never copy that person. Magpies have strict rules about vocalisations. Copying parents is taboo. The reason for this is associated with their need to disperse. Magpies are territorial and usually the offspring are driven out of the parents' territory before the next breeding season begins. Sometimes, they are allowed to stay on as helpers but they eventually disperse to find their own territory. Vocalisations are individual markers and they go with the territory. They are like trademarks and, once they have been registered, they cannot be used by any

other bird, not even their own offspring. Some bits of a song may be borrowed from a neighbour, but usually not more than a quarter.

My female hand-raised Magpie never learned to speak a single word from me, despite me trying daily, patiently and repeatedly for half a year. Instead, another member of the household who spent absolutely no time with the bird (she certainly didn't help with any of the chores associated with it!) infuriatingly had phrases copied instantaneously—things like "Go away", or "I've got dinner for you"... and with a strong Australian accent. The Magpie practised these phrases over and over again through most of the year. I have since learned that all Magpies investigated so far mimic sounds only of permanent inhabitants of their territory. That rules out any visitors (human or otherwise), transient occupants and any occasional sounds.

And now for the most important question: why do Magpies mimic? We do know that they don't use it as an embellishment to increase their chances of mating, as is the case in lyrebirds. For a start, both male and female Magpies mimic and they do so in various circumstances, not just in the presence of the opposite sex.

Could mimicry discourage predators? Magpie predators include the Lace Monitor (*Varanus varius*), which may steal the eggs and young, and most birds of prey, including the Southern Boobook (*Ninox novaeseelandiae*) and Barking Owl (*N. connivens*). Magpies have been known to mimic both these owl species but there is no evidence to date that this has an effect on potential predators. The Channel-billed Cuckoo (*Scythrops novaehollandiae*) is also an enemy of Magpies, parasitising their nests, yet Magpies are not known to mimic their calls.

Maybe mimicry is just a mistake? It has been postulated that large vocal repertoires can't all be hardwired and must depend on some learning. In this view, mimicry might simply be an error in copying the bird's own song. However, this option has to be ruled out for Magpies, because I have heard them deliberately and selectively practising mimicry. The accuracy of the mimicked sounds also shows that Magpies have extraordinarily highly developed auditory perception and great musical abilities. In short, mimicry is no accident.

I believe that Magpies mimic as part of knowing their territory. They have a geographic and a vocal map, and these may belong together. The fact that probably not all Magpies mimic suggests that mimicry is an optional and additional way of knowing. However, whether mimicry is related to social structure (do only some learn to mimic because of their position in the group?) or to cognition (is it only the clever Magpies that can reproduce sounds of other occupants and therefore defend their territory better?) remains to be seen.

So, which is the better mimic—the Superb Lyrebird or the Magpie? As far as showmanship goes, the answer is the lyrebird. But if it's accuracy and preservation of knowledge that you're after, take the Magpie. □

FURTHER READING

Brown, E.D., Farabaugh, S.M. & Veltman, C.J., 1988. Song sharing in a group-living songbird, the Australian magpie, Gymnorhina tibicen, *I. Vocal sharing within and amongst social groups.* Behaviour *104(1–2): 1–28.*

*Kaplan, G., 1999. Song structure and function of mimicry in the Australian magpie (*Gymnorhina tibicen*) compared to the lyrebird (*Menura *spp.).* Internatl J. Comp. Psychol. *12(4): 219–241.*

Kaplan, G., in press. The Australian Magpie. *Natural History Series. University of New South Wales Press: Sydney.*

Sanderson, K. & Crouch, H., 1993. Vocal repertoire of the Australian Magpie Gymnorhina tibicen *in South Australia.* Aust. Bird Watcher *15(4): 162–164.*

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GISELA KAPLAN

A juvenile Magpie is transferred by the author to an outdoor aviary for flight practice after recovering from a wing injury. The bird is complaining noisily about being held, although it is not distressed. Magpies are always good at vocally communicating their emotions.

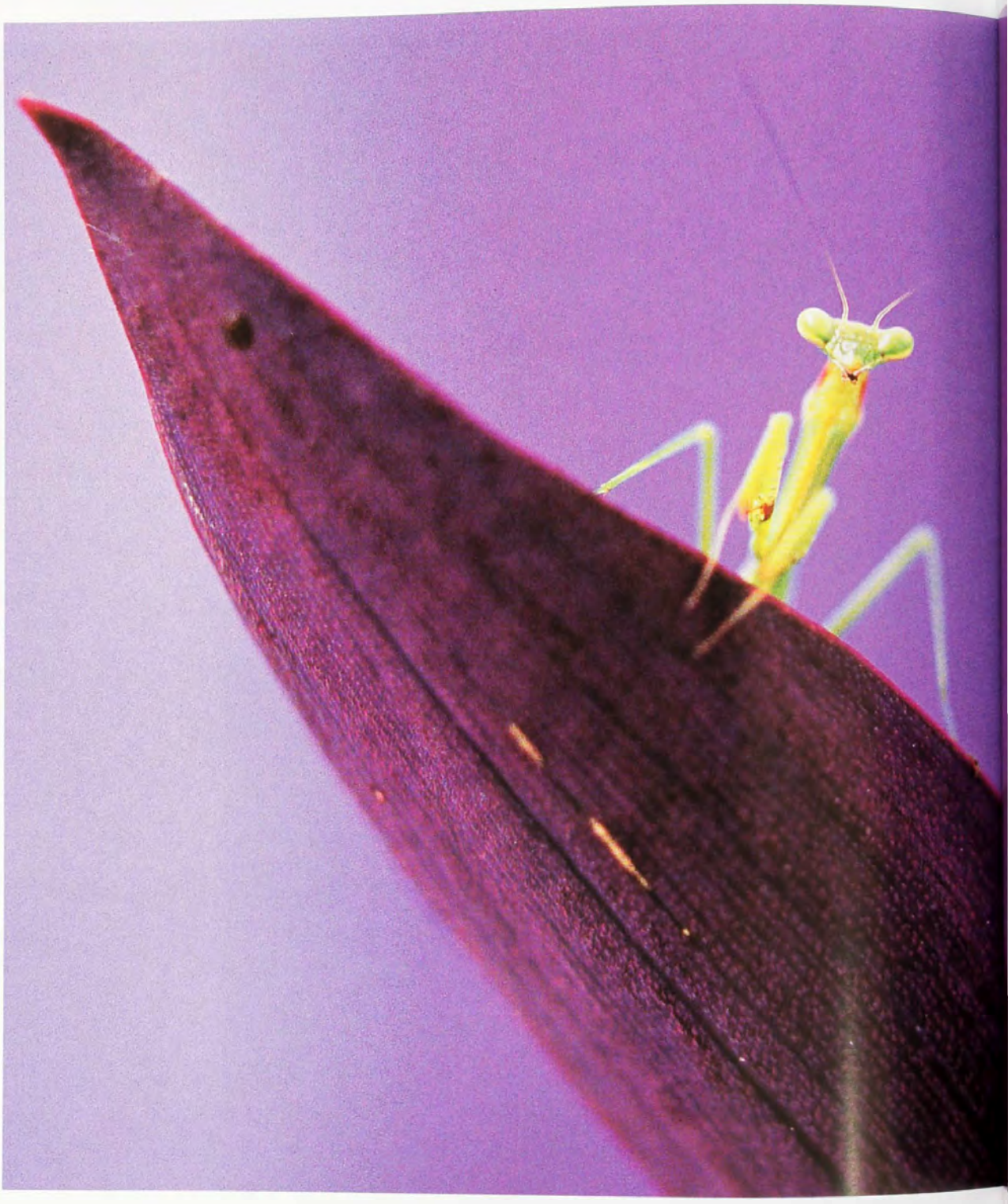
Katydid
(family Tettigoniidae).

Transverse Ladybird (*Coccinella transversalis*).

beautiful nature

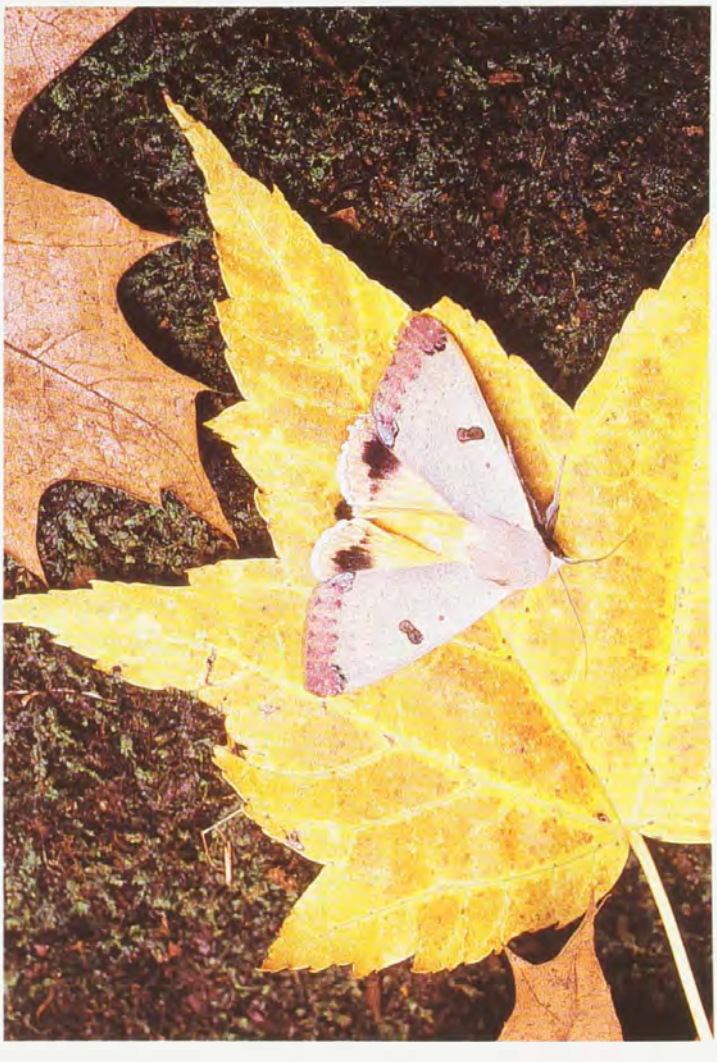
BY BRENT WILSON

NATURE FOCUS



Praying mantid (family Mantidae).

Moth (*Ophiusa* sp).



The creature from the deep lagoon

With some difficulty, she managed to convince the taxi driver to carry the human-sized fish back to the museum in his taxi.

WHEN MARK TWAIN'S obituary was published prematurely, he remarked "the reports of my death are greatly exaggerated". It's a sentiment echoed in the history of the coelacanth, an extraordinary fish believed to have become extinct 70 million years ago.

On 22 December 1938 a coelacanth in its early 30s was trawled from about 70 metres off the East Coast of South Africa. Marjorie Courtenay-Latimer, who was curator of a small museum in the nearby coastal fishing town of East London, visited the docked trawler and recognised the blue fin sticking up among the bodies of sharks and rays as something special.

With some difficulty, she managed to convince the taxi driver who had driven her to the docks to carry the human-sized fish back to the museum in his taxi. Laid out on a museum table, the primitive-looking fish, with its stumpy fins, puppy-dog tail and hard bony scales, just didn't make sense, even though the Chairman of the museum dismissed it as "nothing but a rock cod". This was an ichthyological gaffe equivalent to John Lennon's Aunt Mimi saying to the budding Beatle, "The guitar's alright for a hobby, John, but it won't earn you any money".

However, Marjorie had a friend who could tell the difference between a rock cod and a coelacanth, and she was about to change his life forever. James Leonard Brierley (JLB) Smith was a chemistry lecturer and competent ichthyologist at Rhodes University. Unfortunately he was away on holidays, so Marjorie wrote to him and included a sketch of the fish. When he finally got her letter 11 days later, he immediately sent her a telegram asking her to preserve the skeleton and gills. Alas, even living fossils go off and, because Marjorie had only a litre of formalin to preserve the body, time and summer temperatures took their toll. By the time JLB got her letter, she had arranged for a taxidermist to mount the specimen and discard the rotting internal organs. To JLB this was a tragedy of Shakespearean proportions and fuelled his obsession to find a complete specimen. However when he finally got to see the fish on 16 February 1939, he wrote, "Yes, there was not a shadow of a doubt, scale by scale, bone by bone, fin by fin, it was a true Coelacanth."

Alas, even living fossils go off and time and summer temperatures took their toll.

He named it *Latimeria chalumnae* and it was a hit around the world, not only because it was a "living fossil, virtually unchanged for 400 million years", but because, in those days, fossil coelacanths were thought to be our distant aquatic relatives whose descendants evolved to live on land. The coelacanth's most distinctive features are its stocky paired pectoral and pelvic fins, and it was thought that these evolved into the limbs that carried the first animals onto land. (Currently, lungfishes hold that honour as the closest relatives of the first land animals.) While the real thing is better than a fossil, the evolutionary affinities of the coelacanth are still being debated, and of course nobody really knows why it survived when almost all its relatives became extinct.

The specimen Marjorie had found appears to have come from an elusive population of coelacanths only discovered in South Africa in 2000. For JLB it was to be 14 years of distributing thousands of 'coelacanth wanted' posters before somebody in the Comoros Islands, an archipelago between Madagascar and Mozambique, recognised that the fish in the photograph was what the locals called *gombessa* (meaning taboo, probably because it tasted bad). One or two were caught a year and a *gombessa* had just been fished from the depths. When JLB heard of the find, he was frantic to get to Comoros before history repeated itself. He wept tears of joy onto the second coelacanth as he held it for the first time. It was taken to Grahamstown where, like a human lying in state, it also brought tears to the eyes of the thousands of curious onlookers who filed past, but these were perhaps more from formalin fumes than tears of joy.

JLB never saw a live coelacanth before he died in 1968. However, his wife, also a skilled ichthyologist, wept when, shortly before her death in 1985, the first images of swimming coelacanths were projected onto a wall in her hospital room. While almost 50 years of coelacanth research had focussed on their anatomy, physiology and genetics, scientists could now watch and track living coelacanths from submersibles and with tracking devices. They found that coelacanths live for at least 40 years (possibly over 100), and are nocturnal predators that hunt other fishes and squids. During the day they huddle together in small volcanic caves between 100 and 200

BY SIMON D. POLLARD

JÜRGEN SCHAUER/JAGO-TEAM

A coelacanth (*Latimeria chalumnae*) in its natural environment drifting at around 200 metres depth along the steep lava slopes of the Comoros Islands off Africa's East Coast.

metres below the water surface, where their metallic blue colour and white speckled flecks perfectly camouflage them against the cave walls. Coelacanths often stand on their heads when approached and move as if they are dancing. Since they have a brain the size of a grape, it is unlikely this behaviour is because they are pleased to see visitors. It is more likely that it helps them pick up electrical signals from prey and predators through an electroreceptive organ in the snout. With a jaw-dropping, hinged skull they can increase their gape to grab prey and, although they manage short bursts of speed, for most of the time their metabolism dictates that they move slowly, like gentle residents in a deep-sea rest home.

While fishermen in the Comoros had their *gombessa*, fishermen in Indonesia's northern Sulawesi, 10,000 kilometres away, had their *Raja Laut* or 'King of the Sea'. And in September 1997 Arnaz Mehta Erdmann, on her honeymoon with marine biologist husband Mark Erdmann, spotted one on a cart that was being wheeled through the Manado fish market. Mark recognised it as a coelacanth, but didn't realise that they were only known from the East Coast of Africa. Although JLB got a skin and skeleton from the first specimen, Mark had only photographs of the Indonesian specimen before it became just another fish in a fish market.

Back in the US, the enormous significance of their find was realised, and they returned to Sulawesi where fate was much kinder to them than it had been to JLB, and only ten months later another Indonesian coelacanth was caught. It was named *Latimeria menadoensis* and DNA analysis suggested it had separated from the Comoroan population of coelacanths about five million years ago. Which just goes to show that, although coelacanths would not be out of place at a Devonian dinner party, evolutionary mechanisms are never static...even 70 million years after a premature obituary. □

FURTHER READING

Weinberg, S., 2000. A fish caught in time: the search for the coelacanth. *Fourth Estate Ltd: London.*

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Making faces

Most human facial expressions are displayed and understood cross-culturally and worldwide.

Duchenne de Boulogne taught us a lot about the facial expression of human emotions. Here he poses with one of his patients.

A PICTURE PAINTS A THOUSAND words, but so can a face. Facial expressions reveal many distinct emotions. A face can say it all. It can elicit a loving embrace, request a meeting outside, or warn others to back off. But we can sometimes get it wrong, as with the subtle differences between being bothered or being angry, and interpreting the difference can be important if we wish to avoid a fight. Throw in make-up, or Botox injections, and reading a face can be hard. Is anyone clear on what Michael Jackson is feeling?

Recently I came across an amazing interactive catalogue of human facial expressions. Over 1,000 words identify the 412 discrete emotional concepts, which are arranged into 24 groups. In alphabetical order, these are afraid, angry, bored, bothered, disbelieving, disgusted, excited, fond, happy, hurt, interested, kind, liked, romantic, sad, sneaky, sorry, sure, surprised, thinking, touched, unfriendly, unsure and wanting. The program, called "Mind Reading", was specifically designed by Simon Baron-Cohen (University of Cambridge) to help people with disabilities like autism who find it difficult to read emotional expression and to understand what others are thinking. There is a whole drama course in here, but there's also a lot for the ordinary person, and who doesn't have trouble reading minds these days?

For a laugh, try the romantic group in front of the mirror, and see how effectively you can convince yourself of 12 distinct variations on this theme: attracted, attractive, bewitched, enticed, entrancing, flattering, flirtatious, intimate, passionate, romantic, seduced, seductive. How did humans evolve such an extraordinary display of subtle expressions?

Throw in make-up, or Botox injections, and reading a face can be hard. Is anyone clear on what Michael Jackson is feeling?

Thirteen years after publishing *On the origin of species*, Charles Darwin published *The expression of the emotions in man and animals* (1872). In it he argued that most expressions of human emotion, and the ability to recognise them, are instinctive or inherited, rather than acquired through learning (even people born blind smile and frown). He explained that emotional expression and recognition were essential for the welfare of the species, and that "all the chief expressions exhibited by man are the same throughout the world".

Darwin's synthesis included extraordinary photographs taken by Duchenne de Boulogne—a remarkable French scientist who electrically stimulated the facial muscles of patients in a lunatic asylum in order to reproduce different expressions. Duchenne discovered that combinations of eyebrow movement cause the illusion of mouth and lip movements, and that small changes seem to make a large difference in the expression of different emotions. He could make one half of a face smile and the other half grimace, by gently stimulating particular muscles. Duchenne also studied art and ancient sculpture to assess whether the artists had captured true expression. Today his work is important for surgeons who reconstruct deformed or damaged faces.

Paul Ekman (University of California, San Francisco) followed Duchenne's lead and demonstrated that facial expressions of emotion are determined by a unique combination of particular muscles. He catalogued at least 10,000 configurations, some of which (although fleetingly brief) betray just what we are feeling and whether or not we are telling the truth. No prizes for guessing why intelligence organisations like the FBI are interested in this research. Watch the face of Richard Nixon discussing Watergate or Bill Clinton on the definition of sex and you'll see what the Eagles meant when they sang "You can't hide your lyin' eyes".

BY RICHARD FULLAGAR

It seems that most human facial expressions are displayed and understood cross-culturally and worldwide. This, according to Steven Pinker (Massachusetts Institute of Technology), provides evidence that human brains are not a *tabula rasa* or blank slate to be shaped solely by experience, but that genes play a profound role in shaping human nature. Culture is only possible because we inherited the mental machinery to create and learn it. Most people believe that the 'nature *versus* nurture' debate is a dead issue, and are resigned to the conclusion that we humans develop from a mix of both. But how dead is the issue?

Pinker argues that many people still cling to the idea of a Blank Slate and other related historical concepts, such as the Noble Savage (natural innocence of humans) and the Ghost in the Machine (existence of a human soul). And he points out that these views have combined to misrepresent human nature and cognitive science, often with dire political and social consequences. Think of religion, stem cells and the abortion debate. Cognitive neuroscientists believe that our sense of self is rooted in the complex network of inherited brain systems. However, for those who believe in the existence of a soul or life force, the idea of having genetically determined brains is abhorrent because they think it means we would lose our free will and would be able to abrogate responsibility for our actions (blame it on the genes!). Pinker shows that this logic is wrong.

Still, social scientists rarely admit that human behaviour is determined by the genes. Those who have suggested an inherited genetic basis for IQ, intelligence and other personality traits have been quickly vilified. For example, famous anthropologist Margaret Mead attacked Paul Ekman for supporting the ideas that facial expression had evolved, and that all races had a recent common ancestry. Others called him a fascist and a racist.

The history of anthropology is full of debate on just what determines cultural change. Culture, biology and physical environments seem so intertwined that it remains difficult to define general laws about why different societies have developed, sometimes into hunters, gatherers, farmers and industrial citizens. Psychological make-up may be a factor and there is still argument about whether all cultural groups share the same full gamut of emotions and facial expressions. It is difficult to track archaeological expressions of emotion far back in time, although we could examine ancient portraits and sculptures. Darwin and Duchenne did (and found that the Greek sculptors could not always crack a true expression). The earliest portraits I know of are from the Upper Palaeolithic of France: five young faces etched in stone, two of which bear the unmistakeable down-turned mouth of sadness. But even with a core group of shared human emotions and expressions, how can we sometimes get it so wrong and totally misread a face? Perhaps some of the 412 emotional feelings are used so infrequently that we forget. Time to check the "Mind Reading" program again. □

FURTHER READING

Baren-Cohen, S., 2003. Mind reading: an interactive guide to emotions. *DVD & CD-ROM set. Human Emotions Ltd for University of Cambridge,* www.human-emotions.com.

Duchenne de Boulogne, G.-B., 1990. The mechanism of human facial expression. *Edited and translated by R.A. Cuthbertson. First published 1862. Cambridge University Press: Cambridge.*

Duhard, J.-P., 1993. Upper Palaeolithic figures as a reflection of human morphology and social organization. Antiquity *67: 83-91.*

Ekman, P., 2003. Emotions revealed. *Weidenfeld & Nicholson: UK.*

Pinker, S., 2002. The blank slate: the modern denial of human nature. *Allan Lane/Penguin: London.*

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PHOTOS FROM G.-B. DUCHENNE DE BOULOGNE. FIRST PUBL. 1862. COURTESY ANDREW C. CUTHBERTSON

Electrostimulation of the superficial muscles of the forehead and neck produce the expressions of fright (top) and, combined with an open mouth, terror.

Stored in the rings

Tree rings of the Wollemi Pine tell us about the life of one 270-year-old tree that crashed to the canyon floor some 20 years ago.

JAIME PLAZA/UBC SYDNEY

To understand the real story of the life of the Wollemi Pine, you need to read its rings.

THE STORY OF THE WOLLEMI Pine has been told in many different ways. Its discovery in 1994 was announced in one overseas tabloid under the headline "Jurassic Bark". Six years later Sydney journalist James Woodford wrote a racy book about, as he put it, "a living fossil from the age of the dinosaurs". Meanwhile, a steady stream of papers on its evolution, genetics, diseases and horticulture have offered variations to the basic Wollemi Pine story (with barely a nod to Spielberg or the terrible lizards). But for a fresh perspective, you need to 'read the rings'—tree rings, that is—dark circles in the heartwood of most trees caused by seasonal growth spurts.

The tree rings of the Wollemi Pine (*Wollemia nobilis*) are particularly easy to read—so much so that John Banks and Cris Brack from the Australian National University have been able to give a first-person perspective of the life of a 270-year-old tree that crashed to the canyon floor some 20 years ago. The details of the story come from a trunk section that was rescued from the still-secret site in the Wollemi National Park north of Sydney.

Wollemi Pine tree rings are very distinct, indicating strong seasonal growth. At the end of each growing season, the wood cells that are produced are narrower and have thicker walls, creating a darker band in the trunk cross-section. Overriding this annual pattern is an approximately 35-year cycle that may be related to El Niño events, with growth pulses reflecting the good years.

The blemishes and cracks in the wood have their own stories to tell. Banks and Brack blame a pocket of rot from the tree's 16th decade on a falling rock. The rock may have gouged the bark, letting in bacteria and fungi to infect the woody tissue. Fires were rare in the canyon but soon after the rock fall a bushfire burnt the outer layer of the thick bubbly bark. The tree survived the fire, but not long after its 200th birthday a violent windstorm bent the tree so far over that its insides fractured. This 'wind shake' was permanently recorded as a large semi-circular crack now inside the trunk. However, the storm had its benefits as well, with all the nearby siblings apparently torn from the ground—for in the twilight of its life this Wollemi Pine had an amazing growth spurt unhampered by competition.

Another of Banks's colleagues, expert electron microscopist Roger Heady, has had an even more in-depth look at the wood. The Wollemi Pine shares different microscopic features of its wood-cell anatomy with *Agathis* (Kauri Pine) and *Araucaria* (Hoop Pine, Bunya Pine etc.), yet differs from them in other ways. These features include resin plugs, pit rows in a staggered configuration, and warty structures whose functions are unknown, and can only be observed by the high resolving power of electron microscopy. Unfortunately the wood ultrastructure so far tells us nothing about which of the two genera is the Wollemi Pine's closest relative, currently thought to be *Agathis* based on DNA evidence.

Farther north, in the rainforests near the border of New South Wales and Queensland, wood anatomy has provided the critical piece in a botanical identification puzzle. Prickly juvenile leaves of an unknown species were discovered in the Nightcap Range in the 1950s and sent to the Queensland Herbarium in Brisbane, where they were tentatively assigned to the Australasian rainforest

BY TIM ENTWISLE

family Corynocarpaceae.

Forty years later, Robert Kooyman, then a forest ecologist with State Forests of New South Wales, rediscovered these unusual juvenile leaves sprouting from the base of a large tree trunk but again could not confidently identify them. Some years later, while surveying rare or threatened plant species in Nightcap National Park, he came across these mystery trees again but this time noticed a patch of exposed dead wood on the trunk. The wood-grain was coarse and flecked with dark brown spots.

Any forester, wood-turner or carpenter will tell you that all woods are different. At the most basic level, softwood, from conifers, is usually homogeneous in structure while hardwood, from flowering plants, is more variable but often strong, dense and heavy (balsawood being a notable exception). One distinctive wood pattern is that of the banksia and protea family (Proteaceae), characterised by an abundance of large rays. Rays are narrow slivers of tissue that radiate through the wood layer of a tree. In the Proteaceae, some of the ray cells are larger than others, and appear as dark flecks in a cross-section. This is what Robert Kooyman saw in the mysterious damaged trunk from the Nightcap Range.

Kooyman collected foliage, wood and rat-gnawed fruits from the tree and sent them to the Royal Botanic Gardens and Domain Trust in Sydney, where it was confirmed as a new species, the Nightcap Oak (*Eidothea hardeniana*), belonging to a recently described genus from northern Queensland. The two known species of *Eidothea* appear to be relics of a Gondwanan lineage that has barely survived in the rainforests of eastern Australia.

Eidothea has another intriguing feature—both species produce a hard 'woody' nut with a very distinctive cross-section, a bit like a walnut. A specialist in fossil botany, Andrew Rosefeld, now at the Tasmanian Herbarium, had seen an identical nut illustrated in a book published in 1860. That nut was from a 20-million-year-old fossil found in the Victorian goldfields by the State Government Botanist of the day, Baron Ferdinand von Mueller. Mueller misidentified the fossils as belonging to something in the olive family, but then he didn't have access to its wood.

It might seem perfectly reasonable for fossil evidence to be incomplete—who would expect to find well-preserved wood samples attached to leaves, fruits or nuts in the same fossil? But with a living tree, all the critical pieces are there, at some time. Unfortunately, most botanical samples collected and kept in herbaria include leaves and, if available, flowers and fruits, but not wood. In the case of the Nightcap Oak, this useful piece of evidence was lacking. For the Wollemi Pine, the wood hasn't yet told us anything we didn't already know about its classification, but it has revealed the details of everyday life for a tree and a forest that were totally unknown to us just ten years ago. □

KATHIE ATKINSON

A young Wollemi Pine grown 'in captivity' at the Royal Botanic Gardens Sydney.

FURTHER READING

Banks, J.G. & Brack, C.L., 2001. The Wollemi Pine: a captured history. *Wollemi Pine Recovery Team brochure. Royal Botanic Gardens Sydney: Sydney.*

Heady, R.D., Banks, J.G. & Evans, P.D., 2002. Wood anatomy of Wollemi Pine (Wollemia nobilis, *Araucariaceae).* IAWA Journal *23: 339–357.*

Weston, P.H. & Kooyman, R.M., 2002. Systematics of Eidothea *(Proteaceae), with the description of a new species,* E. hardeniana, *from the Nightcap Range, north-eastern New South Wales.* Telopea *9: 821–832.*

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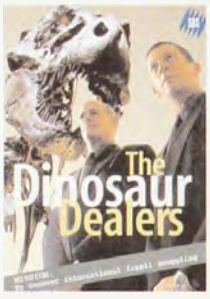
reviews



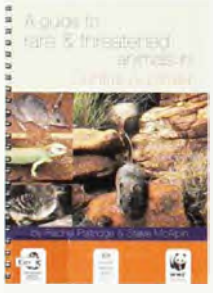
The Dinosaur Dealers: Mission, to Uncover International Fossil Smuggling

By John Long. Allen & Unwin, NSW, 2002, 220 pp. $29.95 rrp.

THE DINOSAUR DEALERS OPENS WITH THE SHOCKING THEFT of rare dinosaur footprints from a beach near Broome, Western Australia. Not only were these footprints scientifically important, being the only evidence of a stegosaur trackway in the world and the only evidence of the group in Australia, but they were also sacred to the Aboriginal people of the area. To try and recover the footprints, John Long, vertebrate palaeontologist at the Western Australian Museum, Perth, hooked up with Sergeant Steve Rogers, a Wyoming lawman specialising in fossil crimes such as this one. Their search for the dinosaur footprints takes them across the globe, and tales of their travels (often dangerous) are interspersed with descriptions of other fossil thefts around the world. Long and Rogers make a great team, although John nearly blows his cover at the Arizona Mineral and Fossil Show in Tucson, when he insists on correcting a dealer's identification of a fossil amphibian as a fish (the latter being Long's speciality)!

Long's intention is to draw attention to the scale of these fossil crimes in the hope that Western Australian (and indeed all Australian) legislators will act to better protect fossil localities. Hopefully this well-written and entertaining book and the accompanying documentary screened last year on SBS, will make all Australians aware of this ever-increasing problem.

—ZERINA JOHANSON
AUSTRALIAN MUSEUM



A Guide to Rare & Threatened Animals in Central Australia

By Rachel Paltridge and Steve McAlpin. WWF Australia, Sydney, 2002, 87 pp. $22.00 rrp.

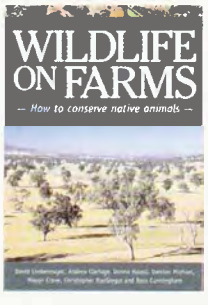
CENTRAL AUSTRALIA IS SPARSELY POPULATED but it has witnessed many of the mammal extinctions for which Australia is infamous. Most mammals in the range of 5–35 kilograms that were present in the mid 1800s have disappeared from the region; nine are extinct.

This guide catalogues the causes of decline and has practical advice on management options for protecting the remaining fauna from five major threats—predators, Rabbits, other feral herbivores, fire and weeds. A section explains how community groups and landholders can access funds for conservation projects.

For 24 threatened mammals, birds and reptiles, information on description, behaviour, habitat preference, how to find them, and conservation status, is given. Each is illustrated in colour and there are maps of past and present distribution, and photos of tracks and scats. Fourteen common species of mammals, reptiles and a frog are also illustrated. The authors' extensive field experiences furnish many hints for locating and identifying elusive (and often nocturnal) fauna.

Also included are a directory of useful contacts, a list of field guides, a checklist of central Australian fauna, Indigenous names for animals, and an index of scientific and common names. I recommend this compact guide to all naturalists and land managers concerned about the central Australian fauna.

—ELIZABETH CAMERON
AUSTRALIAN MUSEUM



Wildlife on Farms: How to Conserve Native Animals

By David Lindenmayer, Andrew Claridge, Donna Hazell, Damian Michael, Mason Crane, Christopher MacGregor and Ross Cunningham. CSIRO Publishing, Collingwood, Vic., 2003, 118 pp. $29.95 rrp.

SOME BOOKS ABOUT ATTRACTING WILDLIFE into gardens or farms are full of wishful thinking, but the ecologists who created this CSIRO book have kept it realistic. They admit that nest boxes may benefit unwanted starlings, that frogs don't always indicate environmental health, and that native Noisy Miners pose a problem, even suggesting "a strong case for noisy miner control on many farms". They recommend keeping fish *out* of some farm dams to help frogs, and concede that Koalas sometimes kill trees.

Much of the book consists of selected species and their needs, for example Brown Treecreepers and their reliance on fallen timber. All the examples are vertebrates from south-eastern Australia—the book's main focus—although most of the concepts are applicable everywhere. This small book does not cover habitat restoration in detail, instead recommending the Bushcare report *Revegetation and wildlife*, by A. Bennett and colleagues. But it is crammed with practical suggestions for the thoughtful farmer wanting to know why all his small birds and frogs have gone.

—TIM LOW

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

These books give effect to the aims of the Society, namely to study and conserve the native fauna of Australia.

Managing the Grey-headed Flying-fox as a Threatened Species in NSW

Edited by Peggy Eby and Daniel Lunney 2002

$25

Proceedings of a forum held to debate changes to management following its listing as a threatened species. This volume explores the management controversies surrounding fruit crops and camps, and highlights the need for conservation and restorative management.

A Symposium on the Dingo

Edited by C.R. Dickman & Daniel Lunney 2001

$20

This book publishes the outcome of a successful conference that debated whether the dingo qualifies as a threatened species and, if it does, then what practical issues does this raise in the control of wild dogs.

A Zoological Revolution: using native fauna to assist in its own survival

Edited by Daniel Lunney & C.R Dickman 2002

$25 (Published with the Australian Museum)

Proceedings of a forum on a revolutionary approach to conservation by using wildlife to ensure it maintains a value in our society. This special issue explores the scope and potential value in the concept as well as its ethical and social implications

A Clash of Paradigms: Community and Research-based Conservation

Edited by Daniel Lunney, C.R Dickman & Shelley Burgin 2002

$15

Proceedings of forum that debated whether there is a fundamental difference in the way that researchers and community groups approach the conservation of our fauna. The lively debate that emerged during the forum is a key part of the book.

Conserving Marine Environments: out of sight; out of mind

Edited by Pat Hutchings and Daniel Lunney 2003

$15 (in press, available in September 2003.)

The rationale for the RZS hosting a marine forum reflects not only Australia's island status and our vast oceanic surroundings, but the work of a small, dedicated band of researchers who have brought so many of the current issues in marine and coastal environments to the surface for public comment. This book is a high water mark in capturing the range of skills that are needed to see and conserve our marine environments.

Urban Wildlife

Edited by Daniel Lunney and Shelley Burgin 2003

$20 (in press, available October 2003)

This book captures the diversity of ideas from the most popular forum the RZS has ever held. Its appeal reflects the fact that Australia is an urbanised society, thus wildlife to most Australians is urban wildlife. This book acknowledges that urban wildlife is a subject on its own, and considers fauna and fauna habitat as a special case in conservation.

These books are available from the Australian Museum bookshop or directly from the Society at www.rzsnsw.org.au or 02 9969 7336. Postage will be added. Alternatively, you can order now by sending a list of the book(s), adding $7.50 for postage within Australia (for o/s orders, see website) and send to Royal Zoological Society of NSW, PO Box 20, Mosman NSW 2088, or fax 02 9969 7336, with either a cheque or credit card (bankcard, visa or mastercard only) details (1. name on card 2. card no, 3, expiry date, 4. signature, 5. date signed).

Prehistoric Mammals of Australia and New Guinea: One Hundred Million Years of Evolution

By John Long, Michael Archer, Timothy Flannery and Suzanne Hand. University of New South Wales Press, Sydney, NSW, 2002, 244 pp. $69.95 rrp.

THIS BOOK SUCCEEDS IN THE DOUBLE PURPOSE of providing a comprehensive reference on Australian fossil mammals, useful for the specialist, and of making available to the general public an impressive heritage of past biodiversity. The first 37 pages consist of introductory and general chapters, usefully summarising the geological and anatomical concepts necessary to fully appreciate the bulk of the book, which is organised as a 'field guide' of fossil mammals. The general and technical data offered about each of the covered mammalian genera are supplemented by competent colour reconstructions by artist and palaeontologist Anne Musser, illustrating the life appearance of 60 selected species. The book is clear and well organised, which, combined with the attractive layout and illustrations, make it a successful mixture between an academic volume and a 'coffee-table' book. With all the effort done by authors and designers to make the book accessible to a general audience, it seems regrettable that the cover price is high enough to discourage many potential readers. Publishers might have more faith in the appeal of a subject like fossil mammals, which, if not as popular as the dinosaurs, is attractive enough to allow larger initial print orders and more affordable prices.

—MAURICIO ANTÓN
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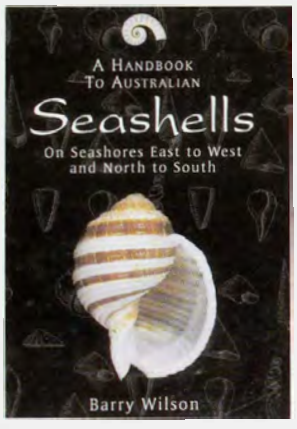
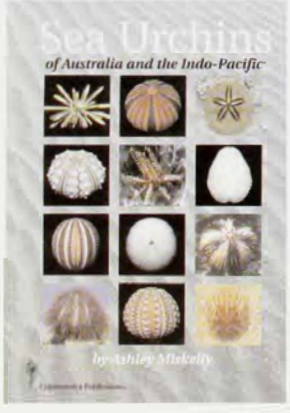


A Handbook to Australian Seashells on Seashores East to West and North to South

By Barry Wilson. Reed New Holland, Sydney, 2002, 185 pp. $29.95 rrp.

THIS BOOK CONSISTS BASICALLY OF COLOUR PHOTOS accompanied by short descriptive paragraphs. The colour photos, although small, are excellent, but with so few species covered, this book is no more than a tantalising introduction to the marine molluscs of Australia. The author tells us that Australia is blessed with tens of thousands of different kinds of shells, of which about 350 are illustrated. With such a small selection of the species that a collector is likely to find, one is left to wonder just what the purpose of a book like this is. To the avid collector who wants to make their collection as complete as possible, the book will be irritatingly shallow, and to the amateur naturalist this is definitely a 'shell' book with little information on the living animals. Although scientific names are present, common names are given priority. Many of the common names are made up for the book, so are clearly not common in the sense of being in common use. The author discusses this in the book but fails to see the paradox of using non-common 'common' names. Why is it that book publishers accept that gardeners are clever enough to use *Geranium* and *Callistemon*, while other naturalists are deemed incapable of handling words like *Tellina* and *Strombus*?

—BILL RUDMAN
AUSTRALIAN MUSEUM



Sea Urchins of Australia and the Indo-Pacific

By Ashley Miskelly. Capricornica Publications, Sydney, 2002, 180 pp. $33.00 rrp.

ASHLEY MISKELLY HAS HAD A LIFELONG INTEREST IN SEA URCHINS and his passion for the subject is evident in this attractive and thorough book. The book describes and illustrates 86 species of urchins that are found from the intertidal to depths of about 2,000 metres. For each species there is a description of the distribution, the appearance of the test and spines, and comments on habitat and diet. Most species are illustrated by a picture of the live animal and several views of the test without spines. A comprehensive glossary is included with well-labelled photographs to assist the reader with technical terms. The introduction gives an overview to the classification of sea urchins (Echinoidea).

It would have been useful if the author had included more information for identifying similar species with overlapping distributions. He does this for *Parasalenia polylii* and *P. gratiosa*, but not for others like *Heliocidaris erythrogramma* and *H. tuberculata*. This minor point aside, the book is a worthwhile addition to the library of anybody interested in our marine fauna, be they divers, beachcombers or students of invertebrate zoology.

—PENNY BERENTS
AUSTRALIAN MUSEUM

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.

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q&a

RON & VALERIE TAYLOR/NATURE FOCUS

A parrotfish takes a nap in its mucous sleeping bag.

Fish Naps

Q: *Do fishes sleep?*

—David Webster
Townsville, Qld

A: This is a complex question with no simple answer. Deciding if a fish is asleep depends on many factors, least of which is the definition of sleep.

In humans, the transition to sleep (or even closing the eyes) involves specific changes in the pattern of brain waves, in the area of the brain called the neocortex. Fishes don't have the same degree of neocortical development as mammals and thus don't display these brain-wave patterns associated with sleep. So, as far as brain-wave patterns go, fishes don't sleep.

If, however, you define sleep as a combination of a reduced metabolic rate, slowed physical activity, lowered response to stimuli and the assumption of a resting posture, then many fishes do sleep. Perhaps the best-known 'sleepers' are the parrotfishes (family Scaridae). Many parrotfishes find a suitable spot on the seafloor and secrete a mucous envelope in which they spend the night. Such fish normally swim away from a diver by day, but can easily be approached and even gently handled at night.

Many fishes, however, seem not to sleep. Pelagic (oceanic) species such as tunas and some sharks never stop swimming. One idea is that, during sleep, sensory information (predominantly visual) gathered during the day is processed to form memories. Fishes that swim constantly in blue oceanic waters receive little 'unusual' visual input and require less 'memory-processing time' and thus need no sleep. This is supported by studies on several species of blind fishes that live in caves. These sightless fishes do not sleep.

Having said all that, though, I did enjoy the simple answer of a young neighbour who told me with confidence that fish can't sleep because they don't have eyelids.

—Mark McGrouther
Australian Museum

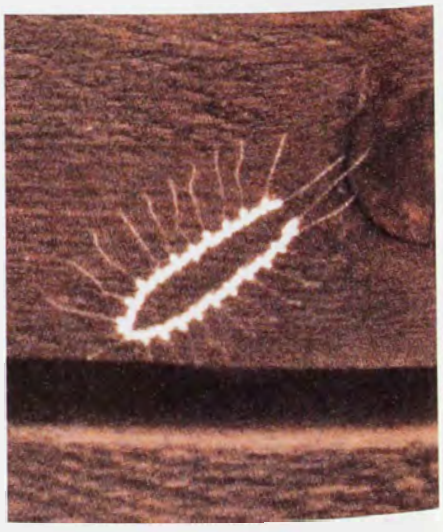
Whose Necklace?

Q: *The 'necklace' of eggs shown in the accompanying photograph (shown below) was attached to the outside of our house. What lays them, and why do they stand off like that?*

—Austin Adams
Eraring, NSW

A: This characteristic U-shaped arrangement of 30–40 eggs is the work of a female lacewing, *Nymphes myrmeleonoides*—a beautiful, golden brown insect, with filmy wings, each of which has a cloudy area near the tip. The wingspan is about six centimetres. The 'necklaces' are sometimes quite common underneath logs in eastern Australia, but in the suburbs the females usually have to settle for the underside of wooden beams or the slats of outside decking. The eggs alternate in two directions. Every second egg is attached to the substrate via a thread and the others bridge between them, so that the whole 'necklace' is supported well away from the log. Why the eggs are held away like this is anybody's guess.

The eggs take about three weeks to hatch, but the small larvae stay together in a group for a while, sometimes for a few days. They then disperse for food—small, soft insects that they can pierce with their long mouthparts and from which they suck the juices. Although they are common, they are not easy to find because they camouflage themselves with particles of debris.



COURTESY AUSTIN ADAMS

A characteristic U-shaped string of lacewing eggs.

It can take a year or longer for the larvae to grow to full size, after which they spend a month or so as pupae before the adults emerge.

—Courtenay Smithers
Australian Museum

Answers to Quiz in Nature Strips (page 19)

1. *Blue* **2.** *Dolly the cloned Sheep* **3.** *Severe Acute Respiratory Syndrome* **4.** *Tim Flannery* **5.** *Bird guano* **6.** *Two Peoples Bay, WA* **7.** *Sewer Rat, Norway Rat, Laboratory Rat or White Rat* **8.** *They weigh the same, but register more when the scales are on the carpet.* **9.** *Emperor Penguin* **10.** *They squirt them with water.*

Australian Museum: 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 *Australia: the journey*. Winter's Pic Teaser was a Thorny Devil (*Moloch horridus*).

Shark nets in the spotlight

How many more sharks and other harmless animals must be killed before meshing is removed?

SHARK NETS OFF SYDNEY BEACHES are part of our culture, having given comfort to swimmers for over 65 years. However, it is a common misconception that shark nets physically prevent sharks from entering shallow waters. The nets, which are set on the bottom, do not reach the surface and are open at both ends, so sharks swim over and around them. Those that try to swim through them (from either direction!) become entangled and immobilised in the wide mesh, and 'drown'. This is the only purpose of shark nets—to reduce the population sizes of sharks and thus the threat to swimmers.

In July 2003, the New South Wales Fisheries Scientific Committee (an independent group of scientists) released, for public comment, a proposed recommendation to list the current shark-meshing program in New South Wales waters as a 'key threatening process'. Today 49 beaches in greater Sydney, Wollongong, Newcastle and the central coast, covering some 200 kilometres of coast, have nets set at least 13 days per month.

Mesh nets were first introduced off Sydney beaches in 1937, when shark populations were abnormally large and shark attacks numerous. The sharks were attracted to offal from the Homebush abattoirs, which was discharged through the sewage outfall at Malabar between 1916 and 1970. In the first 17 months of meshing, 1,500 sharks were killed. But the number of sharks killed each year has progressively declined due to falling populations. The 2001/2002 figure was just 69.

A combination of relatively late maturity and low reproductive rates means that sharks are unable to replace depleted numbers. Shark populations around the world have dramatically decreased due to various human activities. In Australia, seven shark species are listed as threatened, including the endangered Grey Nurse Shark and vulnerable Great White Shark, while two species of wobbegongs have declined in New South Wales. All four of these are killed in shark nets, as well as numerous other animals (whales, dolphins, Dugongs, seals, turtles, rays, bony fishes).

It is a common misconception that shark nets physically prevent sharks from entering shallow waters.

There have been only three fatal shark attacks in New South Wales since 1970, the last in 1993. This is surprising, considering that Australia's population has increased by 50 per cent, Sydney's population has almost doubled, and the numbers of international tourists and water users have greatly increased. Clearly individual risks of shark attack are very low.

Nevertheless, New South Wales governments of both major parties have failed to make public any review of the shark-meshing program. The press has reported that the Premier has refused to remove shark nets off the New South Wales coasts, citing swimmer safety. The move by the New South Wales Fisheries Scientific Committee to put the shark-meshing issue out there for public discussion is a step in the right direction.

Those people in favour of shark netting cite the lack of fatalities and serious shark attacks on Sydney's surf beaches since it began, as justification for its continuation. However, such reasoning ignores the cessation of meshing for three years during World War 2 (that is, even without meshing, there were no fatalities). It also ignores the fact that over 1,300 kilometres of New South Wales coast are unmeshed, yet attack rates are miniscule.

Shark netting has not occurred during the winter months of June and July since 1983, and May and August were added as non-meshing months in 1989 with little public fanfare. Meshing should now be stopped during September and October, as there has never been a Sydney beach attack in these months since the first record in 1791.

A detailed risk analysis, starting with data for the three dangerous shark species (Bull, Tiger and Great White), must be conducted and made available to the public. If the results indicate protection is still warranted, alternate methods such as drum lines as used in Queensland need consideration.

In its attempt to guarantee the impossible—that is, freedom from shark attack or any other accident for every individual human that enters the water—the Government is paying a high environmental price, and without public debate. How much time must pass, and how many more sharks and other harmless animals must be killed, before the meshing is gradually but steadily removed? □

BY JOHN PAXTON

DR JOHN PAXTON IS A RESEARCH FELLOW IN ICHTHYOLOGY AT THE AUSTRALIAN MUSEUM, HAVING RETIRED AS PRINCIPAL RESEARCH SCIENTIST IN THAT SECTION FIVE YEARS AGO.

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