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FRONT COVER
Pied Cormorants (*Phalacrocorax varius*) roosting in a dead tree in the interior of Australia. Pied Cormorants that visit inland lakes often become stained with iron oxide in the water, leaving a telltale sign of where they have been.
PHOTO BY JON NORLING

up front

As I write this, it's forecast to be 42 ° C in Sydney, the hottest November day on record, and to survive it most people will stay indoors in air-conditioned comfort. In our modern world surviving extremes of temperature, whether it be hot or cold, usually means relying on some form of technology. But people have been around for a lot longer than technology and 20,000 years ago, during the last ice age, they were living and surviving in the coldest parts of Tasmania in one of the coldest of times. So how did they do it? How did these early modern humans survive such extreme temperatures particularly when resources were scarce? Archaeologist Richard Cosgrove found the answer by looking at a resilient little wallaby.

When the weather heats up, bushfires are rarely far away. Yet there have been relatively few studies that provide quantitative data on the effects such events have on our wildlife and ecosystems. With a five-year plan in mind, biologist David Lindenmayer established over 100 study sites throughout Booderee National Park, in order to do just that. Except things didn't go to plan and one year after setting up the sites a bushfire ripped through the area destroying everything in its path. Or did it? This unexpected turn in David's study has provided some interesting insights into the real effects of bushfires and points the way forward for managing fire and our wilderness areas.

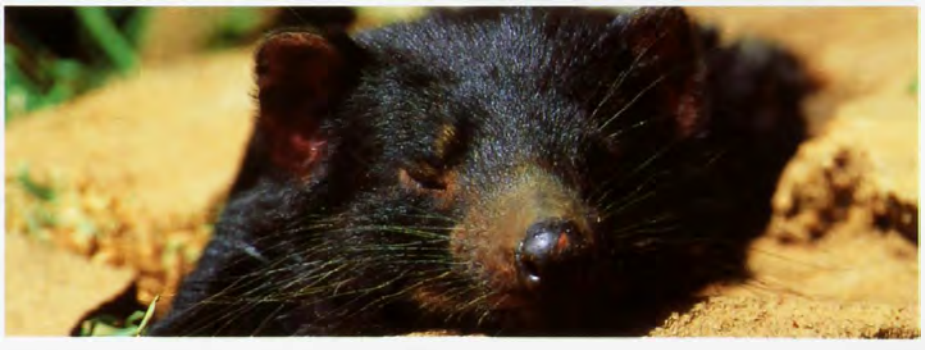

ESTHER BEATON

Short-beaked Echidna (*Tachyglossus aculeatus*).

Imagine living in a world without Devils. Just a few years ago such an idea would have been scoffed at. Tasmanian Devils were plentiful and confidently labelled as secure. How quickly things change. Over a third of the Devil population in Tasmania is now dead from Devil Facial Tumour Disease and the species is at risk. Now our scientists are racing to stop the Devil going the way of the Thylacine.

Also in this issue we take a look at those wonderfully adaptable cormorants, explore the sexually deceptive world of orchids and wasps, discover what's killing India's vultures, and ask why humans have such long and drawn-out childhoods.

— JENNIFER SAUNDERS
Publishing Manager


KATHIE ATKINSON

Tasmanian Devil (*Sarcophilus harrisii*).

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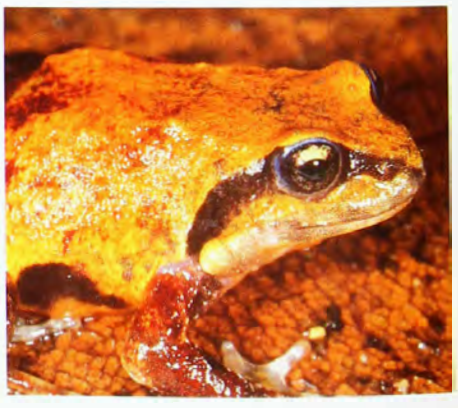

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Butcherbird Concert

One time we were visiting Queensland in our caravan, and as I was to play in a concert in Brisbane, I was practising Benjamin Britten's Simple Symphony on my mandolin behind the caravan. At the back of the van was a narrow strip of shrubs protected by a layer of mulch. While I was playing I saw a Grey Butcherbird scratching about there, and as soon as I started playing the Saraband, which is very melodic, the bird hopped nearer, and sat next to my right foot with its beak up in the air, obviously listening to the music. Even when I struck the two strident chords in the piece, it merely gave a little start, but did not fly away until I finished the piece. It flew to a nearby tree and came back with another bird, its mate I presume. They then sat in a bush near me and 'sang' to each other! Were they paying me for the 'concert', or were they letting me know that Nature also is a magnificent composer?

I enjoy reading your magazine very much, and I have learned a lot about nature from it. Keep up the good work.

—Francina P. Postuma
Corio, Vic.

The Iceman's Salute

I read with interest Richard Fullagar's article on the Iceman (*Nature Aust.* Winter 2004). I have a theory about what happened to the Iceman in that remote alpine pass. Having been shot in the back with an arrow, probably during a failed attempt at armed robbery, the Iceman retreated into the mountaintops where he positioned a decoy of his precious tools up against a rock and buried himself under snow, where he watched (through a peephole) and waited for his assailant to return. In readiness for a counterattack, the Iceman placed his left arm underneath his chin, which would have provided excellent purchase against the ground and enabled him, in martial-arts style, to rotate his torso and catapult his dagger-holding right arm into his enemy. However, the more he waited, the more it snowed, and eventually he froze to death. Because he had already intentionally buried himself in the snow, his body was well protected from scavengers, microbes and the elements.

—Petr Jandáček
New Mexico, USA

Lemming Lies?

"Myth of the Suicidal Lemmings" (*Nature Aust.* Spring 2004) reports that the mystery of the cyclic outbreaks of Collared Lemmings in Greenland has been solved. Not so! As an accompanying commentary in *Science* stated, the study merely proposed a hypothesis to explain the lemmings' observed cycles. This was a mathematical model that excluded any influence of food, and assumed the accumulating numbers of the lemmings' predators eventually killed them faster than they could breed, so that their numbers collapsed, ending the cycle.

However, two recent experimental studies of outbreaks of other rodent species with same or similar predators fail to support this hypothesis. One, in England, used replicated comparisons of populations of Field Voles where European Common Weasels were either trapped out or left alone. The second, in New Zealand, used similar comparisons with or without removal of the introduced Stoat to show that it has no significant influence on outbreaks of feral rats and mice. On the contrary, these studies and others demonstrate that eruptions of these rodents are driven not by predation but by changes in the availability of their food.

—Tom White
St Georges, SA

Tolerance in the City

I read with interest the article "Living with Crows" (*Nature Aust.* Spring 2004). The line "…the long-term solution must be one of increasing the community's tolerance of corvids in cities" hits the nail on the head. I would just add to this, wildlife in general, not only corvids.

There must be innumerable complaints about native wildlife. A couple with which I am familiar include Common Eastern Froglets (*Crinia signifera*) calling for a mate, and flying-foxes that poop on our awnings and cars after a meal of palm dates.

With the natural environment being relentlessly diminished into islands, a time may come when the only wildlife will be species that can survive with people in urban environments. If there isn't some tolerance and compromise, then even the wildlife that can put up with us will be under threat.

—Adam Crawford
Greenfield Park, NSW

Nest or Drey?

Surely a possum's nest is just that and not a 'drey' (Quick Quiz, *Nature Aust.* Spring 2004), which is by definition a squirrel's nest. This corruption of the language is just as bad as the recent piece by *National Geographic* magazine where they defined a 'ringer' as an Australian cowboy!

—Raymond McQueen
Airlie Beach, Qld

The term 'drey' may well have originally referred to a squirrel's nest but has been used in Australia, since at least the early 1940s (by Ellis Troughton in his "Furred animals of Australia"), to describe the free-standing, spherical nests that ringtail possums sometimes build, as opposed to the leaf-lined tree hollows used by most other possums (and also some squirrels and ringtails). That the word derives from another country or culture does not worry me, just so long as it has a useful application here.

—*G.H.*

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 *Frozen oceans*. The winner this issue is Peter Jandaeek.**

Summer

Compiled by Geordie Torr and Martyn Robinson

Bluebottle.

AN ILL WIND

It's a hot summer's day and down at the beach, zinc-daubed kids are frantically trying to eat their ice creams before they melt. The nor'easter that's been blowing for the past few days freshens up a bit and suddenly the screaming starts…

The Bluebottle (*Physalia physalis*), also known as Portuguese Man-o'-War, is a regular, painful visitor to our beaches. Unusually, each individual Bluebottle is actually a colony of polyps. The various members of the colony all hatch from a single egg and then differentiate as they take on different tasks—one individual is the float, another the digestive system, another the reproductive system and another the stinging tentacles, which the colony uses to catch small marine animals when it's not getting them tangled around some poor child's legs.

The float, also known as a pneumatophore, doesn't just keep the colony from sinking; its odd, asymmetrical shape also causes it to act as a sail. Of course the colony has little or no control over where the wind takes it, which is why an onshore breeze can make your trip to the beach a memorable one.

But such winds don't spell doom for all the Bluebottles in the area. This is because they come in 'mirror morphologies'—if you look at a group of them from above, you'll see that the floats of half curve to the right and half curve to the left. This means that any breeze that blows half the population onto Manly Beach will send the other half sailing out to sea.

For more about these sea-going stingers, visit **www.amonline.net.au/factsheets/bluebottle.htm**

KOALA CAPERS

Summer is a time of great activity for male Koalas (*Phascolarctos cinereus*). Warm weather sends them wandering around their territories chasing off rival males and mating with receptive females. They proclaim their readiness for fighting and/or fornicating by bellowing loudly. It seems quite incongruous for these cuddly, rather placid-looking leaf-eaters to produce such fearsome battle roars, and they may well have given rise to tales of Bunyips.

Females that succumb to the males' charms usually give birth in December or January to a single joey (very rarely twins). The new arrival will remain in the pouch for about six months, before becoming the familiar fluffy jockey, riding around on its mother's back.

Interestingly, a Koala's pouch faces backwards—or downwards if it's sitting in a tree fork. This doesn't seem terribly sensible for an arboreal mammal, but the young in the pouch is quite safe, thanks to the firm grip it maintains on its mother's teat and its needle-like little claws. The pouch's orientation is actually a reflection of the fact that the Koala's ancestor was a burrower—a type of wombat.

The place to go for everything you've ever wanted to know about these cuddly icons is *Koala: natural history, conservation and management* (1999) by Katherine Handasyde and Roger Martin.

Koala.

Winged termites.

LOVE FLIES ON EPHEMERAL WINGS

At dusk they appear—after a warm summer downpour when the air is nice and humid—dark shapes that boil up out of the ground in their hundreds, and make their way, on their long fluttering wings, towards the lights of our cities and towns.

They're termites—virgin kings and queens leaving their natal nests and seeking out mates to help them found a new colony. When they arrive at a suitable spot, they land, give a little shrug, and all four of their equal-sized wings drop off. They then 'call' for a partner using pheromones. When a suitable mate appears, the pair scurries off together to bury themselves in the first damp ground they can find. If they're lucky, they'll never see the light again.

Together they build a shelter to house a small number of eggs that then hatch into the first workers and soldiers of the new colony. The brood quickly sets about enlarging the nest and feeding the founding queen, which now begins to lay almost continuously. Eventually the colony will grow to contain more than a million termites—hopefully not near your house.

To learn more about these tireless wood-munchers, only six of the 350 Australian species of which are serious pests, visit **www.ento.csiro.au/insect_id/termites.html**

AUSTRALIAN MUSEUM

FROM THE COLLECTION

*This is the earliest specimen of a Crown-of-Thorns Starfish (*Acanthaster planci*) in the Australian Museum's collection. It came from Vanuatu and was registered in December 1888. For reasons unknown, half the specimen was sent to the Australian National University in 1971. However, because starfish are radially symmetrical, you only really need a half to identify it to species.*

The Crown-of-Thorns is one impressive starfish, growing to a diameter of up to 80 centimetres and covered in brightly coloured venomous spines. It spawns in summer, broadcasting sperm and eggs into the water. The resulting larvae drift around in the plankton before settling back on a reef.

The Crown-of-Thorns was once thought to be uncommon on the Great Barrier Reef and little was known about it. Then, in 1962, for reasons still not fully understood, its numbers suddenly soared, and speculation that it fed on live coral polyps was dramatically verified. We now know that these outbreaks are a regular feature of the reef. They generally start in the north and spread south—probably as the larvae are carried on the southerly currents—and may take a decade to go from one end of the reef to the other.

For further information, see ***www.gbrmpa.gov.au/corp_site/info_services/publications/sotr/1998/cots_frame.html***

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

nature strips

COMPILED BY GEORGINA HICKEY

RUTH BERAN, CAROL BURROW, RICHARD FULLAGAR, KARINA HOLDEN, KAREN MCGHEE, RACHEL SULLIVAN, ABBIE THOMAS, GEORDIE TORR, PAUL WILLIS AND STEPHEN WROE ARE REGULAR CONTRIBUTORS TO **NATURE STRIPS**.

Lighthouse Blues

As the light from a lighthouse sweeps around in the night, it promises safe passage for the many ships that rely on its penetrating beam. But for migrating birds, it can spell doom.

Jason Jones (Dartmouth College, New Hampshire, USA) and Charles Francis (Canadian Wildlife Service) found a single lighthouse in Ontario, Canada was responsible for killing over 18,000 birds from 121 different species in the past 41 years (*J. Avian Biol.* 34: 328). In one night, over 2,000 birds were killed.

Migrating birds at night are attracted towards the light emanating from lighthouses, but are killed when they collide against windows or from exhaustion as they try to get to the light. Those most often killed (vireos, ovenbirds and some warblers) tended to be species that make short, fast flights through dense cover, using patches of light to guide them.

But the study by Jones and Francis isn't all bad news. After a new type of light was installed in 1989 that halved its intensity and reduced beam width, far fewer birds were killed (less than 30 per year, compared to nearly 600).

Birds are also far less attracted to strobe lights

For Megellanic Penguins, soft nesting material is hard to come by.

JEAN-MARC LA ROQUE/ARCAPIX

Fatal attraction? Lighthouses can be a real problem for migrating birds.

than rotating beams, possibly because the interruption of the light allows them to disperse away from the beam. With the thousands of lighthouses lining our coast, soft strobes may be the humane way to go for the future.

—A.T.

Penguin Mothers Show True Grit

Imagine you're a penguin egg. Not only do you have to live in some of the harshest places on Earth, you are often made to lie on the hard ground with next to no nesting material, while your parents are tripping over each other and bickering with the neighbours. Chances of making it to hatching would appear pretty slim.

Not so for Megellanic Penguins (*Spheniscus megellanicus*). Dee Boersma (University of Washington) and colleagues have discovered that only a tiny 2.6 per cent of eggs from a colony in Argentina broke or cracked before hatching (*The Auk* 121: 148). The secret of success lies in the thickness of the shell—a heavy-duty number, half as thick again as that of most other birds' eggs the same size.

But for thick shells you need lots of calcium. And where does a fish-eating bird that fasts for the week or so before egg-laying get it from? The researchers discovered that early in the egg-development stage, females get a craving for shelled molluscs, which they pick up from the nearby beach and bay. The seashells are rich in calcium carbonate and, over several weeks in the stomach, break down to calcium, which is stored first in the bones, and later released when it comes time to form the eggshell.

Most birds lay thin-shelled eggs and protect these in a feather- or grass-lined nest. But soft linings are hard to come by in the penguins' tough environment, and so they've been forced to take the thick-shelled option, thanks to a binge on the local seashells.

—A.T.

Stradivari's Secret

What is it about a Stradivarius violin that makes it so superior to more recent models? Did the 17th-century Italian craftsman, Antonio Stradivari, use some sort of 'secret ingredient' to give his violins that magical quality? Was it the varnish? Did he 'season' his wood?

No need to invoke special tricks, according to Lloyd Burckle (Columbia University) and Henri Grissino-Mayer (University of Tennessee). It was all to do with where he lived and, more importantly, the timing of his birth (*Dendrochronologia* 21: 41).

Stradivari's wood of choice was spruce, hewn from

PAINTING BY JAMES L. DAWSON, © NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY FOUNDATION

Were Columbian Mammoths (*Mammuthus columbi*) subjected to mass killings by palaeoindians? The answer's in the bones.

forests close to his workshop in Cremona, southern Italy. These grew at high elevations, on north-facing slopes, and on thin, nutrient-poor soils—conditions that promote slow, even growth and a dense wood grain, which makes for a higher-quality sounding board. But, as the researchers point out, such growing conditions occur throughout the world. Could the trees that grew through Stradivari's lifetime have been subjected to some other set of environmental conditions that made them unique?

Stradivari was born in 1646, one year after the beginning of the 'Maunder Minimum'—a curious cold spell that gripped Europe for 70 years. Temperatures dropped 1–2° C, and led to drastically reduced growth rates in trees. The trees that Stradivari used to make his violins all grew through this period. The researchers believe it was a combination of local growing conditions and dramatically reduced temperatures that produced the sweet-sounding wood of the Stradivarius—conditions that have never been repeated since.

—G.H.

Mammoth Underkill?

Evidence for 'mass kills' of mammoths by North American palaeoindians at the end of the last ice age is often flagged in support of the blitzkrieg model of megafaunal extinction. However, a recent analysis by Kathryn Hoppe (Stanford University) of carbon, oxygen and strontium isotopes in mammoth teeth shows that this was not so, at least in the three fossil sites she considered (*Paleobiology* 30: 129).

Isotopic profiles vary according to diet. Mammoths travelled in herds and, being in close proximity and eating the same foods, isotopic variability should be minimal among herd members. By studying the degree of variability in mammoths both from an undisputed mass-death site and from a site where unrelated individuals had died over a long period, Hoppe was able to calibrate results for three sites in which mass slaughter by humans had been proposed. Her results showed that there was simply too much variation—the individuals from these alleged mass kill sites could not have formed a herd and consequently could not have died together. If they were killed by people, then it was one individual at a time and over a protracted period.

Hoppe's results do not demonstrate that humans *didn't* play a role in the extinction of mammoths. But if they did, it is unlikely to have happened according to the overkill model, which requires high kill rates and high predation efficiency.

—S.W.

Lopsided Flies

You'd think for any flying animal, having two different-sized wings would be a major setback, guaranteeing it to a life of circle work, if it managed to survive at all. Which is why Justin Runyon and Richard Hurley (Montana State University) were surprised to discover a new species of long-legged fly (*Erebomyia exalloptera*) whose males have one wing at least six per cent larger than the other (*Biol. Letters* 271: S114). According to the scientists behind the find, this degree of asymmetry has never before been found in an animal capable of flight.

The mating behaviour of *Erebomyia exalloptera* may provide clues to the origin of its peculiar wing asymmetry. During courtship, the male approaches the female, while frantically fanning his extended wings. If the female does not fly away, the male attempts to copulate. Runyon and Hurley suggest that the male's wing-fanning may produce sound inaudible to the human ear but which the female may use to detect differences between an individual male's wings.

But why would females want to mate with asymmetrical males in the first place? It may be that these males are more attractive to females because they have managed to escape predators and survive, *despite* their handicap, thus displaying their superior genetic quality.

And in case you're wondering, the males of this new species do not fly in circles. At least over limited distances they are able to keep on the straight and narrow. But how they manage it is a mystery.

—R.B.

COURTESY JUSTIN RUNYON

Asymmetric wings of the male long-legged fly (*Erebomyia exalloptera*).

Redating a Crater

When the Chicxulub crater was found buried beneath hundreds of metres of rock off the east coast of Mexico, it was hailed as the smoking gun from the great dinosaur massacre 65 million

Meteorites leave lasting impressions, like the Wolf Creek Crater in Western Australia. But the hunt is still on for signs of the one that killed off the dinosaurs 65 million years ago.

years ago. It had been hypothesised since the early 1980s that a meteorite had slammed into the Earth, causing all kinds of environmental havoc leading to the Cretaceous extinctions. Now here was an impact crater of about the right age and size. It all seemed quite neat.

But a recent study of a new core through the heart of the buried crater has thrown a geological spanner in the hypothetical works (*Proc. Natl Acad. Sci.* 101: 3753). As Gerta Keller (Princeton University) and colleagues show, the impact at Chicxulub occurred some 300,000 years before the extinction event that marked the end of the Age of Dinosaurs, the so-called Cretaceous/Tertiary (K/T) boundary.

Careful analysis of the microfossils above the impact layer in the core indicates that life was typical of the latest part of the Cretaceous, not the radically different and depleted fauna of the Tertiary. The dramatic change in fauna is not seen until long after the dust had settled from the Chicxulub impact.

Other lines of evidence, including analysis of the direction of the Earth's magnetic field and investigations into stable isotopes within the core, support the conclusion that there were a few hundred thousand years of the Cretaceous left to play out, after the Chicxulub impact event.

Does this mean that the meteorite impact theory for the K/T extinctions is dead? No. The fine layer of iridium-rich clay found around the world at the K/T boundary clearly indicates that there was a major impact event associated with the extinction. It's just that it didn't create the older crater of Chicxulub.

—P.W.

Pygmy Bluetongue Real Estate

Only recently rediscovered after being thought extinct for more than 30 years, populations of the Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) are at risk from agricultural disturbance of their remnant grassland habitat. But scientists have discovered an easy recipe for success to improve the diminutive lizard's prospects: increased housing in the form of artificial spider burrows.

Pygmy Bluetongues inhabit slender vertical burrows previously excavated by wolf and trapdoor spiders, which they use for breeding, sheltering from the elements, and sitting and waiting for their insect prey. Earlier work had revealed that they prefer a burrow around 30 centimetres deep, but most spider burrows are much shallower, a limiting factor in lizard population densities. So Nicholas Souter (Flinders University) and colleagues constructed deep artificial spider burrows to determine whether increasing the number of optimally sized holes would result in more lizards (*Biol. Conserv.* 116: 403).

It did. Populations of both adults and juveniles were significantly greater in the study area than in control plots. The researchers discounted the theory that this was due to the local population redistributing itself, because there was no matching decrease in the surrounding area. Instead, they say, the population boom was thanks to lizards being able to find high-quality burrows more easily, reducing both the distance

Pygmy Bluetongue Lizards are fussy when it comes to choosing a home. Only the deepest spider burrows will do.

they had to disperse and its associated mortality rates.

They also examined whether the density of hole-dwelling lizard predators, such as large centipedes, would increase with the presence of artificial burrows, but found that, although there were more predators, they made little impact on the bluetongues.

Souter cautions, while artificial burrows are a valuable conservation tool, they may also reduce dispersal rates and therefore colonisation of new habitat.

—R.S.

Trophy Lions

Long feared and respected, the King of Beasts has become a public-relations basket case, now commonly depicted as a lazy bum. Even worse, from a human perspective, is his tendency to kill cubs following the successful overthrow of other rulers (bringing Lionesses into heat more quickly). Still, the male Lion (*Panthera leo*) is a conservation asset because Westerners pay well to see him in the wild...and even more to kill and take him as a trophy. For cash-strapped African nations, this is strong incentive to preserve the Lion and his habitat.

Trophy-hunting of adult male Lions may present ethical dilemmas, but was thought to present no serious ecological problem, because, provided sufficient males remain to impregnate available females, population numbers should hold. However, it has since been suggested that, by increasing the rate at which new males move in, trophy-hunting may elevate cub-killing to a point at which Lion populations go extinct.

JOHN SHAW/AUSCAPE

Too young to be hunted? The nose will tell.

Recent computer simulation by Karyl Whitman and colleagues (University of Minnesota) confirms this, but also shows that, if hunting is restricted to males older than six years, populations could be maintained (*Nature* 428: 175). This is because it would allow time for cubs to reach adulthood before new males took over.

And how can a hunter pick the age of a Lion at a glance? By the colour of his nose. A Lion's nose becomes increasingly freckled with dark pigment as it ages, with Lions over the age of six having noses that are 50 per cent black. Nose colour, according to the researchers, is a far more reliable indicator of age than colour or length of the mane.

However, even the best-managed hunting reserve still has to contend with the most serious threat to the future of the Lion: rural Africans, who kill hundreds of Lions each year, females as

well as males, in retaliation for the loss of livestock and human life. Lions are now virtually restricted to game reserves and national parks, but even these animals occasionally wander into rural areas where they are often poisoned or speared.

—S.W.

Choking the Virgin

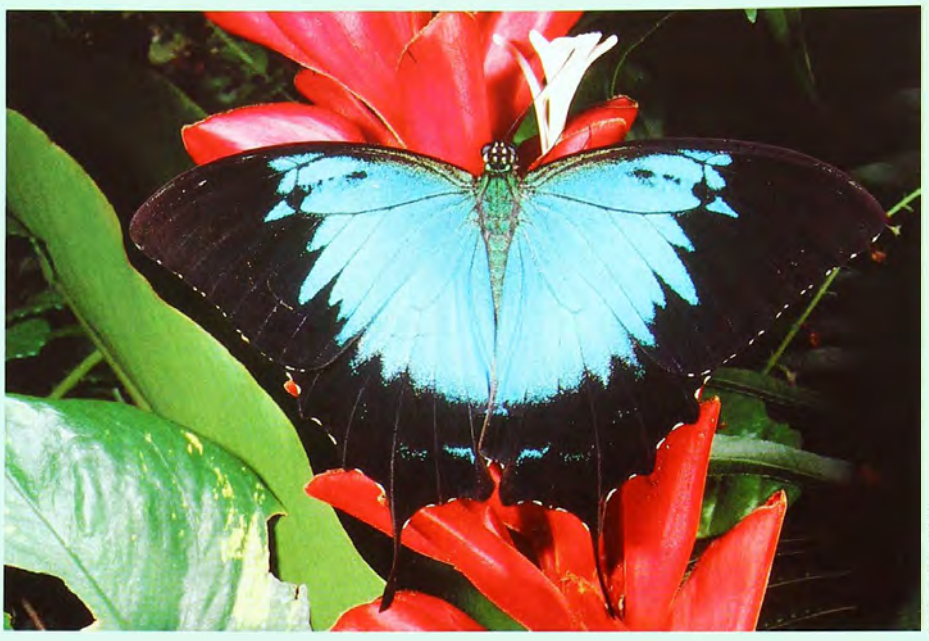
There's not much on our planet that hasn't been affected by the expansion and industrialisation of the human race. Even virgin rainforest still untouched by human encroachment is being affected by our consumerist ways.

Scientists from Brazil and the US discovered the changes during a 20-year study in the Amazon region. Led by William Laurance (Smithsonian Tropical Research Institute, Panama), the team established plots in both fragmented and virgin forests, tagging over 60,000 trees to monitor their growth. While they expected to find changes to growth patterns in the fragmented areas, which had previously been isolated from other forest areas by burning the surrounding vegetation, they were surprised to find massive changes also occurring in areas of no human activity. The researchers found that quick-growing canopy species were flourishing at the expense of slow-growing hardwoods (*Nature* 428: 171).

Plant growth requires carbon dioxide (CO_2) and the team speculates that the Amazon trees are getting an extra boost of CO_2 caused by rising vehicle exhausts, factory emissions and other industrial processes. Different species absorb CO_2 at different rates and convert it into growth. These factors help determine which species come to dominate the forest, and how useful the forest is as a carbon sink.

The species that are doing well are large, fast-growing canopy and emergent species, which tend to have lower-density wood than the slow-growing species they replace. Yet it's the dense hardwoods that are the most important absorbers of carbon in the Amazon. Now that these slow-growing species are in decline, the forests may become less able to absorb the excess CO_2 in our atmosphere. As the Amazon accounts for more than half the world's remaining rainforests, this could have major implications in the planet's ability to cope with rising CO_2 levels and the fight against global warming.

—K.H.



MICHAEL CERMAK

Male Ulysses Butterfly. The blacker the black, the bluer the blue.

Ultra-black Butterflies

A common Australian butterfly is making a radical fashion statement, as has recently been exposed by Pete Vukusic (University of Exeter) and colleagues. Now everyone, from scientists to artists and clothes designers, are talking about the new 'ultra-black' produced on the wings of the Ulysses Butterfly (*Papilio ulysses*).

Found in the Australian tropics, this lustrously coloured insect is recognised by the male's striking black and blue wings. The blacker the black, the more the blue stands out as a signal to mates or rivals.

When examining the wing scales of the male Ulysses under the electron microscope, Vukusic realised that it isn't just pigment that makes these areas black—it is also the structure of the scales (*Biol. Letters* 271: 237). Within the black parts of the butterfly's wing, the scales are covered in tiny pits less than a micrometre across that form a honeycomb pattern. These nano-structures actually trap light—up to 90 per cent of all light hitting their surfaces.

By trapping more light in its wings, the butterfly achieves 'ultra-black', making the dark pigment look even darker. This has inspired human design engineers to experiment with nano-structures to create blacker-than-black colours. If these early flutterings are anything to go by, then the Ulysses Butterfly may have started a new trend. Perhaps next season, 'ultra-black' will be the new black.

—K.H.

Neanderthal Face?

A piece of flint from La Roche Cotard, France, bears an uncanny resemblance to a face. Approximately 32,100 years old, it is associated with stone artefacts typical of Neanderthals. Can it be attributed to the handiwork of Neanderthals, or is it just a case of 'paraeidolia', when we see things, such as familiar shapes in clouds, that are not really there?

Jean-Claude Marquet (Musée Départemental de Préhistoire du Grand-Pressigny) and Michel Lorblanchet (CNRS) argue that it is a 'pierre-figure' (*pierre* being French for stone)—a curious natural object that was noticed and collected by prehistoric people, and sometimes modified. Distinctive scars indicate that the piece of flint (with its naturally occurring tubular perforation) was clearly shaped to enhance symmetry. A small bone splinter was wedged firmly through the tube giving the impression of a face, with eye sockets, forehead, nose, cheeks and mouth (*Antiquity* 77: 661).

JEAN-CLAUDE MARQUET

Stone face: handiwork of Neanderthals, or all in the imagination?

Pierres-figures have been found in early and modern contexts in Europe and Asia, and may help track origins of human beliefs and symbolic behaviour. One proto-sculpture from Berekhat Ram, Israel, has been dated stratigraphically to between 250,00 and 280,000 years old, and is similar to the famous Venus figurines made by modern humans about 30,000 years ago (see "Stone Clothes", *Nature Aust.* Autumn 2001).

Neanderthals could certainly have produced the stone face from La Roche Cotard (or perhaps acquired it from contemporary modern humans). But whose face do you think it depicts? Is it human? Feline? Or something else?

—R.E

Do Dogs Resemble Their Owners?

We've all seen people who look suspiciously like their Dog—my

KLEIN-HUBERT-BIOS AUSCAPE

When choosing a pet, people tend to pick one that resembles themselves in some way.

grandfather, for example, bore a staggering resemblance to his succession of Scottish Terriers—but until recently there was no scientific proof to support this common lore. Now Michael Roy and Nicholas Christenfeld (University of California) have discovered that, if you own a purebred Dog, chances are there's more than a vague resemblance between you (*Psychol. Sci.* 15: 361). But not if you love a mongrel.

To discover whether the perceived similarity is due to people choosing Dogs that resemble them (in which case resemblance should be greater for purebreds whose facial features are more predictable), or if it is due to convergence (where resemblance grows with length of ownership), the researchers took photographs of 45 Dogs (25 purebreds and 20 mongrels) and their owners at local parks. A panel of judges were then shown pictures of an owner, their Dog and one other Dog, and asked to pick the true pair. They correctly matched 16 purebred Dogs with their owners, but found no significant link between owners and their 'Heinz-variety' pets.

They also found no correlation between the degree of resemblance and the length of ownership, discounting the convergence theory. Instead, say the researchers, when choosing a pet, people seek one that resembles them at some level and they're more likely to find it with a purebred.

However, exactly what that level is, is still unknown. There was no obvious link between the owners' and Dogs' hairiness, size, sharpness of features, attractiveness, apparent friendliness or perceived energy levels. So it seems that, when matching a pet to a personality, people (owners and researchers!) look for that special something that cannot be defined.

—R.S.

Wind Beneath Their Wings?

Widespread celebrations were held last year to mark the centenary of the first controlled, powered flight by the Wright Brothers on 17 December 1903. The Wrights undertook their early experiments at Kitty Hawk, North Carolina, to take advantage of the steady winds blowing in from the Atlantic Ocean. Tony Thulborn (University of Queensland) has recently argued that the Wright Brothers' use of such winds to facilitate flight was pre-empted 140 million years ago by the most famous fossil bird, *Archaeopteryx* (*N. Jb. Geol. Paläont. Abh.* 229: 61).

Debates over the origin of flight in birds have fallen

Archaeopteryx most likely relied on the wind for takeoff.

ILLUSTRATION BY JAMES REECE

mostly into two camps: the 'ground-up' and the 'trees-down' hypotheses. Thulborn pinpointed a potentially important parameter, wind speed, which had been ignored in previous investigations of *Archaeopteryx*'s flight capabilities. Why would wind be important?

Consider the environment in which *Archaeopteryx* lived. Thulborn's earlier analyses of its dentition and foot structure indicated that the bird was probably a shoreline hunter and forager. This hypothesis was supported by other workers' calculations that its wing dimensions were comparable to those of modern shorebirds. The Wright Brothers were only able to achieve flight in the sand dunes at Kitty Hawk with the help of winds blowing off the sea at about 20 knots. Similarly, even though *Archaeopteryx*'s fastest running speed was less than the slowest possible flying speed, it could have relied for lift-off and extended air-time on the trade winds that blew steadily in the islands and shores where it lived.

Way to fly without getting in a 'flap' about it!

—C.B.

Cloacal Cooling

Fancy putting a nappy on a lizard! It's an unorthodox technique, but it allowed Dale DeNardo and his colleagues (Arizona State University) to demonstrate that the Gila Monster (*Heloderma suspectum*) employs its own rather unusual technique to keep itself cool.

When many land animals start to get too hot, they produce sweat. As the moisture evaporates, it carries heat away with it. But while the animal cools, it also dehydrates, so desert species, for which moisture is often at a premium, will

Old habits die hard. Waanyi elder Jackson Diamond picks his teeth with a grass stalk.

usually try to minimise their water loss through sweating. The Gila Monster lives in the hot, dry environment of the Sonoran Desert of the southern USA and northern Mexico, and accepted theory says it should have a very low rate of evaporative water loss.

The scientists placed Gila Monsters into specially designed chambers and measured the water content of the air around them at five different temperatures. By placing 'nappies' on the lizards—cotton wads secured with an H-shaped piece of latex—they were able to calculate how much water was coming from the skin and how much from the cloaca (the combined urogenital tract).

They found that, contrary to expectations, Gila Monsters have quite high rates of evaporative water loss (*J. Exp. Biol.* 207: 945). The loss through the skin was relatively low but increased slightly with temperature. Loss through the cloaca was also low at low temperatures but rose dramatically once the lizards' body temperature exceeded 35° C. This rise in cloacal water loss was immediately followed by a drop in body temperature.

This is the first time that the cloaca has been shown to have a role in evaporative cooling. Let's just hope the technique doesn't catch on among humans.

—G.T.

The Gila Monster has an unconventional method of cooling itself.

Grass Floss

If curved grooves on the base of teeth are evidence of toothpicks, then humans across the ages, from *Homo erectus*, *H. neanderthalensis* and *H. sapiens*, have been picking their teeth for 1.8 million years. Critics of this idea have pointed out that when we use toothpicks today we don't leave behind similar grooves. But that's because the wood of modern toothpicks does not cut into tooth enamel (the hardest substance in the human body). New experiments by Leslea Hlusko (University of California, Berkeley) show that grass stalks used on modern-day teeth leave lasting impressions, strikingly similar to the wear patterns on prehistoric teeth (*Current Anthrop.* 44: 738).

Grass has silica within its cells—a hard and abrasive substance that also protrudes from leaves and stalks in the form of tiny sharp spikes. These spikes can easily cut flesh (ever cut your hands on grass?) and even tooth enamel. Hlusko found that only 40 grass-stalk toothpicks used over a period of three hours on modern human teeth were needed to reproduce a groove like that on the 1.8-million-year-old fossil *Homo* premolar from Omo in Africa. An Aboriginal colleague of mine from northern Australia carries a small grass-stalk toothpick under his hatband. Toothpicking probably represents the most persistent habit documented in human evolution.

Toothpicking may also provide indirect evidence for the evolution of hominid language about two million years ago (*Current Anthrop.* 45: 403). The trigeminal nerve in the mouth makes small holes feel like craters and fragments of meat feel like the whole T-bone steak. Surprisingly, the trigeminal nerve and the auditory nerve are vital for the development of complex speech. William Agger (University of Wisconsin) and colleagues suggest that the ability to sense, and the consequent need to remove, food particles between the

teeth developed as a result of selective pressures driving the evolution of complex speech.

—R.E.

Ancient Arctic Algal Bloom

It's well known that even remote Arctic and Antarctic habitats are tainted by the wastes and excesses of modern human lifestyles. It seems, however, that pollution at the poles is not a strictly recent phenomenon.

A team led by Marianne Douglas (University of Toronto) claims that at least one High Arctic freshwater ecosystem was significantly altered by human impact long before Europeans arrived in North America (*Proc. Natl Acad. Sci. USA* 101: 1613).

The researchers uncovered their evidence by reconstructing events that occurred around a large pond on Somerset Island in the Canadian Arctic. There, whalers over-wintered in a small village of whalebone houses for hundreds of years.

Semi-nomadic ancestors of Canada's modern-day Indigenous Inuit, the Thule people arrived on the island about 800 years ago and remained for four centuries. During that time, it's thought they annually landed up to six Bowhead Whales (*Balaena mysticetus*), hunted by teams of men in boats of skin, and caught and killed with harpoons and lances.

More than 60 per cent of each carcass was used for food, fuel and building materials. As the rest slowly rotted, it released nutrients into the waters of the nearby pond and surrounding soil. By analysing fossilised algal cells in sediment cores from the bottom of the pond, the researchers built a picture of the physical, biological and chemical nature of the water before, during and after human occupation of the site.

Nutrient levels and algal diversity and biomass rose significantly following the arrival of the Thule and declined following their departure. To this day, however, nutrient levels remain elevated compared to sites that weren't used by the Thule.

—K.McG.

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 colour are the male Zebra Finch's cheek patches?*
2. *Name the NASA spacecraft that is exploring Saturn.*
3. *How many molars do placental mammals have?*
4. *What do you call sound waves that have a frequency of over 20,000 hertz?*
5. *Name the fourth largest island in the world.*
6. *Does a Fossa have fins, fur or feathers?*
7. *What is the name given to one millionth of a metre?*
8. *In which month and year did the last Transit of Venus occur?*
9. *What are swan chicks called?*
10. *Which scientist, famous for his work on the structure of DNA, died in July 2004?*

(Answers on page 79)

Mullett: spatchcock of the sea

Even if you don't like seafood, you have to admit that the Sea Mullet is exceptional as far as fish go.

WHO CAN REMEMBER WHAT part of Warrick Capper's anatomy he was happy to let flop all over the shop in the 1980s, making women swoon, men throw up and the Sydney Swans momentarily forget their financial woes? Correct...his long, white, mullet. But how *did* that unfortunate hairstyle (#1 on the sides, #6 on top, don't touch the back), pioneered by David Bowie and Suzi Quatro, ever get its name? Evidently, it was a simple matter of physiognomy. The cut made you look like the fish. Tragically though, for its exponents, from about 1857 the American word 'mullethead' was applied to anyone considered dullish or stupid, because the mullet fish with its large flat head and lack of neck was thought to be the embodiment of feeble-mindedness. Somehow the association between the haircut, and the expectation of modest aptitude under it, has stuck.

When you put a sleek, silvery mullet alongside a stonefish or a toado however, it's hard to draw the same conclusion as the Americans. Most of us Aussies cut our teeth on mullet, and even those who think it's below them to eat it, still unwittingly support the market because pubs and fish-and-chip shops know that once mullet's battered and cremated no-one can pick it from something more snobby anyway.

Even if you don't like seafood, you have to admit that the Sea Mullet (*Mugil cephalus*) is exceptional as far as fish go. It can live in all sorts of water (fresh, super-salty or brackish); it's almost impossible to catch on a fishing line (being vegetarian, it just won't take regular bait); it breaches full clear out of the water like a dolphin; and it is one of the few fish to have a gizzard...a gizzard that looks like a Ferrero Rocher chocolate and is (evidently) very good to eat.

Gizzards are standard issues in birds and they usually contain bits of gravel that help do to food what a toothless beak can't. But such a grinding-mill affair in a fish is rare. So rare that in 1919, a Florida lawyer, Patrick C. Whitaker Sr, was able to have a case dismissed against half a dozen youths arrested on charges of fishing outside the season.

Whitaker presented the judge with (then scientifically inaccurate) books showing that fish did not have gizzards and then argued that, like whales and beavers, just because mullet lived in water like fish, did not necessarily mean they were fish. He referred to them instead as "some kind of aquatic fowl". Following the lost case, State legislators altered fishing laws to specifically account for mullet, regardless of whether they were fish or fowl!

Just about everyone has brushed up against mullet. As a child I used to load up long, narrow oyster bottles with small balls of dough and leave them on their side in shallow rock pools. When the tide was receding, there the fingerling mullet would be, like self-packed sardines, jammed so tightly into the bottle they couldn't turn around to escape. Unfortunately for my wife, the memory of boarding school mullet dished up every Friday night evokes gaggingly bleak flavours of rancid fish oil and mudflat flesh that were the highlight of her school's thrifty nutrition policy.

On the far side of mullet appreciation, Even Bruhn, whose 40-metre throw remains the world Mullet Toss record, worries that he's peaked as an athlete at age 26. "I don't think I'm gonna toss next year," he confides to author Michael Swindle. "When you're in competition you have to stay too sober."

To the casual observer, mullet life-history is a confusing issue. One minute they are nibbling algae in a sparkling freshwater stream 80 kilometres from the coast; next time you see them they are leaping out of the water in a muddy mangrove-lined creek; and then somewhere else they are getting dragged up in near-bursting nets from the ocean surf by a team of rusty tractors.

You see it takes three years for a Sea Mullet to reach adult size (33 centime-

Sea Mullet

Mugil cephalus

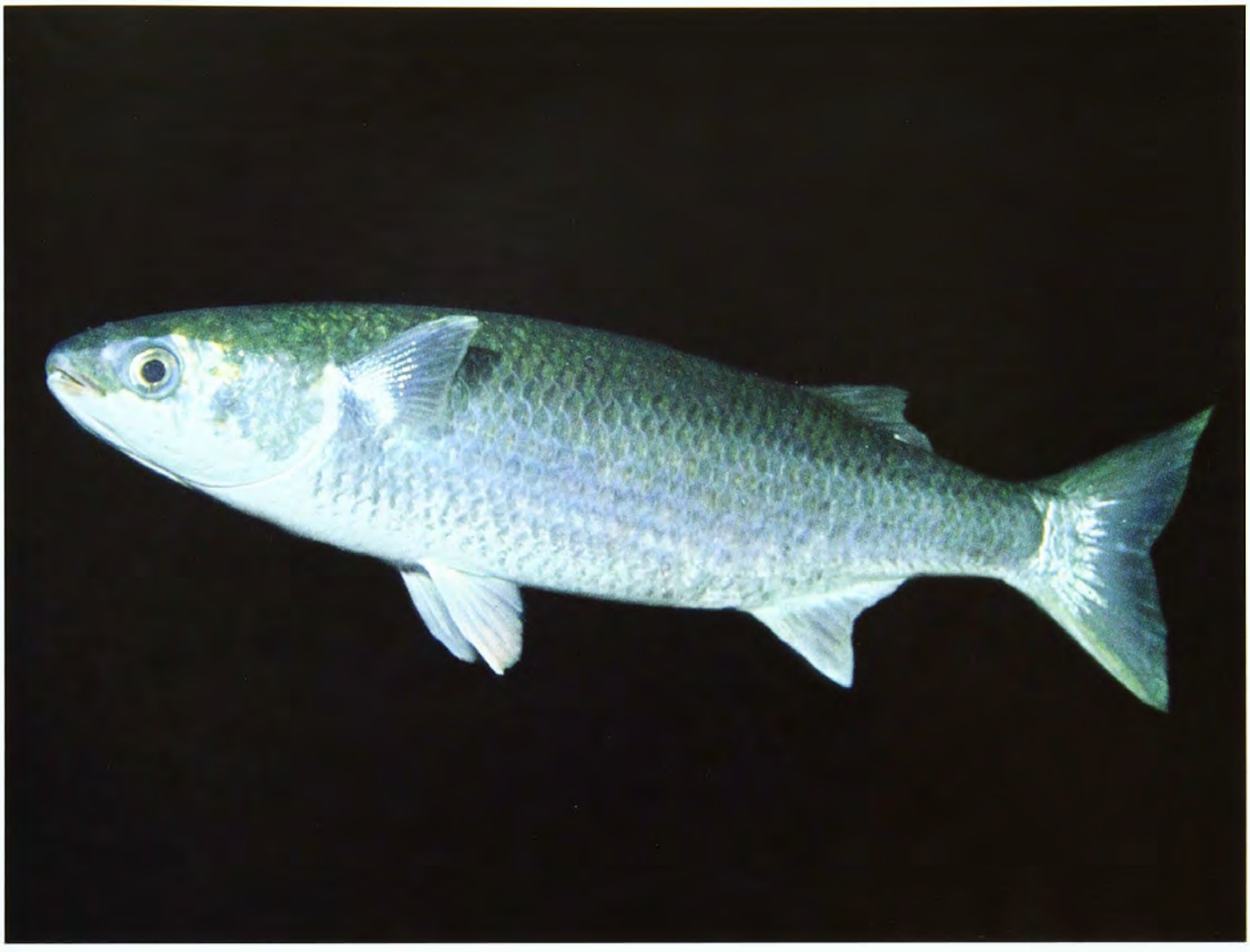
Classification
Family Mugilidae.

Identification
In oceans, silver belly and olive-green back; in fresh water, white belly and deep brown to almost black back. Black spot at base of pectoral fin, 8 soft anal rays behind the 3 anal spines. Sexes similar size, max. 76 cm and 8 kg.

Habitat and Distribution
Worldwide between 42°N and 42°S. In Aust., coastal waters and estuaries (except Great Australian Bight and western Tas.).

Biology
Found between extremes of fresh and saltwater. Eats algae, diatoms and microscopic invertebrates. Adults (3 yrs old) leave estuaries and spawn along coastal beaches between March and July. Lives 9-10 yrs.

BY STEVE VAN DYCK



RUDIE KUITER/AQUATIC PHOTOGRAPHICS

The Sea Mullet is one of the few fishes to have a gizzard.

tres). Nearly all the maturing happens in estuaries and freshwater streams and creeks. When the prevailing winds shift to offshore (around March in eastern and western Australia) most mature Sea Mullet start leaving the estuaries in schools. Just like Humpback Whales at that time of the year, they move north *against* the prevailing oceanic current and stay near to the coastline.

Spawning, which is thought to take place close to the surf along beaches, lasts at least a couple of months and the fry generated from it drift south with the current and swim into the estuaries when they are about two to three centimetres long. The adults, rather than die like exhausted salmon, slink off into the nearest river or stream and body-build for next year's oceanic orgy. The new stream they occupy might be 100 kilometres north of the estuary they left, but some extraordinary runs of over 700 kilometres have been recorded.

Because a mullet's roe (eggs) are worth at least 20 times the wholesale value of its flesh, most commercial fishing happens off the beach when the fish are ripe and just about ready to burst. In south-east Queensland alone between one and two million mullet are net-caught in the surf each year, and this represents just a fraction of the number of fish preoccupied with the procreative frenzy. Each female produces up to four million eggs and each male squirts out enough milt (sperm) to fertilise them as they disperse into the water.

So, with this in mind, next time you decline the offer from the kids next door to join them for a swim in their backyard pool (full off warm, watery wee-wee), try not to think too long about the creamy egg chowder you could well be relaxing in on your next Easter holiday to the beach! There may be more sea than pee in the ocean, but there's probably less chance of getting embroiled in a messy reproductive free-for-all in the neighbour's pool! □

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

Pugh's Mountain Frog

Pugh's Mountain Frog maintains a secretive existence and stays under cover for its entire life.

IN APRIL 2004, MY COLLEAGUES and I described two new species of mountain frogs (*Philoria*) from eastern Australia. It seems surprising that entirely new vertebrate species can still be discovered today, but in the case of Pugh's Mountain Frog (*P. pughi*) there is good reason, relating both to its appearance and way of life.

Pugh's Mountain Frog has been found in only a handful of sites in the boggy headwaters of rainforest streams in remote sections of the northern ranges of New South Wales, west of Grafton. It looks very similar to the other three species of *Philoria* from the same general region. The adults are approximately three centimetres long, with a robust pear-shaped body. They are well camouflaged against the ground and fallen leaves, with their colour variable, ranging from earthy browns to yellow and maroon. Whilst there may be subtle differences in colouration and markings between Pugh's Mountain Frog and other mountain frogs, these are not always reliable. What sets it apart as a new species comes from its genes. Molecular genetic technology has shown that Pugh's Mountain Frog has a separate gene pool with unique characteristics and has been evolving on its own pathway for millions of years.

It seems surprising that entirely new vertebrate species can still be discovered today.

Pugh's Mountain Frog is rarely seen. It maintains a secretive existence under the leaf litter on the rainforest floor and stays under cover for its entire life. Even the tadpoles are kept away from the open waters of streams or ponds. Males construct small breeding chambers in the ground. These are covered by leaf litter, rocks or logs, or are built under the banks of small creeks. Here the males sit and produce their mating call, a muffled 'ork', in an effort to attract a female into their nest. Small breeding groups of six or less males, each in their own separate chamber, have been observed from October to December. The habitat requirements for breeding appear to be highly specific. Nests must be constructed in a site where there is free water available for eggs to be deposited, but without the potential for the nests to be washed away during heavy rain. The conditions seem to be ideal where flatter boggy areas occur towards the top of a mountain ridge, often at the point where a rainforest stream begins.

Once a female has been lured into the nest and egg-laying begins, the female secretes with the eggs a jelly substance, which she beats with her large finger flanges to create a foam egg mass. The foam mass provides oxygen for the early embryos before breaking down to a clear jelly that the tadpoles can swim through. The tadpoles do not feed, but derive all their nourishment from the yolk that was contained in the egg. The embryos complete their entire development and metamorphosis, from egg to tadpole to juvenile frog, within the chamber in the ground.

As a result of this specialised breeding behaviour, Pugh's Mountain Frog may be particularly susceptible to the adverse effects of logging and road-

BY ROSS KNOWLES

making, such as soil compaction and the drying out of the forest floor as the canopy is opened up. Cattle grazing also poses a threat, and the trampling of nests in one breeding site has been observed as Cattle have congregated at water. A more general threat, however, is disease. A fungus, the chytrid fungus, can be deadly to frogs. Whilst it has not been identified in Pugh's Mountain Frog, it has been implicated in the decline of numerous species of Australian frogs, including the closely related Baw Baw Frog (*Philoria frosti*) from the Victorian Ranges.

Pugh's Mountain Frog was named after environmentalist Dailan Pugh. Over many years, Dailan campaigned for the protection of native forests in the north of New South Wales, and he is in part responsible for saving some of the few sites where Pugh's Mountain Frog is found. □

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ROSS KNOWLES IS MANAGING DIRECTOR OF A FINANCIAL-PLANNING GROUP THAT SPECIALISES IN ENVIRONMENTALLY AND SOCIALLY RESPONSIBLE INVESTMENT. HE HAS A LONG-STANDING INTEREST IN AUSTRALIAN NATIVE WILDLIFE AND CONSERVATION.

To shun the sun

Most mammals smell and hear better than they see, which means that daytime activity confers no advantage.

AUSTRALIA IS HOME TO MANY remarkable mammals, but most of them are rarely seen by people. One can spend days hiking or driving through national parks without seeing any at all. They are more obvious at night to experts wielding spotlights. But overseas, mammals are often seen by day. Squirrels scurry across parks, monkeys crash through trees, and Africa's plains bustle with big game. Why should Australia be so different?

One reason is that Australia is arid and our mammals feed at night to avoid the drying sun. Desert rats that eat nothing but dry seeds and vegetation certainly need to conserve water and they happen to be strictly nocturnal. But Australia is not all arid and there is more to the story than this.

Unlike other continents, Australia has lost virtually all its megafauna. A hundred thousand years ago diprotodons and other giant marsupials were an imposing presence. These big mammals probably foraged partly by day and also at night, depending on the weather and on predator activity, just as most big animals do today. Why they went extinct remains contentious, but their absence certainly makes the bush quiet.

Australia since European settlement has also lost, or almost lost, many of its smaller mammals, some of which engaged in daytime behaviour. One could say that Australian mammals are seldom seen because Australia has the most depleted fauna of any continent.

Small carnivorous mammals such as the Common Dunnart (*Sminthopsis murina*) are mainly nocturnal because their insect prey is mainly nocturnal.

BY TIM LOW

The Numbat (*Myrmecobius fasciatus*), our most consistently diurnal mammal, once ranged right across southern Australia, but now keeps to a few reserves in the south-west. Yet even visitors to these places rarely see it, which raises another point—that Australian mammals are often active by day; it's just that people fail to see them.

Southern Brown Bandicoots (*Isoodon obesulus*) often forage in daylight, but because they are discreet most people blunder past them unknowingly. Platypuses (*Ornithorhynchus anatinus*) feeding underwater are also overlooked. When rodents and dasyurids venture forth by day they are both small and quiet enough to be missed. I once spied a Yellow-footed Antechinus (*Antechinus flavipes*) carrying a dried leaf up to its nest inside a dead tree. By remaining stock still I watched it scamper up and down the trunk 15 times at around nine in the morning. But I was lucky to see this little critter at all. Similarly, the Kowari (*Dasyuroides byrnei*) and Mulgara (*Dasycercus cristicauda*) sometimes bask in the morning sun, but few people venture into the deserts where they live. Wombats often emerge on sunny mornings, or late in the afternoon, and I have seen Koalas (*Phascolarctos cinereus*) and Common Spotted Cuscuses (*Spilocuscus maculatus*) active by day, including one Koala galloping up a hill in the late morning. Most kangaroos and wallabies engage in some daytime activity, echidnas too, and they are the mammals most often encountered by day. Diurnal activity is more common in southern Australia where nights are cold.

Nights are the best time for insectivorous mammals to emerge because their prey is more active then. Cockroaches, grasshoppers, moths, beetles and centipedes emerge after dark when few birds are hunting. There are owls to consider, of course, and they turn out to be vital to this story. It's a remarkable fact that no owl fossils more than a couple of million years old have ever been found in Australia. The vast Riversleigh cave deposits, dating back to at least Miocene times (about 20 million years

PHOTO: TIM LOW

Mammals are more likely to emerge by day when nights are very cold. This is a Common Wombat (*Vombatus ursinus*) near Cradle Mountain in Tasmania.

ago), contain enormous caches of bones but no owl remains, even though owls often roost and nest around caves where their remains can accumulate as fossils. The owls we have today belong to two genera shared with Asia that evolved overseas. Our frogmouths (and nightjars) are also descended from Asian immigrants, and so too the Letter-winged Kite (*Elanus scriptus*), a nocturnal bird of prey that hunts desert rats. So Australia, until a few million years ago, was an owl-free zone, which made woodland nights somewhat safer for small furry things than the days.

The first mammals ever to evolve during the Triassic (about 240 million years ago) were small, probably nocturnal insectivores, which means nocturnal hunting was the original mammal lifestyle, the default setting for mammaldom. Nocturnal activity in winter may well have been the driving force for evolution of warm-bloodedness. Even today most mammals smell and hear better than they see, which means that daytime activity confers no advantage, especially when days are hot and nights mild. Primates and squirrels are exceptional among mammals in that most species are strictly diurnal (although there are many squirrels and some primates that are strictly nocturnal).

Australia is now bursting at the seams with feral invaders, and they behave much like our native fauna. Exotic rats, mice, Rabbits, Hares, Cats, Foxes and Pigs are all easier to see at night. In fact most of the world's mammals are at least partly nocturnal, but their daytime movements attract the most attention. Why? Because nature shows are far easier to film by day, and because people seldom go looking for wildlife at night. Those African plains that seem so busy by day are often busier again when night falls. □

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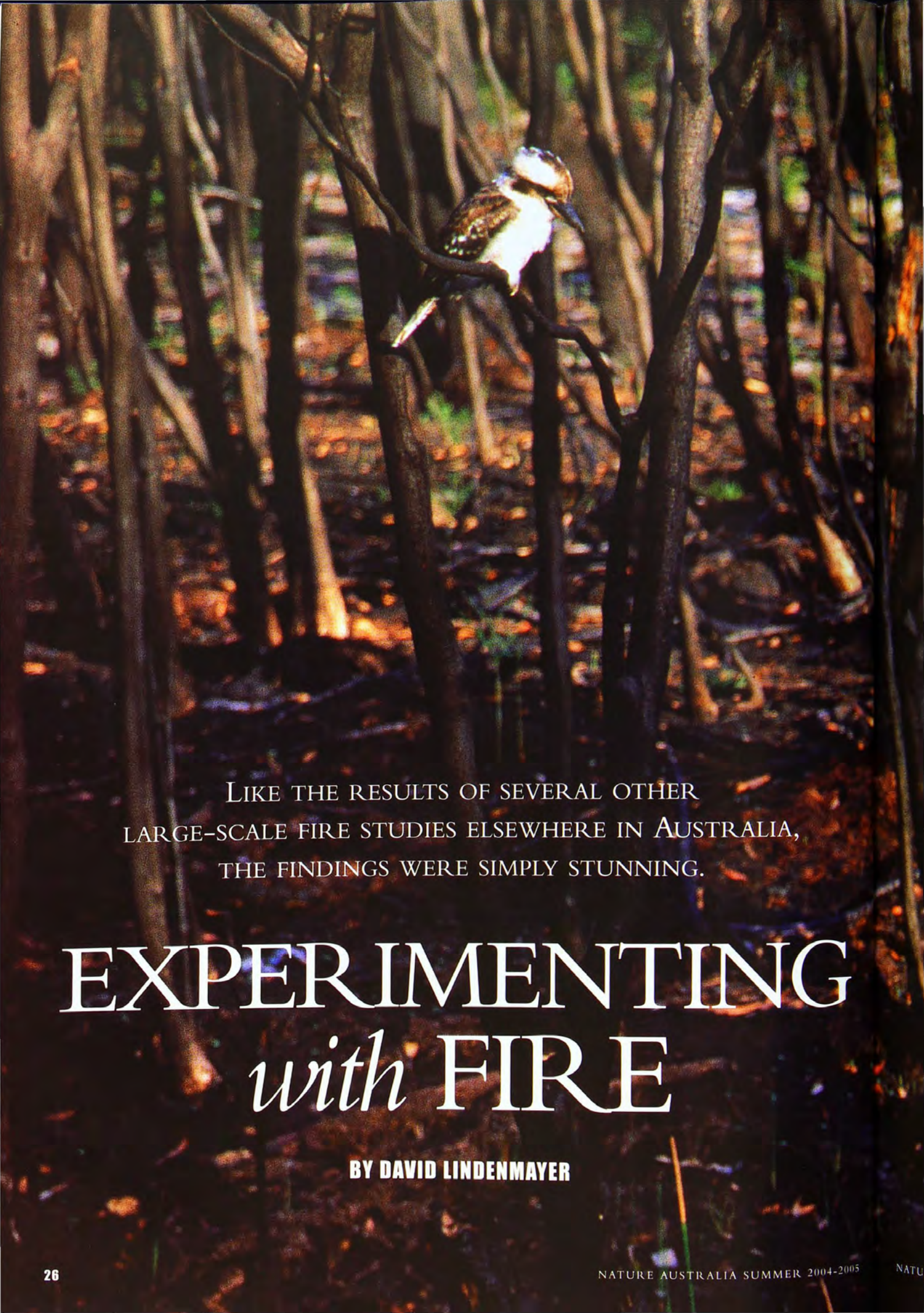
TIM LOW IS A MAINLY DIURNAL BIOLOGIST AND WRITER, THE AUTHOR OF SIX BOOKS, INCLUDING THE PRIZE-WINNING *THE NEW NATURE*.



LIKE THE RESULTS OF SEVERAL OTHER LARGE-SCALE FIRE STUDIES ELSEWHERE IN AUSTRALIA, THE FINDINGS WERE SIMPLY STUNNING.

EXPERIMENTING *with* FIRE

BY DAVID LINDENMAYER

Many species such as this Laughing Kookaburra (*Dacelo novaeguineae*) hunt for animals in burned areas that become significantly more open after fire.

ESTHER BEATON

IT WAS 6 A.M. ON CHRISTMAS EVE 2003. The "Majestic Fanfare"—better known as the jingle that heralds the start of the ABC radio news—filled my kitchen. I'd had little sleep. My kids were too excited about opening their presents the next day to let me stay in bed more than a few minutes past daybreak. Needless to say, I wasn't paying too much attention to the radio; it seemed like the same sad old stuff—more soldiers shot in Iraq, a bomb blast in Jerusalem, some political point-scoring over such and such. And then I heard it. "A major bushfire is burning out of control in Booderee National Park at Jervis Bay, near Nowra on the south coast of New South Wales. Over 1,000 hectares of bushland have been destroyed." This was devastating news for me, and could possibly have meant 12 months of exhaustive field efforts down the drain.

OVER THE PAST YEAR, WITH FELLOW researchers Ross Cunningham, Chris MacGregor, Damian Michael and Mason Crane, we had worked incredibly hard establishing 110 field study sites throughout Booderee National Park. The Herculean efforts were part of a major new experiment to quantify the response of birds, mammals, reptiles and frogs to prescribed (or hazard-reduction) fires in different vegetation types. The study was to be a five-year project, conducted in partnership with Environment Australia and the Wreck Bay Aboriginal Community, co-managers of Booderee National Park. The park was a wonderful venue for a fire and wildlife study. Not only did it support an extraordinary diversity of vegetation types ranging from rainforest to heathland and sedgelands, but there had already been major efforts to map and carefully document past fires—a practice that needs to be adopted more widely in Australian landscapes. It was also, quite simply, a visually stunning place to work, with some of the most spectacular cliffs on the east coast of Australia, beautiful white, sandy beaches, and a wonderful expansive bay environment. In many respects it is Sydney without the over-development.

Against this magnificent backdrop, the research team's task had been to locate and prepare field sites in different types of vegetation that had been burned between 5 and 40 years ago. First a person-wide transect line was slashed through the vegetation, which was often three or more metres high; then a line of pitfall traps (essentially buried buckets) was dug into the ground at each site—sometimes in the sand, sometimes carved into sandstone rock with a crowbar. The next step was to connect these with a 20-metre long, knee-high, plastic drift-fence, which served to direct animals running along it into the pits. Perhaps if we had known beforehand how much effort was involved in establishing these field sites, we may never have started the work in the first place! Indeed, by the time all 110 sites had been established, the study had become what is probably the largest pitfall and drift-fence study in the world.

The results over the first year had proved to be very exciting. We'd captured many Long-nosed Bandicoots (*Perameles nasuta*)—a species that had recovered well following poison-baiting efforts for feral predators, particularly the Fox (*Vulpes vulpes*), within the park.

KATHIE ATKINSON/ALSCAPE

Populations of the Long-nosed Bandicoot have increased substantially in Booderee National Park as a result of a massive poison-baiting program for feral predators, particularly the Fox. This species remains abundant in many areas in the park, including several burned ones.

Seventy of the 110 field sites in Booderee National Park were completely destroyed by the 2003 fires. Here, a new drift fence that connects a line of pitfall buckets is being re-established to replace the one that was melted by the fire front.

There was an extremely unusual marsupial mouse (*Antechinus* sp.), which to this day still does not match any species currently described for the genus, and several rare southern records of the Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*). The team had also added several new species of reptiles to the park's list. In addition, there were captures of Common Death Adders (*Acanthophis antarcticus*), Black-bellied Swamp Snakes (*Hemiaspis signata*), numerous types of skinks, and a legless lizard called the Common Scaly-foot (*Pygopus lepidopodus*).

Before the news bulletin was even over, it was obvious we needed a change of tack for our research project. I was not about to write off the previous year's hard slog to bushfire! So I arranged a visit to the park in early January 2004 and, when I got there, found that the vegetation on about 70 of our field sites had been burned and the pitfall buckets and drift-fences melted on them. Almost immediately we started the huge task of site reconstruction, and we decided to redirect the research focus on species recovery after fire, comparing populations on burned and unburned sites with those quantified before the fire had occurred. A prescribed-burning program was, of course, no longer relevant—this unplanned ('wild') fire having already burned the vast majority of sites planned for future prescribed fires.

By early February 2004, all the field sites at Booderee National Park had been restored. A team of Earthwatch volunteers then assisted the team in counting animals on them. We were not anticipating catching much, given the severity of the fire in many parts of the park. Indeed, we were already aware from reports from ranger staff that many individual animals had been killed. For example, there were many dead and badly burned Common Ringtail Possums (*Pseudocheirus peregrinus*), and raptors such as the Brown Goshawk (*Accipiter fasciatus*) and the White-bellied Sea Eagle (*Haliaeetus leucogaster*) were doing well on the carcasses. We suspected the Greater Glider (*Petauroides volans*) had suffered similar problems to those of the ringtail. In other cases, we thought that bird species such as the New Holland Honeyeater (*Phylidonyris novaehollandiae*), the Eastern Whipbird (*Psophodes oli-*

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Populations of the Common Ringtail Possum were reduced significantly by the 2003 wildfires and many carcasses of the animals were found. The species' dependence on dense understorey vegetation, much of which was consumed in the fire, make it especially vulnerable to fire and also predation following fire.

vaccus) and the Eastern Bristlebird (*Dasyornis brachypterus*) that were common and widespread before the fire, would now be rare or absent from burned sites. But how wrong our initial fears about a lack of animal captures proved to be!

Like the results of several other large-scale fire studies elsewhere in Australia (such as in the northern part of the continent), the findings of our first set of field surveys at Booderee National Park were simply stunning. Even though it was just six weeks since the fire, capture rates were remarkable. We caught lots of mammals such as the Long-nosed Bandicoot, the native Bush Rat (*Rattus fuscipes*), Brown Antechinus (*Antechinus stuartii*), Common Brushtail Possum (*Trichosurus vulpecula*), Eastern Pygmy-possum (*Cercartetus nanus*) and Sugar Glider (*Petaurus breviceps*), and also reptiles including the Black-bellied Swamp Snake and Diamond Python (*Morelia spilota*). While it was clear that many species at Booderee National Park had suffered as a result of the fire, populations of many others had already started to recover, and some such as the Garden Skink (*Lampropholis guichenoti*), seemed to be largely unaffected. However, we are concerned about the fates of some species come winter, when plant growth rates slow or stop. Indeed, the true long-term impacts of fire on populations of many species will not be known for many years, which is one of the reasons we plan to closely monitor the field sites at Booderee National Park well into the future.

As I write, just three months after the fire, there already seem to be some important general lessons emerging from the work at Booderee National Park (and the work completed in many other studies of fire around Australia). The first is the fallacy of how fire destroys bushland—something well known by Australian ecologists but typically misreported by the Australian media. Many of the trees and shrubs at Booderee have resprouted and seedlings of others have germinated. The leaf litter, fallen branches and sticks provide cover and places in which to forage for many species. Also, like most fires, the blaze at Booderee National Park was patchy. Areas of bush were often unburned or only partially burned within the general area affected by the fire. These provided important refugia for many animals, with capture rates being typically much higher near these places. Similarly, rocky outcrops also provided shelter for animals during the

The Diamond Python is a large and charismatic native predator that occurs at Booderee National Park. The way it uses burned areas is unknown and is the subject of a newly commenced radio-tracking study by the author and his team of researchers.

ESTHER BEATON

Animals such as the Short-beaked Echidna (*Tachyglossus aculeatus*) were occasionally found in burned areas with high leaf-litter fall but were far less abundant than in the unburned parts of the park.

fire. So events like these unplanned fires, which are regarded as 'natural disasters' by humans, are not always 'disasters' for the ecosystems or the species that inhabit them.

Another important lesson is that even those trees and shrubs that were killed will still make a significant contribution to the structural complexity of the new stands of forest, woodland and heath that regenerate in the burned areas. Dead standing trees and logs, for example, will be valuable habitat for many elements of the biota in the years to come. These trees and logs are what have been termed the 'biological legacies' of natural disturbance events, and they can play important roles in assisting ecosystem recovery after perturbations like fire. Conversely, removing them, as may occur when salvage operations are made to 'clean up' forests damaged by fire, can significantly impair wildlife and ecosystem recovery.

Finally, the response of many species at the sites at Booderee National Park are likely to be influenced not only by the intensity and patchiness of the most recent fire but also the amount of time that elapsed since the previous fire. For example, species composition and richness in heathland that was burned in late 2003 and five years earlier will be very different from nearby heathland that was also burned in December 2003 but had previously not experienced fire for over 20 years. As noted by Malcolm Gill, one of Australia's leading fire scientists from CSIRO Plant Industry and the Australian National University, "one fire does not an ecosystem make".

This last point is a critical one as it relates to what has been termed a 'fire regime'. A fire regime is the sequence of fires typical of a given area and it has four key components: fire intensity, fire type (for example, crown or ground fire), between-fire interval (or frequency), and season. Europeans have dramatically altered the fire regimes in Australia and numerous native species are threatened as a result. Indeed, altered fire regimes now threaten more species of Australian birds than any other threatening process except for land clearing. Given this, it is essential that we learn much more about fire and its impacts on the Australian biota, and how Aborigines used fire to manage their land, so that in the future it will be possible to determine ecologically sustainable fire regimes and fire-management practices. Hopefully the collaborative effort by the Wreck Bay Community at Jervis Bay and Environment Australia will make a contribution to achieving this goal. □

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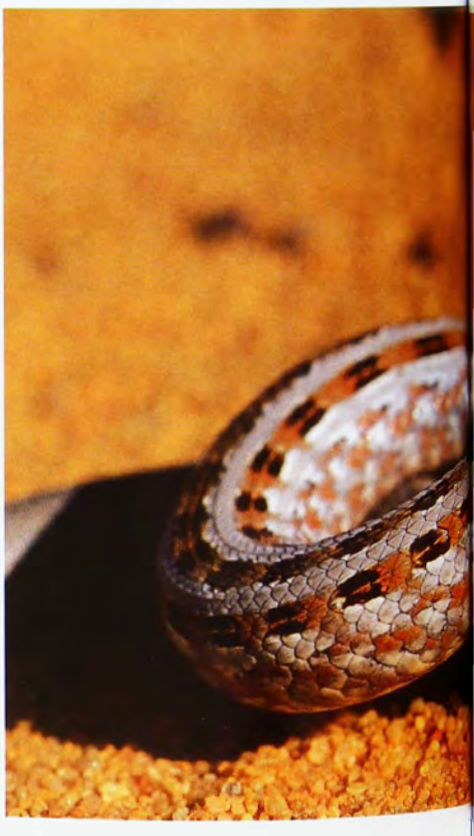
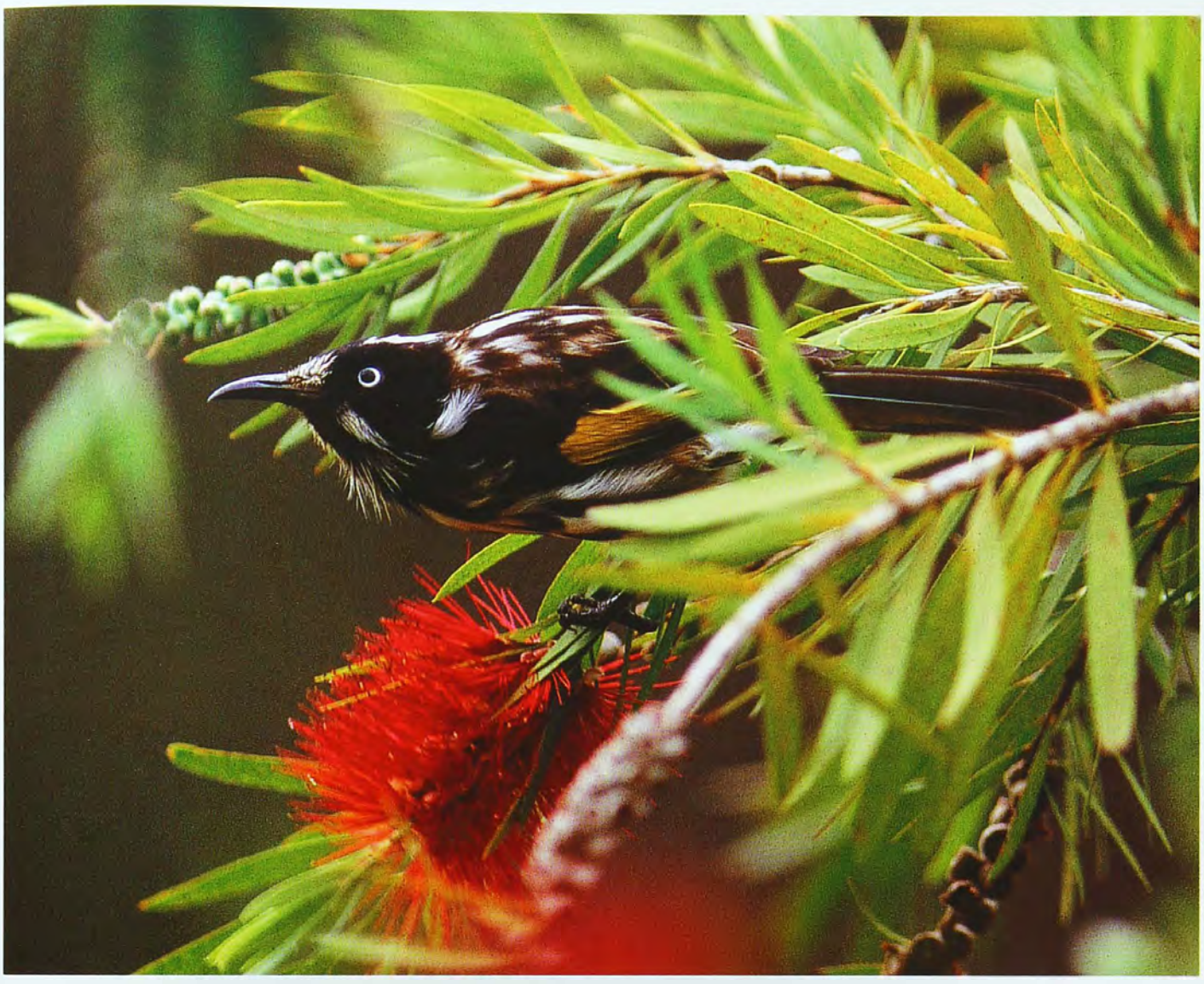
Virtually no burned areas supported the New Holland Honeyeater immediately after the fire. However, by the following spring, small numbers of birds had begun to return to heathlands and shrublands in the park.





JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

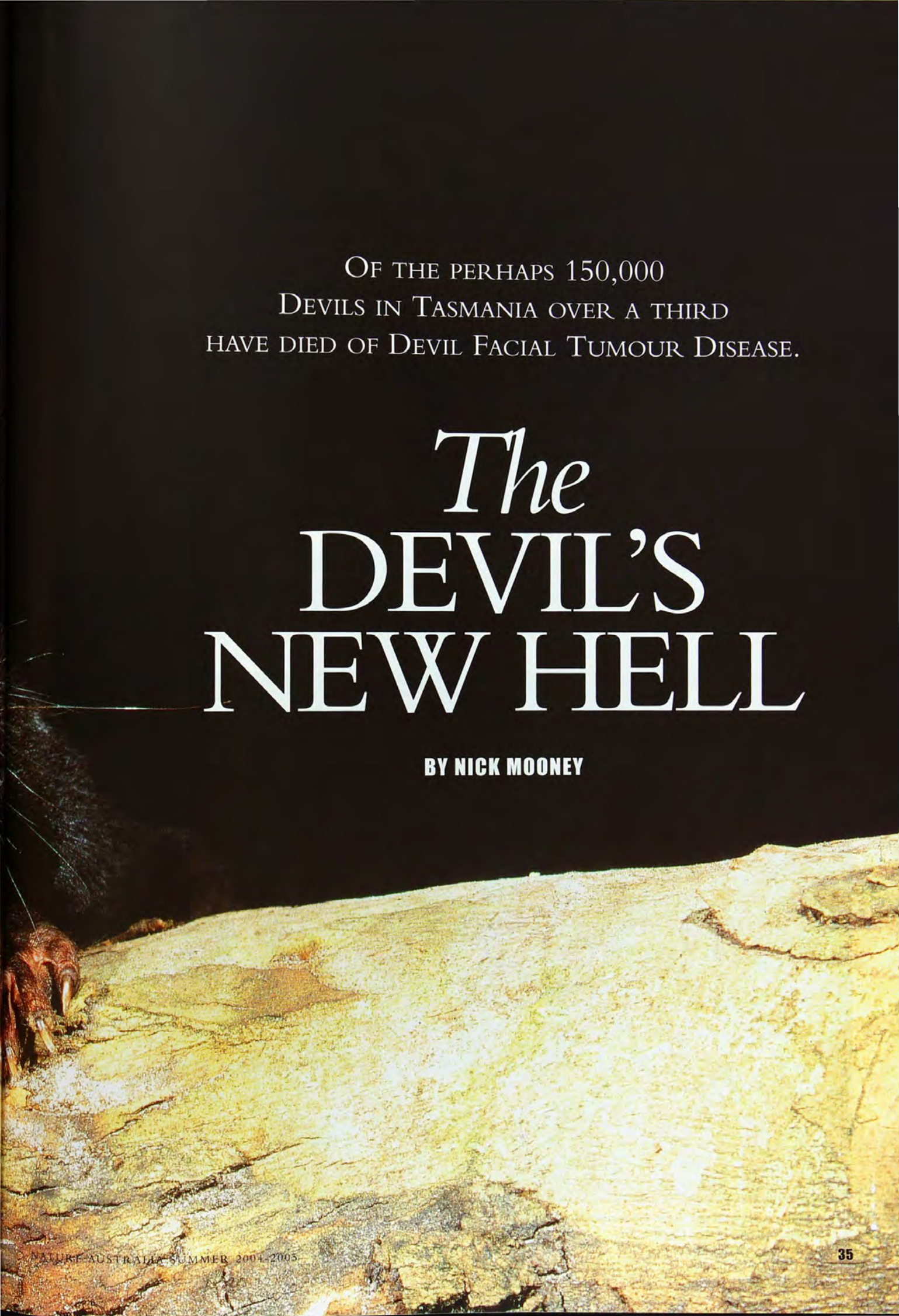
A rarely observed species in Booderee National Park is the Common Scaly-foot. Although superficially resembling a snake, it is a legless lizard, with taxonomic affinities to geckoes.

Although Devils cannot jump vertically, they are steady, persistent climbers, especially useful for picking up scent and sound.

OF THE PERHAPS 150,000
DEVILS IN TASMANIA OVER A THIRD
HAVE DIED OF DEVIL FACIAL TUMOUR DISEASE.

The DEVIL'S NEW HELL

BY NICK MOONEY



NOT SO LONG AGO IT WOULD have been hard to visit any Tasmanian forest or beach and not come across some evidence of Tasmanian Devils (*Sarcophilus harrisii*), be it their footprints, scats or late-night, blood-curdling screams. These days, signs of the Devil are not so common; in most areas, road-killed Devils are now a novelty, and carrion lies rotting where previously it would have been reduced to scraps within hours of darkness. What has happened to "Harris's flesh-lover"?

Devil populations have crashed over half of the State and it's far from over. Of the perhaps 150,000 Devils in Tasmania in 1990 over a third have died of Devil Facial Tumour Disease. Unthinkable a few years ago, Devils now face inclusion on Tasmania's threatened species list.

The first hint that something was wrong came in the early 1990s with comments that Devils had become rare in 'Devil heaven'—far north-eastern Tasmania. Then in 1996, Christo Baars photographed some hideously disfigured Devils at Mount William National Park where David Pemberton (Tasmanian Museum and Art Gallery) first radio-tracked Devils a decade before. A pathologist suggested Lymphosarcoma, likely caused by a retrovirus, and suggested the Devils could have been bitten by Cats (*Felis catus*), a species prone to such things.

THE FIRST HINT
that something was wrong came with comments that Devils had become rare in 'Devil heaven'.

I visited the park and set traps, expecting on past experience to catch 15 or so Devils of both sexes and a variety of ages. However, all I caught was a solitary juvenile. Something strange was happening.

For years David and I had argued for systematic monitoring of Devil populations but because Devils were officially 'secure' they apparently did not warrant funding. Instead we got assurances about the effectiveness of 'passive monitoring' (making incidental observations during other work). How hollow those labels are proving to be.

Meanwhile in 1999, during a Statewide genetics study of Devils, Menna Jones (University of Tasmania) noted badly tumoured adults near Little Swanport, on the east coast. Menna was also studying Devils along nearby Freycinet Peninsula. All was well in this area until 2001 when she started finding gross tumours there too, providing the first specimens for examination by veterinary pathologists. Within five months nearly all the adult Devils had died. Survival of juveniles, however, was unusually high, perhaps because of less competition with and predation from adults (like most carnivores, Devils may eat each others' young). While there were reduced impacts in areas with fewer Devils, the general trend

CHRISTO BAARS

This adult Devil with advanced cancer, photographed at Mt William National Park in 1996, was the first record of Devil Facial Tumour Disease. The Devil probably had less than a month to live.

towards increasingly younger Devils in all diseased areas meant there could be a risky lull in breeding.

To complicate matters, in 2001 Foxes (*Vulpes vulpes*) were discovered in Tasmania—this time not just the past eccentric incidents but an apparently concerted effort at introduction. The Fox Free Taskforce was born and I was assigned to tailor Fox detection and eradication to Tasmania's special situation (having many large dasyurids and very few Foxes, the exact opposite of mainland Australia).

With the help of Marco Restani (St Cloud State University, Minnesota), I went to Epping (northern midlands) to look at the take of Fox baits by Devils. Seven of the 23 Devils we caught, while looking for the tracer dye we had in the baits, were horribly tumoured. Obviously the disease was far more widespread than thought. "A fat lot of good passive monitoring is," we chorused and decided to go 'active'.

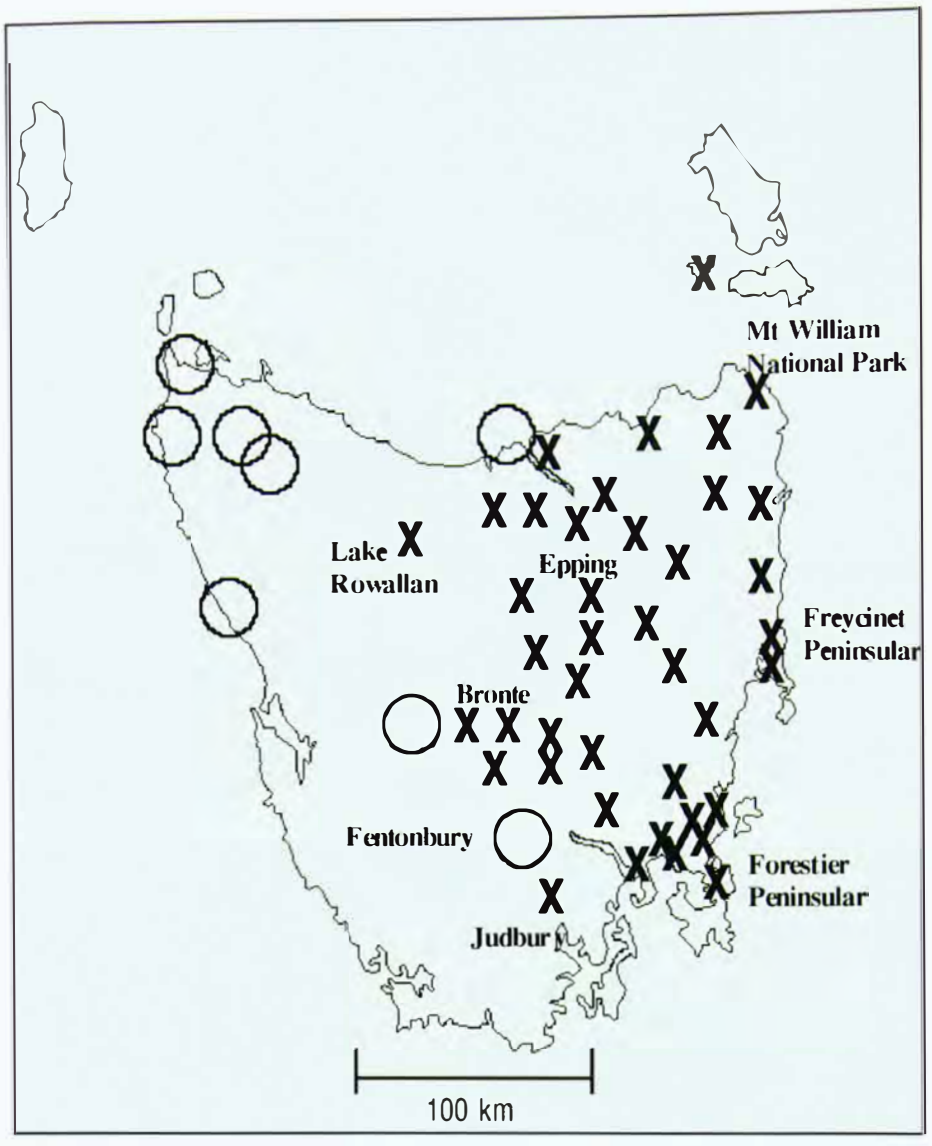
We embarked on a 'snapshot survey' of 40 randomly chosen sites, ricocheting around the State with our rapidly disintegrating hire-trailer. We used new PVC 'pipe-traps', designed to facilitate cleaning and to reduce the incidence of injuries that Devils sustain while trying to escape from cage traps. It soon became apparent that the disease was widespread over central and eastern Tasmania but seemed absent from the far south, west and north-west. This was important, because Menna's work showed that the western Devils were different to those in the central/eastern areas. Perhaps the north–south band of wet forest that crudely separates these subpopulations also acts as a disease buffer.

To prevent further spread of the disease, relocation of nuisance Devils ceased, and tattooing, up to then the standard marking method for Devils, was swapped for microchipping (a method with less risk of infection). Movement of captive Devils within Tasmania and to the mainland was also put on hold because there was no test for the disease beyond looking for tumours.

In late 2003 some of Australia's top wildlife disease experts came together

PHOTOS DAVE RALPH

(Top) The author checks a PVC 'pipe-trap' containing a Tasmanian Devil. The PVC traps prevent Devils from injuring themselves and can be thoroughly cleaned to prevent any cross-infection. (Bottom) The author examines an adult Devil with a tumour on her nose and large pouch-young. Contrary to their reputation, Tasmanian Devils are easy and safe to handle if treated gently.



Map of Tasmania showing distribution of Devil Facial Tumour Disease, by late 2004. Crosses indicate affected sites; circles are sites where the disease has not shown up.

for a workshop. Although Australia has Ausvetplan to deal with disease outbreaks in stock, nothing similar exists for wildlife. In an unprecedented move, then Tasmanian Premier Jim Bacon declared that "the Devil would not be allowed to follow the Thylacine into extinction" and committed $1.8 million over three years. This funding was crucial, 'kick-starting' a sophisticated rescue program under the Department of Primary Industry, Water and Environment.

The project now involves most of the current Devil experts in integrated programs of disease description and testing, mapping and monitoring the effects of the disease in the field, and management of Devils. Public interest has been phenomenal and I'd have to say that only the rediscovery of the Thylacine would generate more attention.

To work up a formal description of the disease, a team from the Department's Animal Health Laboratories has been closely examining both diseased and healthy Devils. Stephen Pyecroft, Richmond Loh and Anne-Maree Pearse concentrate on the laboratory work, while Robyn Sharpe and Nolan Fox take biopsies and blood in the field. The tumours were first thought to have characteristic rounded cells, suggesting a retrovirus was involved. However, it appears to be more complex. It may even be that Devils' DNA has somehow been damaged, and we are now searching for abnormalities in their chromosomes.

For cancers to develop, they need an 'initiator' (the potential) then a 'promoter' (the trigger). A genetic vulnerability can serve as the potential, and the trigger may be viral, chemical, or result from radiation or even chronic physical damage such as repeated biting (this may be one reason tumours are most obvious around the head and neck). If Devils have the genetic potential for Devil Facial Tumour Disease, then perhaps at high densities something triggers an outbreak. Social stress can suppress immune systems and certainly there are more physical confrontations at high densities. The disease may even be sexually transmitted.

The disease typically starts off as raspberry-like lesions on the gums, palate and under the tongue. Within months tumours become obvious around the mouth and can change so much over a few weeks that once or twice we have had to double-check our records to make sure we were looking at the same individual! Tumours can be in hard tis-

KATHIE ATKINSON

Devils love sunning, stretching and flattening themselves out like a bear rug. In hot weather they sometimes even lie in puddles.

sue connected to bone, even pushing the teeth out, or in the loose skin of the neck, often weeping from secondary infection. Bone loss from the skull of some Devils is also consistent with certain types of cancer that interfere with calcium use. Death occurs usually three to six months from the first symptoms.

Some people have suggested we should euthanase diseased Devils for welfare reasons. With some extreme cases I agree (and we occasionally have); but in humans many tumours have few nerves and people with cancers report varying degrees of pain. The same might apply to Devils. If we euthanase too freely we could be doing more

Tasmanian Devil

Sarcophilus harrisii.

Classification
Family Dasyuridae (carnivorous marsupials).

Identification
Black, usually with white markings on chest, shoulders and rump. Males average 10 kg, females 6 kg.

Distribution and Habitat
Eucalypt forests and woodlands across Tasmania.

Biology
Nocturnal scavenger on animal carcasses, including wombats, wallabies, possums, birds and stock. Also an opportunistic hunter of vertebrates and invertebrates. Produces 1 litter of 4 young per year, with 4-month pouch life. Young left in grass-lined, underground den Aug.–Jan., after which they become independent.

Devils are powerful carnivores with heavily muscled necks and well-balanced senses of hearing, smell and sight. Super-long whiskers allow navigation in dark corners and 'touch-parking' outside nipping range when feeding alongside other Devils.

harm than good, since some minor cases might recover, producing especially valuable individuals. Simple mistakes can also be made; several Devils euthanased by well-meaning people have, in fact, just been battle-scarred warriors. Distinguishing human niceties from animal welfare can be a tough call.

Still, the resilience of some Devils is astounding. Some severely diseased Devils continue to breed and exhibit the normal seasonal changes in body condition, provided they have not lost too many of their teeth and their senses are not critically impaired.

We are finding that old males (four to six years of age) are the first to get the disease, then old females, then younger adult males. Adult males sometimes fight very fiercely over mates and therefore may be more prone to becoming infected. Immatures (up to two years old) rarely exhibit tumours but as they age, infection rates suddenly rise. This results in serial knock-down of populations—initial loss of most adults then later losses as younger age-groups mature—and perhaps explains why Devils are still rare in the earliest places affected. Recovery, presuming it occurs, may take decades.

Clare Hawkins, Billie Lazenby, Jason Wiersma, Andre Skullthorpe and I are busy mapping the disease spread and monitoring the effects, and feeding the data back to Menna Jones and Heather Hesterman for making management decisions. West-coast Devils are still abundant and seem okay, but with the disease rampant less than 50 kilometres away, it's hard to imagine the disease will not saturate the State sooner rather than later.

WHERE DID THE DISEASE COME from? Many options are being considered, but answers await exact diagnosis. One worry is that the disease is exotic and Devils have little resistance to it, perhaps explaining the widespread, severe impact. If a virus is involved, it may have crossed from another species with resistance. Some chemicals can suppress immunity or even damage DNA, and a few cancers are directly infectious.

Although the disease has only been seen in Devils, we are mindful of the giant leaps HIV, SARS and Bird Flu have made. In the field, it's new standards—surgical gloves, disinfection of hands and traps, and disposal of handling bags. Luckily Devils are easy to work with if you are gentle, and bites are very rare.

Devils have been rare in the past. Research by Eric Guiler (while at the University of Tasmania) suggests three population lows since Europeans arrived, but we don't know what happened in between, since reports were very anecdotal. Certainly Devil cap-

tures in the 1940s and '50s were newsworthy, and Menna's study shows that Devils have surprisingly little genetic diversity suggesting a past 'bottleneck'.

We don't know whether Devil Facial Tumour Disease has occurred before. A few old-timers claim to have seen something similar in the 1960s but there is nothing in the literature and no specimens. Importantly, Eric Guiler *never* saw the disease in the many Devils he trapped through the '50s, '60s and '70s.

The lack of a practical diagnostic test handicaps both survey and management. We might move to prevent catastrophe by isolating apparently healthy Devils, but for all we know, squeaky-clean juveniles could be incubating the disease, perhaps being infected before birth, or through milk, saliva or contact with a mother's lesions. So far, captive Devils seem healthy, suggesting contact with a diseased individual is necessary for infection.

Disease alone rarely exterminates a species, historic exposure usually giving species some degree of resistance. However, often it is the less obvious effects of disease that are more insidious, with species being set up for extinction by fragmentation of populations and diminished genetic diversity. Some people have suggested the disease is simply nature's response to unprecedented high densities (perhaps in part because the Thylacine is gone), but it is Foxes that make the situation especially dangerous. Normally Devils would likely act as a buffer against Foxes, through competition for carrion and predation on Fox cubs, but where Devils have 'crashed' independently of food, conditions are perfect for Foxes. Some farmers are compensating for the lack of Devils by burning or burying their dead stock, but most of the hundreds of thousands of wallabies and possums shot to protect crops are left where they fall.

If Foxes take advantage of this unprecedented opportunity, Devils will be unlikely to recover and Foxes will devastate Tasmania's wildlife and stock. Foxes are not the only bad news; in areas of Devil disease, Cats already seem to be more abundant.

There are positives though. I have long thought Devils to be a limiting cap of sorts on Spotted-tailed Quolls (*Dasyurus maculatus*), and these lithe dasyurids seem to be increasing in diseased areas. Likewise, raptors such as eagles and harriers that rely heavily on carrion may do well. Devils' principal prey (wallabies and possums) may increase too—although this news is unlikely to be welcomed by farmers.

Almost unbelievably, some people still persecute Devils, but the Fox and disease sagas have produced a general shift in how Devils are viewed. Many hard-liners have mellowed, with one farmer who habitually killed Devils recently enthusing to me about protecting them. Even though the disease has decimated Devils on his property, he says they are still his best defence against Foxes "since you buggers in Government are so bloody useless". Fine by me; I'll eat any amount of humble pie to help our Devils through the 'last hurrah' of European predator-hysteria and their new hell—disease. I too do not want this fantastic animal to follow the Thylacine into premature oblivion. They deserve much better than that. □

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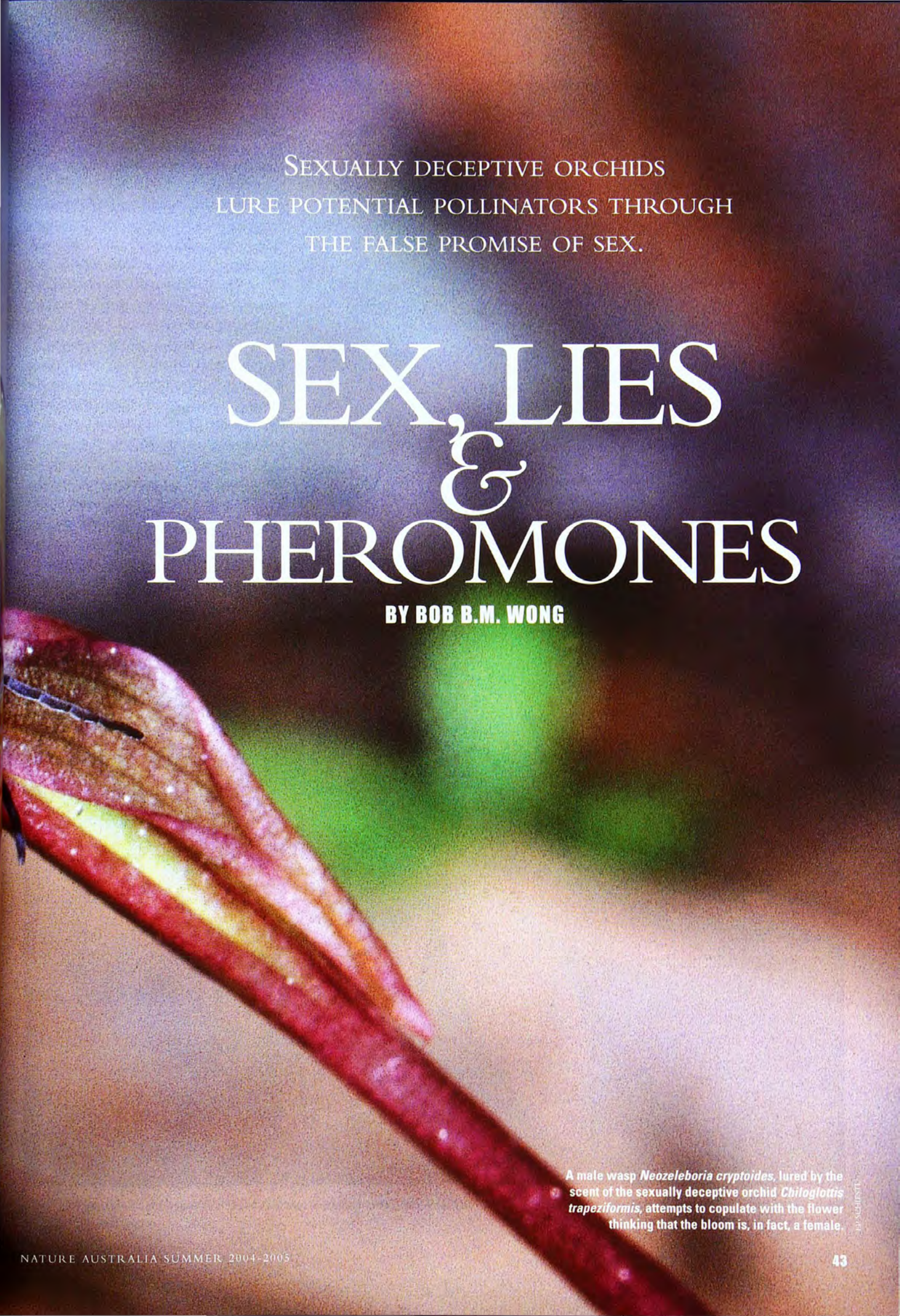
ESTHER BEATON

Although Devils fight over food and mates, and even during copulation, most bites are not serious. However, Devils' mouths may yet prove to be lethal weapons by spreading disease.

SEXUALLY DECEPTIVE ORCHIDS LURE POTENTIAL POLLINATORS THROUGH THE FALSE PROMISE OF SEX.

SEX, LIES & PHEROMONES

BY BOB B.M. WONG



A male wasp *Neozeleboria cryptoides*, lured by the scent of the sexually deceptive orchid *Chiloglottis trapeziformis*, attempts to copulate with the flower thinking that the bloom is, in fact, a female.

IT DOESN'T TAKE A LOT OF EFFORT to induce a sexual frenzy in the middle of the Australian bush. You only need a single flower. And getting to the right spot isn't too much of a hassle either. Black Mountain is a nature reserve located minutes from the city centre of Canberra. Telstra Tower, one of Canberra's most conspicuous landmarks, is perched high on top of the mountain's summit. Despite the tower's presence over the city, the concrete behemoth is hardly visible from where I found myself standing one morning in early September.

I was on the western side of the mountain in a typical patch of open native woodland. The air was warm, there was a scent of eucalyptus, and the sounds of birds and bugs rang in my ears. My colleague Florian Schiestl and I made our way up one of the many dirt tracks that crisscrossed through the bush. Not too long afterwards, we diverged from the track and scrambled our way through the scrub. We soon came to a halt. Florian gently freed a six-centimetre tall orchid from a container in his backpack and propped it on the ground. We then stood there with our eyes fixed on the tiny bloom and waited for the sexual flurry to begin.

It didn't take long for a male wasp to appear. In fact, it was only a matter of seconds. Quick on his wings, the wasp zigzagged through the air, landed on the flower and tried desperately to mate with it. I then noticed a second male. He too was flying in a strange zigzag configuration close to the ground. Soon, it seemed, a whole swarm of wasps had alighted on the same flower, which by now had become a seething bundle of tangled legs, beating wings and thrusting abdomens.

THERE IS SOMETHING MESMERISING about orchids. Human fascination with this diverse group of flowering plants dates back to at least 500 BC. The Chinese first made reference to them in some of their ancient writings, and early Europeans were fascinated by the curious tubers of certain ground-dwelling species that bore a remarkable resemblance to testicles. In fact the name orchid comes from the Latin *orchis* meaning testicle. Since then, they have been cultivated, decimated, revered, plundered and coveted the world over. Of all the flowering plants, orchids are, without a doubt, the most seductive, captivating and sensual.

Orchids employ a variety of strategies to achieve pollination. In most cases, they rely on the help of insects. Some species reward their pollinators with food in the form of nectar or edible pollen, but many orchids do not. In fact, orchids are masters of duplicity when it comes to luring insects. Why reward when you can deceive? For example, at the time of our visit, the western slopes of Black Mountain were peppered with the delicate blooms of

STEVE WILSON

When it comes to pollination, orchids are not only masters of sexual duplicity. *Caladenia carnea*, a species common on Black Mountain, fools its pollinators through the empty promise of food.

Both the orchid *Chiloglottis trapeziformis*, and female wasps *Neozeleboria cryptoides*, use the same single compound to attract males. By applying a dab of the compound onto a bead, the author and colleagues were able to test how the sexually deceptive orchid impacts its pollinator.

ROD PEAKALL

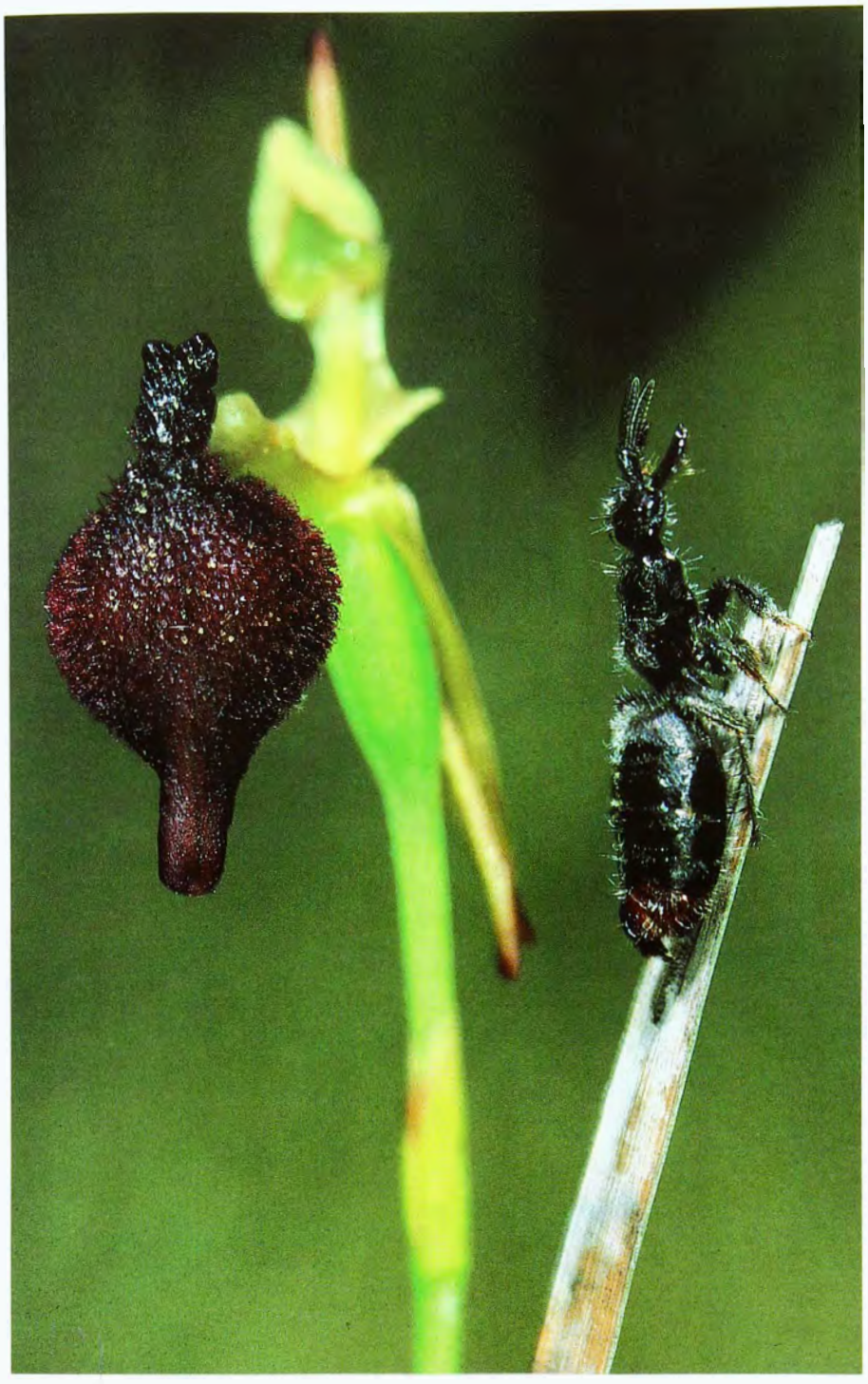
Caladenia carnea. The tiny pink flowers of this orchid promise prospective pollinators a nutritional reward for their efforts but deliver nothing but lies and hunger. Food trickery seems bad enough but more insidious, in my mind, is to lure potential pollinators through the false promise of sex.

Sexually deceptive orchids usually mimic the smell, look and feel of female insects to attract unsuspecting males to the flower. The most important of these cues is scent. *Chiloglottis trapeziformis*, the orchid that seduced the male wasps on Black Mountain, is a sexual swindler. The orchid is found in south-eastern Australia and flowers in the spring, roughly the same time that its wasp pollinator is active. Like other sexually deceptive species, *C. trapeziformis* relies on chemical mimicry of wasp sex pheromones to lure its pollinator from afar. By doing so, the orchid is essentially exploiting the intense competition that exists when males are looking for females. This explains why so many males were drawn to the flower so quickly.

At close range, visual and tactile mimicry of the female completes the sexual masquerade and mediates the sexual encounter necessary for pollination. The males usually alight on a modified petal known as the labellum, which is purpose-built for providing an important landing platform for pollinators. In the case of *Chiloglottis trapeziformis*, small globular maroon bumps on the labellum bear a striking resemblance to the look and feel of a female wasp. These female dummies, however, are slightly larger than the real thing and recent research suggests that this makes them just that little more alluring. In many animal species, males often prefer larger females, probably because such females also produce more offspring. In wasps, it appears, big also is beautiful. As the male attempts to mate with the dummy female—a behaviour known as 'pseudocopulation'—pollen from the orchid rubs off onto the wasp. Eventually though, the male realises that his efforts have been futile and, with pollen glued to his back, flies away in search of another 'female'. And if that female turns out to be another orchid, then he has the potential to fertilise it with pollen from his previous encounter.

Only a few scientists have looked at the impact of sexually deceptive orchids and most of what we know concerns the males that get duped. In contrast, we know little about how females are affected by the orchid's deceit. This may be hardly surprising since males are often a lot easier to find than females. Nevertheless male and female wasps often have very different biologies and so are likely to be affected in different ways. This is especially true for *Neozeleboria cryptoides*, the wasps that pollinate *Chiloglottis trapeziformis*. These wasps belong to a group known as thynnines, which are frequently employed as pollinators by sexually deceptive orchids in Australia. The females are all wingless, and are entirely dependent on the use of pheromones to attract the flying males. Besides the actual mating, females also rely on males to carry them to their food source and to return them to a suitable egg-laying spot.

The impact of sexually deceptive orchids on males is probably minimal. Male wasps are not completely enslaved by the orchid. Studies have shown that, although males will react very quickly



BOB PEARCE

After luring male insects with their perfume, sexually deceptive orchids complete their masquerade by having floral parts that look and feel like sexy females. This is a female of *Zaspilothynnus trilobatus* compared with the labellum (modified petal) of the sexual deceiver, *Drakaea glyptodon*.

to the scent of the orchid, very few visits to the flower will actually result in the pseudocopulatory behaviour needed to detach the orchid's pollen. Moreover, even when contact is made, ejaculation has never been observed. Since competition for females is so intense, the energetic cost of being duped would be akin to being pipped at the post by earlier-arriving males. In any case, males habituate rapidly to the orchid's presence and soon learn to avoid areas where they previously have been fooled. Although this doesn't mean that they won't get duped again in some other part of the woodland, at least they won't be drawn to the same spot and waste their time over and over again. (This avoidance strategy is also beneficial to the orchid, by reducing the potential for self pollination.)

The impact on females, however, is less well understood. The strategy used by males to avoid repeated encounters with flowers could have important consequences for the wingless females. Occasionally, in several other species of thynnine wasps known to pollinate sexually deceptive orchids, females have been observed in the middle of a patch of orchids trying to attract a mate. Florian Schiestl, who was visiting from the Geobotanical Institute in Zürich, was keen to investigate how sexually deceptive orchids might affect the wingless female wasps. Florian is an expert on sexual deception and has done some remarkable work looking at sexually deceptive orchids and their pollinators in Europe. European *Ophrys* orchids are also sexual swindlers and achieve pollination by fooling male solitary bees. Female bees, however, have wings and so are not entirely dependent on males in the same way that Australian thynnine females are. In this regard, the pollinators used by sexually deceptive orchids in Australia provided an interesting contrast to those in Europe. Specifically, because female thynnine wasps are wingless, this gave us an extraordinary opportunity to study how orchids might affect the models in the mimicry system—the female insects. To our knowledge, this had not been done before. During Florian's visit to Canberra, I happened to be working on my own Ph.D. research on fish (see "What Females Want", *Nature Aust.* Winter 2004). However, because of my long-standing hobby interest in orchids and my desire to get out of a steaming aquarium room, Florian and I decided to collaborate and we spent two weeks in spring studying wasps and orchids on Black Mountain.

WE BEGAN OUR INVESTIGATION BY firstly testing whether male wasps could discriminate between the scent of orchids and females. This was an important question because we were interested in seeing just how good the orchids' mimicry of females actually was. We found that male wasps did not prefer females to orchids. Rather, the two were equally attractive, suggesting that males couldn't tell an orchid from a female based on scent alone. We then tested the attractiveness of females in the presence and absence of orchids.

For this part of the experiment, we set up temporary patches of flowering orchids in the woodland. We found that females were most attractive when tested away from orchids and that they elicited the amorous attention of numerous males when they began to emit their sex pheromone. Females, however, were far less successful when trying to attract the attention of males in areas occupied by flowering orchids. Even in small orchid colonies containing five flowers, females received fewer approaches by males and no copulation attempts than when they were alone. In a larger patch of orchids, comprising ten flowers, the situation was even more dire. During the course of our experimental trials, males neither approached nor attempted to copulate with females in large orchid colonies.

From our results, it appears that females, at the very least, might have to wait longer before a passing male picks up her scent if she tries to attract mates in a patch of flowering orchids. However, because males can't tell the difference between orchids and females, and tend to avoid areas where they have encountered unrewarding flower decoys, females could, potentially, be faced with a challenge. It may be possible for females simply to crawl out of the orchid colony. We have subsequently found that female attractiveness increases with distance away from the orchid patch but for such a small wingless insect, crawling to a better spot away from flowers could still be costly, an issue that needs to be investigated further. At the very worst, especially in larger orchid patches, females may be unable to elicit any copulation attempts. It appears, therefore, that the orchids' duplicity may actually have negative consequences for the pollinating species.

Harm has previously been argued by some scientists as an essential prerequisite for driving the evolutionary arms race between sexually deceptive orchids and their pollinators. According to proponents of this controversial theory, a negative impact on the pollinator would lead to the evolution of male insects that are better at discriminating between flowers and females. This, in turn, would place selection pressure on the orchids to fine-tune and maintain their mimicry of females so they can continue to fool their pollinators. In truth, however, there is still much that needs to be learnt about the evolutionary interactions taking place between sexually deceptive orchids and their pollinators. And, although we have found that orchids can have a potentially negative impact, we still don't really know for sure whether this level of harm is actually enough to trigger a coevolutionary arms race or, indeed, to keep it in motion. What is certain, however, is that both plant and pollinator can ill afford to rest on their laurels in this sordid world of sex, lies and pheromones. □

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ROD PEARCE

Pollen from *Chiloglottis trapeziformis* is firmly attached to the male *Neozeleboria cryptoides*. To effect pollination, however, the wasp will now have to be duped by another flower, perhaps in another part of the woodland.

CORMORANTS ARE HIGHLY ADAPTABLE BIRDS THAT CAN FORAGE QUITE HAPPILY IN AREAS CROWDED WITH PEOPLE.

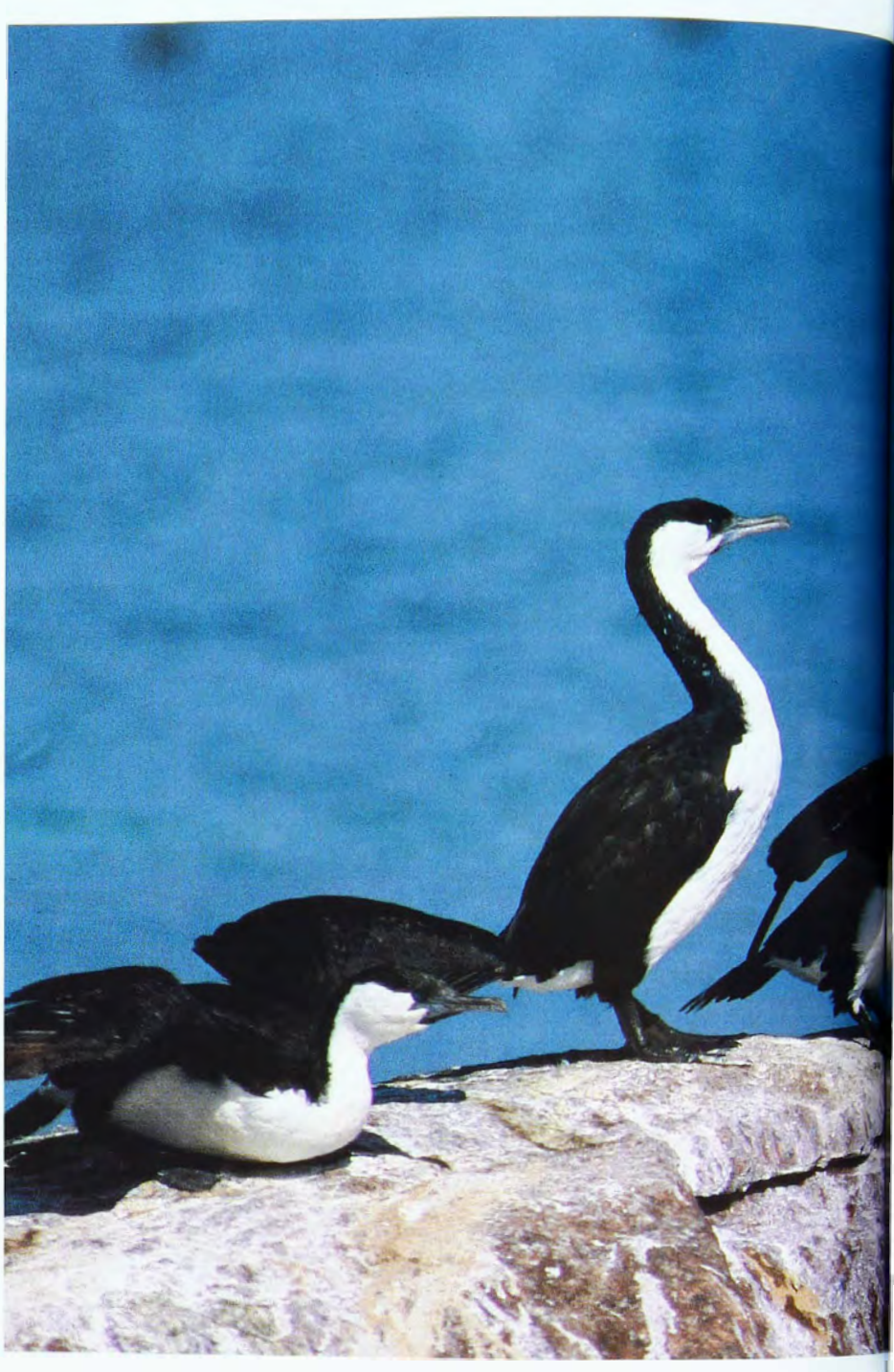
SHAG AT THE ROCKS

BY ERIC DORFMAN

(Above) Unlike the east and interior of Australia, Pied Cormorants on the west coast live and nest in association with the sea, forming large foraging flocks to catch pelagic fish. This could be because of the greater productivity of the eastern Indian Ocean. (Right) Pied Cormorants readily use built objects, like this pier piling, for roosting and foraging, making it easier for them to adapt to human environments.

SEVERAL YEARS AGO, WHEN I was still collecting data for my Ph.D. on cormorants, I was lucky enough to live in a flat that overlooked Sydney's Blackwattle Bay. The bedroom had a spectacular view of the whole of the bay, with the newly built ANZAC bridge and Fish Markets dominating the magnificent scene. One Sunday morning, as I squinted blearily from my bed, I noticed a small black and white bird diving under the water next to busy Pyrmont Bridge Road in search of whatever small prey it happened to encounter. It was a Little Pied Cormorant (*Phalacrocorax melanoleucos*). Not wanting to pass up the opportunity of being the only person I knew who had collected field data from bed, I fumbled for a pair of binoculars, a stop watch and data sheet, and timed the duration of its dives and surfacings for about 15 minutes. This was one small datum point of a study comparing dive patterns of four of Australia's five species of cormorants (also called shags) over different sorts of substrate, looking at the importance of microhabitat to behaviour. I did this work in many habitats, from remote temporary lakes of outback New South Wales to some of the most popular tourist destinations in the heart of Sydney.

A LITTLE *Pied Cormorant feeding at the Hawkesbury River might have hatched in Papua New Guinea, necessitating a flight over Torres Strait.*



Urban Sydney provides a surprisingly large number of sites that are good for foraging cormorants. This is partly because cormorants are highly adaptable birds that become accustomed to the presence of humans very readily and can forage quite happily in areas crowded with people. It is not uncommon to see flocks of Little Black Cormorants (*Phalacrocorax sulcirostris*) foraging between the ferries at Circular Quay, or Great Cormorants (*P. carbo*) hunting for eels at the lake in Bicentennial Park. In addition, many of Sydney's waterways still have a high proportion of natural seagrass meadows, and these harbour a greater abundance and diversity of fishes than other types of local marine habitat such as sand or mangroves. Cormorants are therefore a common part of the landscape of our urban waterways, especially during inland droughts.

TO REACH SYDNEY, CORMORANTS must travel. The distances covered by Australian cormorants, if not prodigious by avian standards, are still impressive with respect to the amount of hostile habitat they must negotiate. A Little Pied Cormorant feeding at Patonga Creek off the Hawkesbury River might have hatched in Papua New Guinea, necessitating a flight over Torres Strait. This would be easy for a petrel or a pel-

STEWART ROPER, LOCHMAN TRANSPARENCIES

Black-faced Cormorants are endemic to Australia and are exclusively marine.

ican, but cormorants have modified barbs on their contour feathers that allow air to escape. This reduces buoyancy and makes diving for food easier, but it also means the birds become wet to the skin when immersed. Resting at sea is therefore difficult because, once wet, there would be nowhere for them to get out and dry off, adding an element of risk to long trips over the ocean.

Cormorants travelling over the arid landscapes of inland Australia face different challenges. In the outback, rain is unpredictable and, when it occurs, it may fill some catchments, or individual lakes, but not others. Many lakes also become more saline as they dry, eventually becoming unproductive for fishes and hence fish-eating birds. Droughts and flood periods contribute to this already complicated pattern, making a highly variable landscape of lakes and arid areas. Many waterbirds, including cormorants, are caught out by locally changing circumstances, and it is not uncommon to see whole flocks of dead cormorants at the bottom of a dried lakebed, having failed to leave before they ran out of food and

WHY DO CORMORANTS

ever leave the eastern coast of Australia, given the dangers associated with long-distance travel?

strength to get to the next location. Thus, travelling to and from the east coast, as cormorants often do, can be very risky.

Why, then, you might ask, do cormorants ever leave the eastern coast of Australia, given the dangers associated with long-distance travel? It is because of the massive opportunities for breeding that occur inland. After an inland lake dries out, the wet soil provides ideal conditions for terrestrial plants to establish. When the next flood occurs, these plants and the decaying vegetation release considerable nutrients into the water. The eggs of fishes and crustaceans that have lain dormant in the soil are quick to respond, and in really wet years produce huge amounts of food that attract hundreds of thousands of birds. This boom and bust cycle does not occur on the east coast. And, unlike the west coast, where the waters are enriched by the cold subantarctic currents, Sydney's waters come from the tropics, which are warm and relatively low in nutrients. So, while the coastal environment off Sydney is more stable than that inland, it is never rich enough for large-scale breeding. Those few colonies that do form here are frequently unsuccessful.

Resource availability is not the only problem that besets cormorants attempting to nest in Sydney. Urbanisation is of great benefit to a number of generalist species (both birds and mammals) that turn to nest predation when the opportunity arises. Several years ago, I watched a tiny colony of Little Pied Cormorants form on the island in the artificial lake in Bicentennial Park. There were just a few pairs, and all built nests in the casuarinas and laid eggs safe from terrestrial predators. However, shortly after the colony was established, a pair of Australian Ravens (*Corvus coronoides*) installed themselves in the treetops and could be seen hanging about or harassing the cormorants as they incubated their eggs. One by one, the ravens managed to steal the eggs and the ground beneath the nests became littered with broken shells. In the end,

An adult Great Cormorant. This species is the most cosmopolitan of all the cormorants, living in Asia, Australasia, Europe and eastern North America. It also lives in Sub-Saharan Africa, where it is black and white, like the Pied Cormorant.

BRIAN CHILDERHOUSE

Great Cormorants feeding in the interior of Australia. In inland waters Great Cormorants forage in flocks to increase their chances of finding prey.

none of the cormorants managed to produce any young.

Corvids—crows and their relatives—are intelligent and opportunistic, and frequently make a good living amongst the urban backdrop of Sydney. Pied Currawongs (*Strepera graculina*), Australian Magpies (*Gymnorhina tibicen*) and others have all increased markedly in the past decades, in response to the greater availability of exotic fruit in gardens around the city. Corvids, in addition, supplement their diet with the eggs of nesting birds but they do so very efficiently, with just one or two individuals having a large effect. Silver Gulls (*Larus novaehollandiae*), Brown Rats (*Rattus norvegicus*) and even Common Brushtail Possums (*Trichosurus vulpecula*) also take their toll on the young of any birds that nest within their reach. All these species contribute to inhospitable conditions for breeding and are more abundant in urban settings.

With such differences in landscape character and opportunities between habitats where cormorants occur, I had an idea that cormorants were probably adaptable enough to change their behaviour in response to local conditions. I sampled foraging methods and microhabitat choice throughout greater Sydney and compared them with sites in outback New South Wales, looking for an indication of what cues cormorants use to locate prey in the different habitats. What I found demonstrated cormorants to be very adaptable indeed.

On the coast, where the water is clear, both Great and Pied (*Phalacrocorax varius*) Cormorants (which primarily eat large schooling fishes) foraged singly, and associated with patches of seagrass within creeks that had a high proportion of seagrass meadows. Little Pied Cormorants (which eat primarily crayfish and other bottom-dwelling crustaceans) did the same. In the murky water of inland lakes, however, Great and Pied Cormorants foraged in large flocks, not obviously associating with any physical characteristics. Instead,

A Little Pied Cormorant in the typical wings-spread drying stance.

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they appeared to be foraging more or less randomly, using one another as foraging cues. Flocking cormorants spent longer at the surface, appearing to watch until one of the flock was successful, and then mobbing that spot. Little Pied Cormorants, however, did not flock, but continued searching for invertebrates from among the aquatic vegetation.

Why should Great and Pied Cormorants change their behaviour in different environments? It seems to be related to water clarity. When the water is clear, individual cormorants can find fish by themselves, or by using the easily recognisable cue of seagrass within which many fishes seek shelter. However, when the water is murky they cannot see the prey and have to guess, upping their odds by choosing a spot that was recently successful. In the Netherlands, Great Cormorants have been seen to change their feeding pattern from single- to flock-foraging as a lake they used became murky, lending support to this idea. Little Pied Cormorants, however, do not change their foraging behaviour because their prey, whether on the coast or inland, sticks to the marginal vegetation. Little Black Cormorants also do not alter their foraging behaviour. They forage in flocks wherever they occur. Reasons for flock-foraging inland would be the same as for Great and Pied Cormorants, but why should Little Black Cormorants still flock in the clear waters of the coast? One reason might be that their main prey—small schooling fish—is more easily caught from flocks, perhaps by herding the fish. It has been speculated that there is, in fact, a minimum flock size that Little Black Cormorants require to forage successfully.

The most interesting part of this story is the notion that Great and Pied Cormorants change not only their foraging cues, but the nature and scale of features

Australian Cormorants

Classification
Family Phalacrocoracidae, genus *Phalacrocorax*. Five species: Great (*P. carbo*), Pied (*P. varius*), Little Black (*P. sulcirostris*), Little Pied (*P. melanoleucos*) and Black-faced Cormorants (*P. fuscescens*).

Identification
The 5 species are separated by a combination of plumage colour (black or pied), colour of facial skin (black or yellow), and size.

Habitat and Distribution
Marine, coastal and estuarine. Great, Pied, Little Black and Little Pied Cormorants breed inland and on west coast, occurring throughout most of Aust. where sufficient water permits. Black-faced Cormorants primarily coastal.

Food
When foraging pelagically, mainly fish and marine crustaceans. When inland, native and introduced freshwater fishes, frogs, ducklings and other vertebrates. Little Pied Cormorants unique in the groups by feeding primarily on crustaceans.

they use to extract information from their surroundings. Seagrass beds change slowly, on the scale of decades, and the presence of fish within those beds is reasonably predictable. Therefore, cormorants use this general measure of the location of fish as a guide to where to hunt. It's a bit like looking for the Opera House at Circular Quay. If you knew where it was five years ago, you could find your way back by heading in the right general direction.

Cormorants foraging inland, on the other hand, are looking for a resource that changes unpredictably over years, days and hours. They need a precise, responsive cue that can keep up with changing conditions. Thus, the success of another flock member gives them information from the last few seconds in a space of just a couple of metres. Imagine if you wanted to find a Mr Whippy van as it trundled through the heart of town. Even knowing where it was 15 minutes earlier would not greatly increase your chance of finding it. In changing from one cue to another, cormorants must change their behavioural responses as well as their perception of their environment. This demonstrates a remarkable ability to adapt, which must certainly contribute to their survival, especially in a setting as difficult to predict as a large city.

I HAVE RECENTLY MOVED TO WELLINGTON, New Zealand, which is a lovely city if you like wind. In addition to most of the cormorant species that exist in Australia, New Zealand boasts a few marvellous endemics. The most spectacular of these—the cormorants' answer to a bird of paradise—is the Spotted Shag (*Phalacrocorax punctatus*). It has pale yellow feet and its head and neck are black with an iridescent green sheen. Long black crests, vaguely reminiscent of Elvis Presley, sit atop a bright green face and throat, with electric blue eye rings. The rest of its body is covered in bits of fawn with black spots, various stripes and a dusting of long white plumes. This remarkable bird is locally common throughout New Zealand in marine and coastal waters. Here it appears to feed mainly on small pelagic crustaceans and fishes. The conservation status is currently healthy, although some question exists as to the long-term effects of marine farming.

Wellington's weather sends many people indoors for exercise and I am no exception. Fortunately, there is a fine pool and gym right on the water near my house. The other day, I was pedalling away on a stationary bicycle enjoying the view from the window when a Spotted Shag began foraging in the water right below me. The timer on the bike would have made a perfect stopwatch. Pity I'm not still collecting data. □

A Pied Cormorant spreads its wings to dry after a swim. Unlike waterfowl, cormorants attain nearly neutral buoyancy by having feathers that become wet when immersed. This characteristic stance helps them to dry out again and may also aid in digestion.

JOE SCHELLING

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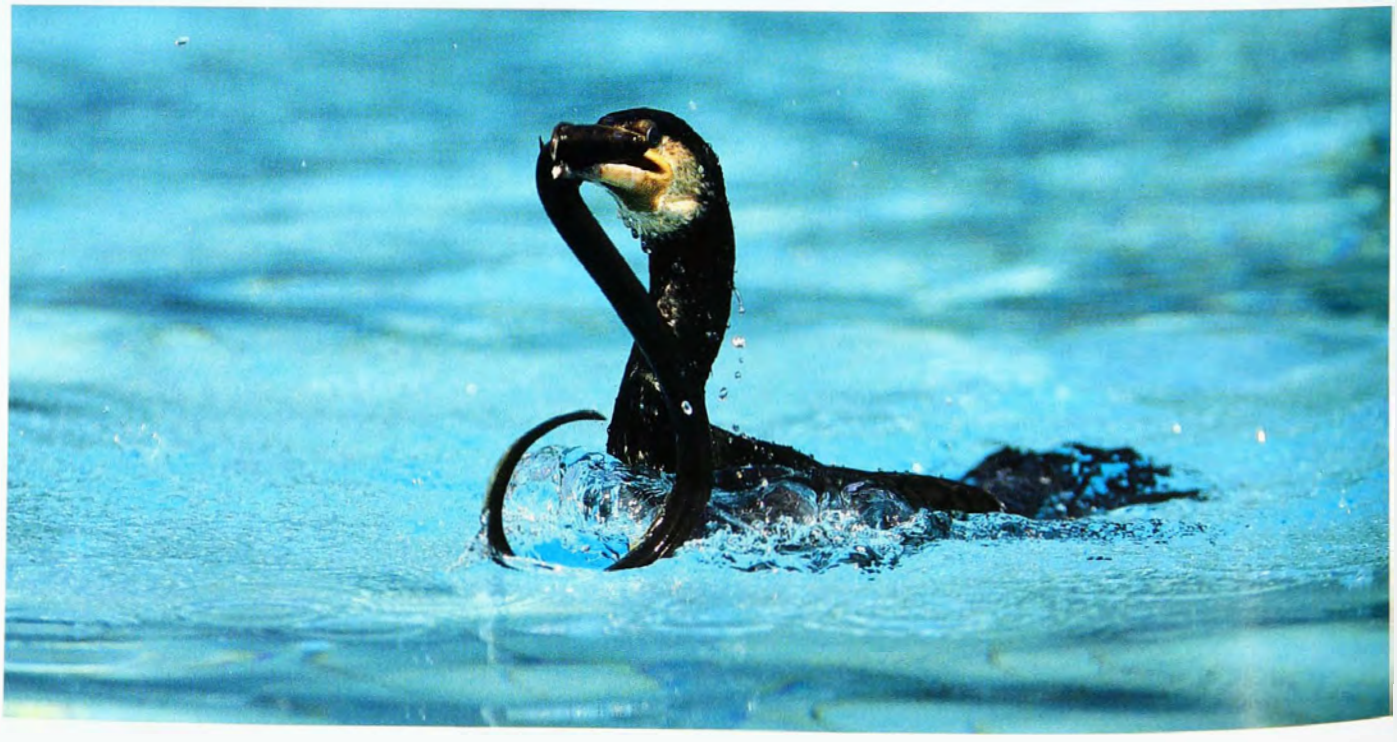


T. COLLIER, FRANZ AUSCAPE

A lone Great Cormorant captures an eel. Cormorants frequently take very large prey. This is made possible by their extendable gular (throat) pouch, which hints at their evolutionary relationship to the pelicans.

FOR THE 35,000 YEARS THAT PEOPLE HAVE LIVED IN TASMANIA THE QUESTION OF HOW THEY MANAGED TO SURVIVE IN THE COLDEST OF TIMES IS ONLY NOW BEING INVESTIGATED.

ICE-AGE HUNTERS *of* TASMANIA

BY RICHARD COSGROVE

EACH SUMMER, THOUSANDS OF PEOPLE IN TASMANIA flock to the beaches, the river valleys or the mountains to take advantage of the warm weather, long hazy days and good fishing. Before white settlement, Indigenous Tasmanians also moved about on a seasonal basis, selecting from a wide range of foods that would become available only during the summer months. It was a time of social gatherings, a time for meeting obligations, and a time to exchange information and material items. In contrast, winter was a lean time; a time marked by icy westerly winds and the mournful cries of Tasmania's Black Currawong. For the 35,000 years that people have lived in Tasmania the question of how they managed to survive with the changing seasons in the coldest of times is only now being investigated. Welcome to the last great ice age.

JOHN CANCALOSI/ARDEA

A Bennett's Wallaby sits out a snowfall. Analysis of the seasonal growth bands (annuli) in fossil wallaby teeth suggests, incredibly, that humans were hunting in the upland cave sites during the coldest periods of the last ice age between about 23,000 and 18,000 years ago.

RICHARD CONGREVE

Western Tasmania is rugged and mountainous. Many of the plants that grew in the ice-age valleys 25,000 years ago have now migrated to higher altitudes while forests moved from the coasts to colonise the inland river valleys, displacing many of the human food resources when the ice age ended abruptly 10,000 years ago. Greenland ice-core data suggest that it ended in less than 20 years.

TASMANIA HAS ONE OF THE RICHEST ice-age archaeological records in the world. Most of the sites are in limestone caves and are found in what is today the dense temperate rainforests of Tasmania's rugged south-west. The vegetation remains a testament to the common geographic heritage of Tasmania, New Zealand and South America, which were once part of the Gondwanan supercontinent. However, about 165 million years ago they began to drift apart, isolating Tasmania's unique fauna and flora.

Humans didn't make it to Tasmania until the island became connected to Victoria via the Bass land bridge. This formed when huge quantities of seawater were locked up in the Arctic ice sheets, allowing people to walk across the exposed plain. Then, about 14,000–13,000 years ago, the ice melted again and the sea rose, cutting Tasmania off for the last time. Nevertheless, Aboriginal people were able to walk with dry feet across this flat, arid and windy plain, for at least 25,000 years.

During that time the world was in the grip of the last great ice age and much of the highlands of Tasmania was covered in permanent ice, with snow a common feature of the lowlands. Winter temperatures were probably as low as –15°C while summers would have been cool and short. Few trees grew at this time and most of the region was open, with patches of grassland and sedgeland. This landscape was very different from that of today, being covered at the lowest elevations with vegetation that now only survives on some of Tasmania's highest mountains.

Many of the limestone cave sites were occupied between 35,000 and 13,000 years ago, being abandoned after rainforest spread across the region at the end of the ice age. They contain staggering amounts of stone tools, animal bones, hand-stencil art, charcoal from cooking fires and bone implements for piercing skins. It is not uncommon to find 250,000 bones and 40,000 stone tools in less than a cubic metre of soil. The major human prey animal was Bennett's Wallaby (*Macropus rufogriseus rufogriseus*). It accounts for about 70 per cent of the animal bone found in the caves.

The number and types of bones found in the sites tell us how wallabies were butchered and what parts of the animals were economically important. Notable are the low numbers of wallaby claws and tail bones in the cave deposits, suggesting that hunters were skinning animals and extracting the sinews and marrow in the field before transporting the carcass back to the rock shelters. The claws were probably stripped off still attached to the skins and discarded, while sinews and fat were extracted from the base of the tail. Also notable is the presence of large quantities of broken long bones such as the tibia (shinbone) and femur (thighbone) in the deposits. This suggests that people were cracking open the bones for marrow, an important nutritional requirement for living in subantarctic conditions where plant carbohydrates were rare. These remains thus give us an insight into the behaviour of early modern humans who were, at this time, the most southerly people in the world.

One of the enduring questions that archaeologists have sought to answer is whether these people visited the limestone caves seasonally and, if so, was it regularly or intermittently? Initial suggestions by the late Rhys Jones (Australian National University) were that people either lived on the Bassian Plain or in what today is Victoria, and made seasonal forays into the toe of Australia

during the summer months, returning at the end of autumn. This made perfect sense since the very cold winters were accompanied by fierce storms, ice and snow. Research on Greenland and Antarctic ice cores has shown that the world was much stormier and unstable during the ice ages. The southern ice sheet would have expanded at this time, forcing very cold ocean currents up the Tasmanian west coast. To be in the rugged terrain of south-western Tasmania would have proved very challenging, even in the relatively milder summer season.

Ethnographic observations in the early 1800s support the notion of seasonal use of the highland areas by Tasmanian Aboriginal people. Indeed it was during the spring and summer months that Aboriginal people moved from the coasts into the highlands to catch birds, collect their eggs, hunt, drink the alcoholic sap from Cider Gum (*Eucalyptus gunii*) and maintain social connections. They appear to have been most mobile at this time of the year.

The question of whether this pattern held true for humans during the ice age was one that my colleagues and I were interested in investigating. Were these people simply opportunistic hunter-gatherers, largely at the mercy of the environment, or did they systematically plan over long-term subsistence cycles? Fortunately, the well-preserved bony remains and teeth of Bennett's Wallaby held clues to answering these questions.

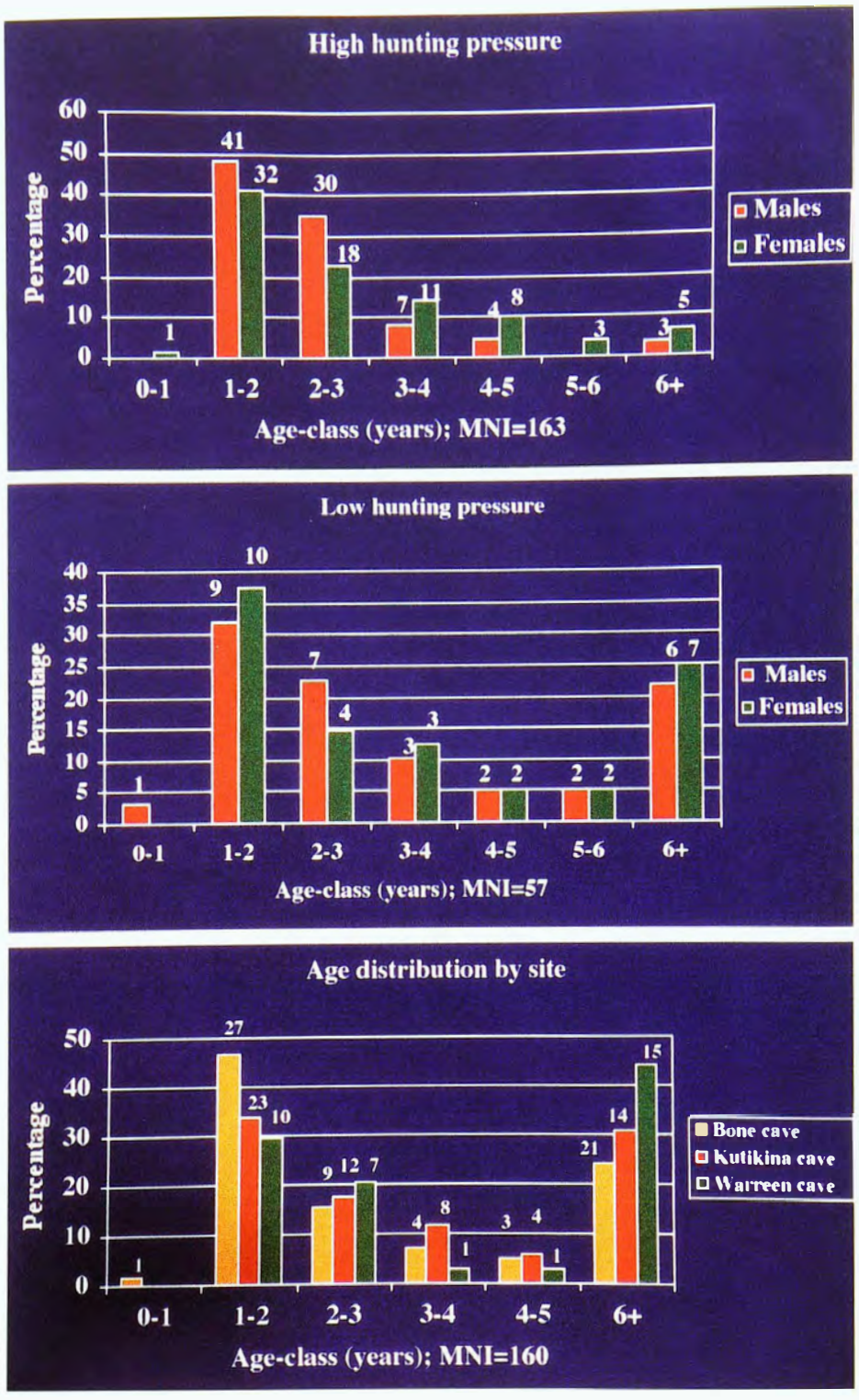
BENNETT'S WALLABY, UNLIKE ITS mainland cousin (*Macropus rufogriseus banksianus*) which breeds throughout the year, gives birth mainly between February and March. We reasoned that, if we found a high percentage of, say, one-year-old wallabies in the sites, we could conclude that people were using the interior valleys during summer and early autumn since by then the embryos of the previous year would have developed into joeys and mothers would have young-at-foot.

To determine how old the wallabies were when they were killed, and therefore estimate the time of year that people were hunting, Jim Allen (La Trobe University) and I looked at the molar eruption pattern in the wallaby jaws, and compared them with modern animals of known age and date-of-death, data collected by Mike Driessen (Tasmanian National Parks and Wildlife Service) for his Masters thesis. The modern sample included thousands of wallabies killed by local hunters from different parts of the State and in various seasons, and then aged at death by the National Parks and Wildlife Service. There were challenges to this study because wallabies only ever have four molars (M1–M4) in their lifetime. M1 appears at 9 months, M2 at 15–17 months, M3 at 2.9–3.5 years, and M4 at 5–6 years. Thus the age of animals beyond the M4 stage cannot be determined by molar eruption. As the animals age, the molars progress and push all teeth in the jaw forward. Thus the accuracy of the age estimates based only on molar eruption is limited to those animals younger than six years.

Jim and I found no wallabies less than a year old (those in the M1 group), and so concluded that people were probably

MEGAN MUIRHEAD/ROBIN SCHILLING

Bone points finely fashioned from the leg bone (fibula) of Bennett's Wallaby were used as awls and needles. People used these tools to pierce skins to make clothing. These implements were first made between 31,610 and 27,160 years ago and occur in the archaeological record until about 3,000 years ago when they appear to have dropped out of use.



The top two graphs show Bennett's Wallaby population structure under high and low hunting pressure. Both males and females are killed, but under higher culling rates, lower proportions of older animals make up the groups. The reverse is true for low hunting pressure. (Data supplied by Michael Driessen.) In the bottom graph the three archaeological sites show an age structure similar to the results of low hunting pressure.

largely absent during late summer and autumn. Nevertheless, we felt certain that people would have used these valleys on a repeated basis, targeting the grassland patches that wallabies are attracted to. So with my colleague Anne Pike-Tay of Vassar College, New York, I compared an even larger sample of wallaby jaws to another set of modern hunting data, again kindly supplied by Mike Driessen. Mike had studied the age patterns of modern wallabies killed under situations of high and low hunting-pressures, and found a striking difference. In populations subjected to high levels of random-aged hunting, a lower proportion of older (larger) animals make up the age profile of those killed when compared with populations subjected to low hunting levels (see diagram). This is because in heavily hunted populations, most of the bigger animals are removed, forcing hunters to take a higher proportion of younger animals.

When we looked at the age profiles of 160 jaws from three archaeological cave sites—Warreen, Bone and Kutikina Caves—we found a higher proportion of older animals, a pattern similar to the modern low-hunting data. This is consistent with irregular periods of hunting and is supported by low deposition rates in the cave deposits. In some sites as little as two centimetres of cultural deposit per 1,000 years was laid down. We do not know exactly how long people camped at the caves since we cannot identify individual hunting episodes within the deposits. Nevertheless people may have hunted in a grassy patch for a number of weeks but then they may not have returned for, say, up to a decade, giving the wallaby population time to recover. The data also clarified a question Jim and I raised about whether ancient hunters took wallabies in proportion in which they encountered them, or whether they deliberately selected particular species and age groups. Because the modern low-hunting profile closely matched the archaeological data, it seems that wallabies were taken in proportion in which they were encountered on the landscape. There is also some evidence to show ancient hunters took a relatively higher percentage of older wallabies when compared with modern population data.

Against this general hunting scenario, we were keen to understand the true ages of the hunted wallabies through an analysis of annuli laid down in the roots of wallaby teeth. Annuli are a bit like tree rings—alternating dark and light bands that record seasonal growth and hence not only age but also season of death. Anne Pike-Tay identified annuli in longitudinal sections of modern wallaby teeth whose age and season-of-death were known. We then compared these patterns with 16 ancient jaws from Warreen Cave. The results were a

total surprise and ran counter to our expectations based on early ethnographic observations and intuition.

Amazingly, the annuli showed that, during the last ice age, people hunted in these upland valleys mostly between autumn and winter/early spring; in other words, during the very coldest times of the year. All wallaby age groups (with the exception of very young wallabies) were represented, including young adults and a large proportion of older animals, covering the full range from six- through to ten-year-old wallabies. This suggests a relative degree of prey selection on the part of these hunters, based on size, quality and fat condition.

So why did humans move into these upland locations during the coldest parts of the year? It is probably best explained in terms of optimal foraging strategies. Mike Driessen has found that Bennett's Wallabies, and especially females, have significantly higher body fat and thicker fur during the cold winter months. At this time of year they are also extremely sedentary, according to studies by Chris Johnson (James Cook University) of *Macropus rufogriseus* in New South Wales, preferring forest edges and sheltered gullies close to grassy feeding areas with a good water supply. Assuming ice-age wallabies were similar, the relatively low costs associated with their search, pursuit, transport and processing, coupled with their high energy returns, would have made winter wallabies the perfect prey choice. By scheduling visits to these patches between autumn and early spring, ice-age hunter-gatherers were able to harvest their prey systematically, which allowed the rejuvenation of animal populations over the long term.

IT APPEARS THAT THE PEOPLE OF ICE-AGE Tasmania were not mere victims of the capricious environment. They systematically planned their approach to their economy, structuring it in such a way as to take best advantage of the resources available. It reflects the breadth of human behavioural flexibility and the ingenious approaches to problem-solving by Australia's early inhabitants.

Tasmanian Aborigines survived for 35,000 years in the face of climatic, environmental perturbations and social restructuring, even after Tasmania was cut off from mainland Australia. Their continued success over 1,200 generations was not "owed more to good fortune than good management", or their near extinction the result of an "internally dysfunctional" society, as controversial historian Keith Windschuttle would have us believe (*The fabrication of Aboriginal history*, 2002). Rather they were a population of behaviourally modern humans with their own complex understanding and appreciation of their world. It was not a lack of "wise men" with long-term vision, nor isolation *per se* that led to their decimation, but ignorant, diseased and evangelical Europeans. □

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JUDY FRASER

Bone Cave in south-western Tasmania contained tens of thousands of Bennett's Wallaby bones dated to between 30,000 and 13,000 years ago. Most intensive occupation occurred after 16,000 years ago when the world was thawing out after the last great ice age. The author is in the trench excavating, while Jim Allen analyses the animal bones.

(Right) Coastal shrubland (mainly Coastal Teatree, *Leptospermum laevigatum*) one month after an intense bushfire. All images taken at Iluka Beach, Booderee National Park, Jervis Bay, NSW.

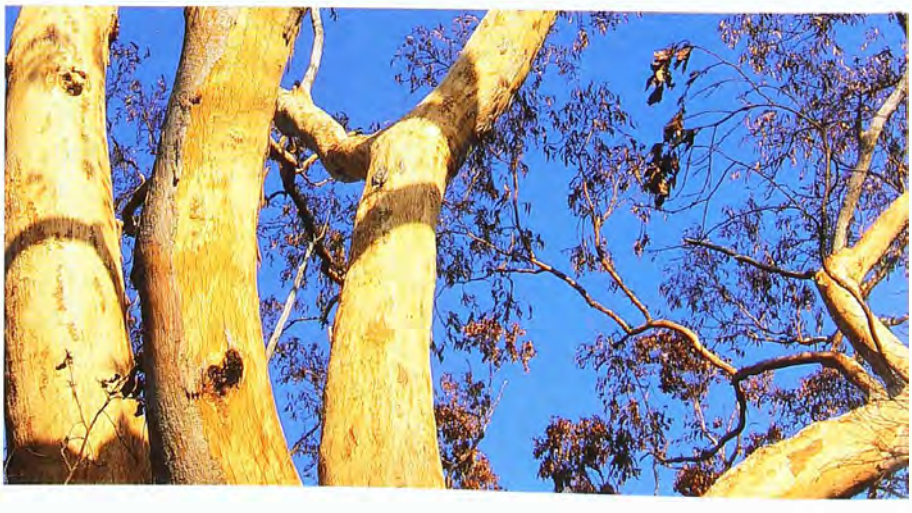
(Above left) New shoots of Common Bracken (*Pteridium esculentum*) in sandy soil. (Below left) Winged seeds of a banksia fallen on the ashy burnt ground will sprout after intense bushfire.

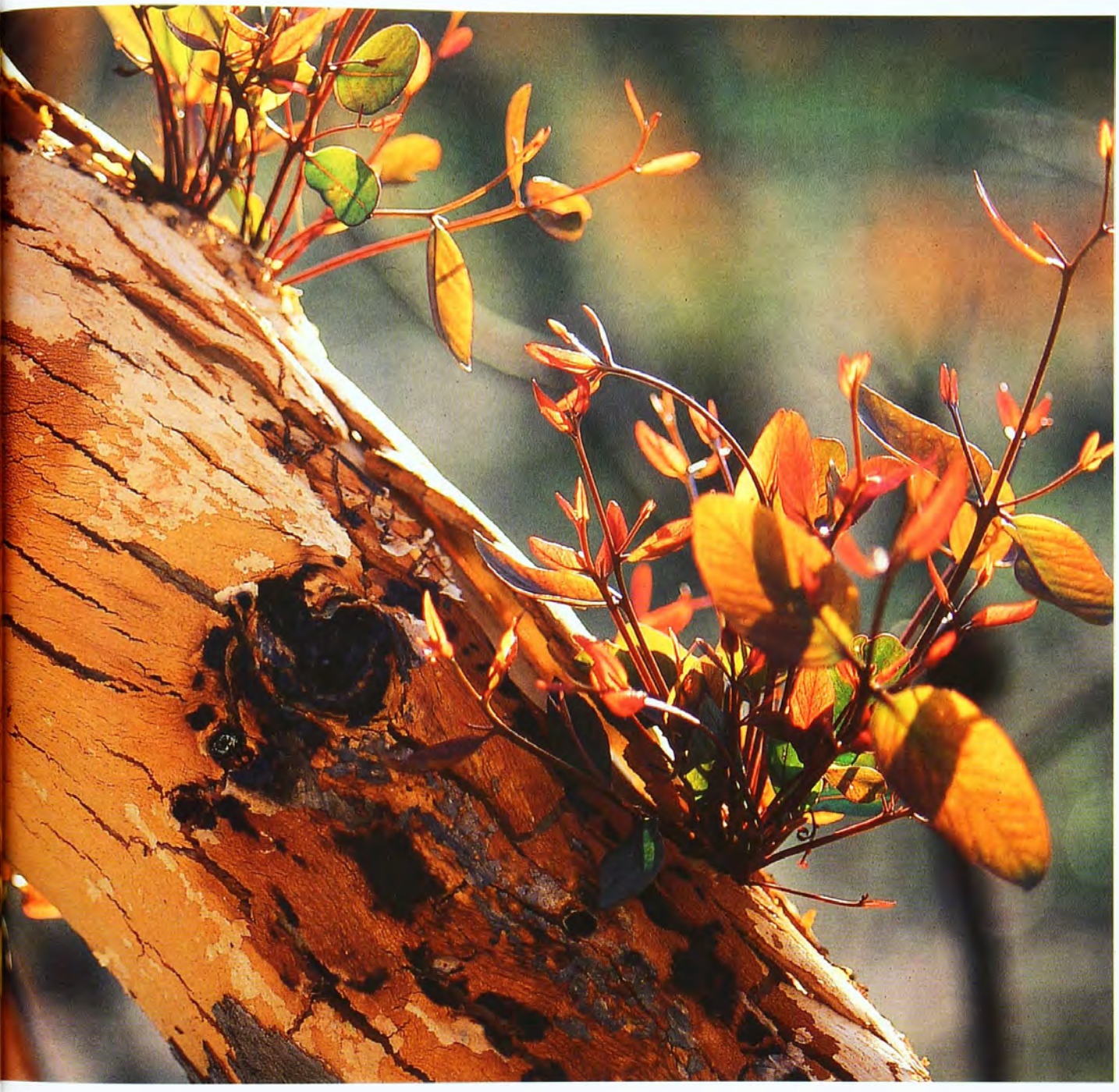
Burnt offerings

BY ESTHER BEATON

(Below) Fire-damaged tips of a grass tree (*Xanthorrhoea resinosa*) pushed out by new growth after a bushfire.

(Right) Hard-leaf Scribbly Gum (*Eucalyptus sclerophylla*) lightly burnt in a bushfire that left the leaves on the branches.





Epicormic shoots on the trunk of a burnt Hard-leaf Scribbly Gum (*Eucalyptus sclerophylla*).

Scavengers at death's door

For over 400 years, vultures have eaten the human dead at the Towers of Silence.

"THERE ARE CEMETERIES THAT ARE lonely, graves full of bones that do not make a sound". These opening lines from Pablo Neruda's poem "Nothing But Death" (1935) may become a haunting epitaph for a dying group of undertakers. For over 400 years, vultures have eaten the human dead at the Towers of Silence, a Parsi burial site that sits atop Malabar hill in Mumbai (formerly, Bombay), India. The Parsi religion forbids ground burial and cremation, and 'sky burials' are a ceremony in which corpses are placed on huge cylindrical stone towers and left for the raptors. Once the Towers of Silence were filled with the noise of birds turning their stomachs into human cemeteries and flying off with the remains of the dead.

Over the last decade, however, populations of the Oriental White-backed Vulture (*Gyps bengalensis*), Long-billed Vulture (*G. indicus*) and Slender-billed Vulture (*G. tenuirostris*) have declined by more than 95 per cent in Pakistan, India and Nepal. For the Parsi, this massive die-off has meant there are too few vultures left to dispose of the dead, and their ancient tradition has turned to tools from a modern world to help with their burials. With limited success, and what seems to be a half-baked idea, solar panels are being used to concentrate heat on the dead to help them disappear.

Over the last decade populations have declined by more than 95 per cent in Pakistan, India and Nepal.

But the plight of the raptors is also having a devastating ecological and social effect on much bigger graveyards in India. Livestock are revered by India's majority Hindu population and, when an animal dies, hide collectors remove the skin and leave the flayed carcass for the birds. As ungulate undertakers, 100–150 vultures can reduce a cow to a skeleton in 20 minutes. But now the carcass dumps are full of rotting bodies with only a smattering of birds to do the job. A bounty of beef must be a dream come true for any carnivore, and the carrion has attracted thousands of potentially rabies-riddled feral dogs, which now live and breed year-round in the dumps.

Based on a three-year study of three rapidly declining Oriental White-backed Vulture colonies in Pakistan, bird virologist Lindsay Oaks (Washington State University) and colleagues from The Peregrine Fund have found that the vultures die after scavenging carcasses that have residues of diclofenac. This safe, effective and cheap painkiller for livestock was first used in the Indian subcontinent in the early 1990s to treat lameness, injury and illness, common conditions before a cow dies. A cow on diclofenac may be on its last legs, but the drug will allow the animal to work a little longer before it shuffles off to its final resting place at the local carcass dump.

Unfortunately, an unintended consequence of the veterinary use of diclofenac is that it is lethal to vultures in very low doses. If a cow or other livestock dies soon after being treated, its body contains sufficient residues of the drug to be toxic when eaten by vultures.

The study found that 85 per cent of the 259 vultures examined had died from visceral gout, a condition caused

Oriental White-backed Vulture—one of three vulture species whose populations have crashed over the last decade.

BY SIMON D. POLLARD

by kidney failure. When this happens, deposits of uric acid coat the internal organs, especially the heart, liver and kidneys. In healthy birds uric acid is excreted by the kidneys and is seen as the white material in their droppings. Oaks points out that "it is the first known case of a pharmaceutical causing major ecological damage over a huge geographical area and threatening three species with extinction".

An early sign that vultures are not well is that they hang their heads down to their feet for long periods, and in this position they finally die and fall from their perch. While death from diclofenac appears to come without warning, head-drooping is still a powerful anthropocentric metaphor for the demise of a species, when these magnificent birds with their two-metre wingspans hang their heads in apparent hopelessness.

Oaks is hoping that the use of diclofenac as a livestock painkiller can be banned, a decision with obvious complex political ramifications. Conservationists are starting captive-breeding programs for these endangered species, but whether these will allow vulture populations to eventually increase to the tens of millions of birds that once filled the Indian subcontinent is unknown.

Two Indian ornithologists, Salim Ali and Laeeq Futehally, in their 1967 book *Common birds* give a wonderful description of scavenging raptors: "The gruesome obsequies at a carcass are attended by incessant jostling and bickering among the feasters and much raucous screeching and hissing... as two birds ludicrously prance around with outspread wings tugging and pulling at a gobbet of flesh from either end." I hope it is not too late for the Towers of Silence and countless ungulate graveyards throughout India to be filled again with the sound of eager undertakers. □

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JEAN-PAUL FERRERO/ AUSCAPE

Childhood's beginning

Why do humans take so long to grow up?

BY RICHARD FULLAGAR

MANY COUPLES THESE DAYS have chosen not to have children, and understandably so. The decision to have children is a minimum 20-year commitment. This is partly because humans have a prolonged, drawn-out growing period, in order to be physically mature, independent and competent adults. Among modern hunter-gatherers, typical childhood spans from about 3 (time of weaning) to 17–20 (age at first reproduction). This is certainly longer than any other animal on Earth. Even our closest living relative the Chimpanzee takes only eight years to reach maturity.

Why do humans take so long to grow up? One argument (called 'ecological risk aversion') is that there was an evolutionary trade-off between the costs of having slow-growing kids (with their poor foraging efficiency) and the advantages of being able to surround them by wiser, more knowledgeable adults who can detect and avoid predation. According to this theory, higher levels of family protection permit extended childhood. This makes sense for some animals, but may not explain the complexities of human culture.

A second idea suggests that slow growth allows time for accumulating the huge amount of knowledge needed for an adult brain to function competently. As culture and learned behaviour gave modern humans an evolutionary edge, the length of childhood extended. One implication of this 'practice theory' is that missed learning opportunities will lead to poor performances as adults. The idea that learning as children prepares us for adult life sounds like common sense, but can it be tested? Nicholas Blurton Jones (University of California, Los Angeles) and Frank Marlowe (Harvard University) looked to see how long it takes Hadza children in Tanzania to learn to hunt and gather, and found that those kids that spent much of their time away at boarding school performed just as well in Baobab climbing and target practice, as those living full-time in the bush. Although practice may be more critical for tracking and hunting large dangerous prey, body size and strength of adults might better explain why adults outperform children in most other tasks.

Further support for this idea comes from Doug Bird and Rebecca Bliege Bird (Stanford University) who worked with children on the island of Mer in Torres Strait. They watched children and adults collecting shellfish and found that, while the Mer kids were just as good at locating shellfish, they lacked the size and stamina to cover as much territory as adults, thus limiting what they collected. Again, it is the body size and strength of adulthood that matters.

An alternative to the practice theory is the idea that extended childhood is simply an artefact of our long lives. For all mammals there is a constant relationship between length of the juvenile period (infant to age of first reproduction) and life span. The longer the life span, the longer the juvenile period. The trade-off is between time spent growing and time spent reproducing, and the optimum is determined by mortality levels. Humans are not really exceptional in this regard—the childhood period is just as expected, and directly proportional to life span. Under this theory, all we need to explain is why we live so long, and the advantages of grandmothers (who live beyond menopause to assist in child-rearing and food-gathering) may hold the key (see "Hunter, Scavenger, Grandmother, Yam", *Nature Aust.* Summer 2003–2004).

John Bock (California State University at Fullerton) takes a bet each way, and argues that slow growth permits both large body size and acquisition of skills that benefit productivity of adults. Bock worked with a multi-ethnic group of children in Botswana to explore how developments in growth and experience are related, suggesting that spurts of learning (like language acquisition) and physical development take place at different times and rates in a series of steps rather than at a smooth constant rate. So learning new tasks or practising techniques may be important at certain stages of growth. At other times growing up is more about getting bigger. He also found that learning activities (like play) came at the expense of immediate productivity (like processing mongongo nuts and grain), but that parents allocated time for both work and play, with the understanding that play is an investment that will increase future productivity. Child's labour is not child's play, but how parents juggle the work-and-play routine does depend on what they do for a living (whether they are hunter-gatherers, farmers, labourers).

So we can take it that children learn faster than we might think, size matters when you are small, and length of childhood is related to human life span. But what can we learn from the archaeological record? When did our long childhoods begin?

Christopher Dean (University College, London) and colleagues have used modern and ancient teeth to track changes in human life-history stages. Microscopic growth lines in tooth enamel provide a remarkable daily record of development right up to full maturity when our wisdom teeth emerge at about 18 years. By measuring the spacing of the lines, they were able to estimate the rate of growth (the thicker the gaps, the faster they grew). The sequence of tooth eruption and development could then be related to physical age, human life span and other biological characteristics.

The researchers compared teeth of modern humans with those of modern and ancient apes, and early hominids including *Australopithecus*, *Paranthropus*, *Homo erectus* and Neanderthals. The

KATHY ATKINSON

Child labour or child's play? An Aboriginal child from the Daly River, Northern Territory, helps with food gathering.

results were surprising because, although scientists knew that stages in the life histories of early hominids were similar to ours, the pace of change was dramatically different, until about 100,000 years ago. Our ancestors had shorter childhoods than us, maturing by about 12 years old. More recent work by Fernando Rozzi (CNRS, France) and José Bermudez de Castro (National Museum of Natural Science, Spain) suggests Neanderthals matured by the age of 15 years, which is still three years short of modern humans. Barry Bogin (University of Michigan, Dearborn) has pointed out that a critical period uniquely prolonged in modern humans is between weaning and eruption of first permanent molars. But I wonder how long after physical maturity humans have continued to stay at home with mum and dad?

What determines when old children/young adults leave the nest? It's an economic decision, according to Karen Kramer (State University of New York) who worked in Mexico with Mayan families to study juvenile dependence. Mayan parents are unable to raise their seven or eight children without financial support from sons, once they're old enough to get paid work, and from daughters who help look after their siblings. The strategy works—after living at home until their late teens and early 20s, Mayan children go on to have seven to eight children of their own.

These days, even with fewer siblings, Aussie 'kids' are staying at home much longer—sometimes well into their 30s. Marriage and the age at which they first reproduce are also being delayed. Certainly it's cheaper to stay at home with the oldies, but unfortunately evolution doesn't work in reverse—it doesn't make you live any longer. □

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Bamboozled

Europe and Antarctica are the only continents without native populations of bamboo.

IN HER BOOK *GUM* (2002), ASHLEY Hay records that when Captain James Cook's crew buried a sailor who died from tuberculosis at Botany Bay, they placed a packet of seeds from his sweetheart's garden in his pocket. Given the 3,000 or so weeds that now clothe our country, it is bleakly romantic to imagine that the first European weed to take root in Australia may have been sewn with this melancholy corpse. Thirty-two years later the botanist Robert Brown prepared a list of 29 species found in the Sydney bush that he thought had escaped from farms and gardens in the new settlement. So began one of the darkest chapters in the history of Australia's biodiversity.

Away from the intensive development around Sydney we might expect a slightly different story. Today of course, native vegetation in tropical Australia is battling massive weed incursions, from the scrubby *Mimosa pigra* to the floating *Salvinia molesta*, but what was it like in 1802 when Robert Brown and most of the Europeans in Australia were huddled around Sydney Harbour?

A short but intriguing note by Don Franklin (Key Centre for Tropical Wildlife Management, Darwin) on Australian bamboos raises more questions than it answers, but it proposes an early influx of weeds (although I doubt Franklin would use the term 'weed') to northern Australia, well before the First Fleet. Distinguishing a weed from a plant that has arrived in its current location through evolutionary processes unaided by humans is not always easy. And the current-day flora of northern Australia clearly has strong 'natural' links with nearby tropical regions: even the quintessential Australian genus *Eucalyptus* has species in Papua New Guinea, Timor and the Philippines.

To most people, bamboos are synonymous with Asia, particularly China. Of the 1,200 species (and 50–70 genera) of bamboo worldwide, 400 grow in China, where they sometimes form extensive forests and of course support one of the most intriguing of mammals, the Giant Panda (*Ailuropoda melanoleuca*). But bamboos also grow on other continents, with over 500 species growing naturally in the Americas (and all the evidence points to a South American origin for the group). Europe and Antarctica are the only continents without native populations of bamboo.

In Australia many assume all our bamboos are introduced by humans. In fact there are three species of bamboo in tropical Australia that we label as native—*Neololeba atra*, *Bambusa morehedaiana* and *B. arnhemica*, although Franklin postulates an intriguing human-facilitated introduction for the latter, but one that far precedes the 200 or so years of European settlement. Franklin remarks that widespread die-off, following a mass flowering of *B. arnhemica* starting in the late 1990s, was assumed by many locals to be part of a weed eradication program by land managers. In fact it was part of a natural cycle.

The flowering of bamboos is the source of many myths and misinterpretations. They are said to flower in dramatic cycles, unique to each species. Some of these cycles are reported to be more than a century long, and to involve every individual of the species. What's more, the plants apparently die once they have flowered so every individual ends its life on this mystic date. As usual, there is an element of truth in all this, but a large dollop of fanciful generalisation.

Simultaneous flowering does happen, often from vegetatively propagated plants from the same source and of the

BY TIM ENTWISLE

same age. In some areas where the stock all comes from the one nursery, the flowering becomes more or less cyclic (and the odd exception is overlooked). But synchronised flowering also occurs in natural populations, and different species flower in cycles of one through to 120 years. The reasons for the long flowering cycles in some species may be an evolutionary strategy to overcome predators eating all the seed—you save up all your energy and blast out so much seed they can't eat it all—or perhaps they are triggered by longer-term environmental conditions. After flowering, some bamboos do die; others are weakened for a while and will recover, while those that flower more frequently (for example, annually) continue to grow quite happily.

The species of interest to Franklin (*Bambusa arnhemica*) is restricted to several river catchments in the Top End of the Northern Territory. It is only distantly related to the other two native species of bamboo (both in Queensland), and it has a flowering cycle of 40–50 years. Some locals claim this species was imported by Macassan fishers who visited the shores from 1720 onwards, well before Robert Brown's trip to Australia. However, while there is good evidence that the Macassans introduced the Tamarind (*Tamarindus indica*), and possibly Dye Indigo (see "True Blue", *Nature Aust.* Summer 2003–2004), there is little to suggest that any bamboos arrived this way. Franklin suggests its more likely, but untested, origin is with Aboriginal colonists who arrived perhaps over 60,000 years ago.

Franklin's research has so far confirmed the endemicity of *Bambusa arnhemica* in Australia, suggesting that it is either extinct outside Australia or that it originated and remained only in the Top End. Either way its current distribution may be 'natural'. However, Franklin feels more comfortable with a dispersal origin, by humans, birds or oceanic drift, and he plans to study the genetics of *B. arnhemica* to test this hypothesis. The amount and structure of genetic diversity within the species should confirm whether the plants are of a single recent origin or not.

Meanwhile Franklin has just published his study of a 'wave' of flowering that began in 1996. Over 80 per cent of the *Bambusa arnhemica* population flowered and died during an eight-year floral orgy that is only now subsiding. Although considered synchronous over a longer time span, the spread of this wave over many years is not consistent with a recent weedy origin (we would expect such immigrants to be genetically very similar). Franklin's intriguing studies continue.

So we can't say with certainty what weeds were growing in the Northern Territory in 1802. In that year and the next, Robert Brown circumnavigated Australia with Matthew Flinders aboard the *Investigator*. He saw bamboo growing in Timor, and noted pieces of bamboo lying around fireplaces on what is now called Macassar Bay, on North Island in the Gulf of Carpentaria. It seems certain that *Bambusa arnhemica* was well established in Arnhemland when Brown landed there in early 1803, but which of his predecessors, if any, brought this bamboo to Australia? □

FURTHER READING

Franklin, D.C., 2003. Bamboo and the northern Australian connection. Flora Malesiana Bull. *13: 275–277.*

Franklin, D.C., 2004. Synchrony and asynchrony: observations and hypotheses for the flowering wave in a long-lived semelparous bamboo. J. Biogeog. *31: 773–786.*

Groves, R.H., 2002. Robert Brown and the naturalised flora of Australia. Cunninghamia *7: 623–629.*

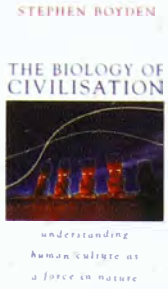
Meredith, T.J., 2001. Bamboo for gardens. *Timber Press: Portland, Oregon.*

DR TIM ENTWISLE IS EXECUTIVE DIRECTOR OF THE BOTANIC GARDENS TRUST, SYDNEY.

COURTESY SURREY JACOBS

(Left and Above) *Bambusa arnhemica* is one of the three species of bamboo that Australia likes to call its own.

reviews



The Biology of Civilisation

By Stephen Boyden. UNSW Press, Sydney, 2004, 244 pp. $29.95 rrp.

THE BIOLOGY OF CIVILISATION EXPLORES LINKS, AND MISS-LINKS, BETWEEN HUMAN BIOLOGY AND culture. The core of the book is a series of essays in "biohistory", on topics from health and farming to warfare. These illustrate how culture can mean that humans live in ways mismatched to their previous evolutionary history, sometimes producing nonsensical "cultural fallacies". A critical one is "ever-more-ism"—a focus on amassing material possessions. Both human wellbeing and the environment consequently suffer, and this book advocates urgent repairs to our "dominant culture".

Boyden's book will be a comfortable read for the already-convinced, but will work best as a thought-provoking book for the skeptic. For example, a "biosensitive" society is seen as necessitating human population at a level that "does not exert harmful pressures on the ecosystems on which it depends". Would a more realistic vision not be one where pressures are inevitable, but effective trade-offs are sought? Similarly, valuing the health of living systems is to be the top priority—but, one wonders, whose values? Would this reduce or reinforce the conflict between local and global values of biodiversity? There is a focus on changing the "dominant culture", but what about the value of cultural diversity?

Clearly, cultural fallacies can diminish both human wellbeing and the environment. This book challenges us to consider how any culture might better recognise these two problems as intertwined.

—Daniel P. Faith
Australian Museum

The New Atlas of Australian Birds

By Geoff Barrett, Andrew Silcocks, Simon Barry, Ross Cunningham and Rory Poulter. Royal Australasian Ornithologists Union, Melbourne, 2003, 824 pp. $89.95 rrp.

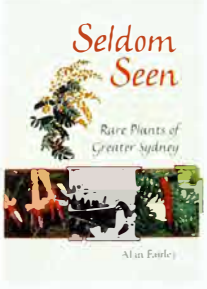
Canberra Birds: A Report on the First 18 Years of the Garden Bird Survey

By Philip Veerman. Published by, and available from, author (24 Castley Circuit, Kambah, ACT 2902), 2003, 127 pp. $22.00 rrp.

CONSERVATION EFFORTS NEED TO UNDERSTAND THE SPECIES THEY ARE TARGETING, PARTICULARLY THEIR DISTRIBUTIONS AND how these vary over time. Two recent publications have taken contrasting, yet largely complementary, approaches to this last task. The new atlas, conducted by Birds Australia, was a large-scale project—nationwide, in fact—over a five-year period (1998–2002). Some 7,000 atlas volunteers provided 279,000 records, noting the presence of species in the 1° blocks into which the country was divided. At such resolution, the data show distributions at a continent-wide level, revealing seasonal patterns and population shifts within that period. The importance of this project was recognised when the book won the Eureka Prize for Biodiversity Research.

On a more constrained geographic scale—the Canberra region—but over a much longer sampling period (18 years), the Garden Bird Survey shows what can be done on a less ambitious spatial scale. The smaller area meant that more information could be gathered for each site and at more regular intervals. As a result, this finer-grain analysis allows more detailed detection of trends across the sampling period, both in monthly numbers and in overall abundance. Between them, these surveys show the alternative methods that can be adopted in determining bird distributions. Both are valuable contributions to the understanding and conservation of Australian birds. All involved in their production are to be congratulated.

—Walter E. Boles
Australian Museum



Seldom Seen: Rare Plants of Greater Sydney

By Alan Fairley. Reed New Holland, Frenchs Forest, NSW, 2004, 208 pp. $29.95 rrp.

BOOKS ON RARE SPECIES CAN BE WORTHY, BUT DEPRESSING. ALAN FAIRLEY'S BOOK IS MORE A celebration of rare plants. Not celebrating their rareness, although of course rarity and extinction are not always the result of human intervention and could be celebrated in an evolutionary sense, but recognising that "there is something intriguing, and mysterious, about things that are rare".

Alongside a photograph of each of the 210 species, we learn a bit about their name, their discovery and what they look like. Although a book of this scope is next to useless as an identification guide, Fairley's pocket descriptions and generally informative photographs mean that you can confirm your identification if you know roughly where to start (and using Fairley's popular *Native plants of Sydney* is a good way to do this!). *Seldom seen* is a quirky book, and I was particularly delighted to discover historic photographs of Botanic Gardens Trust luminaries such as Barbara Briggs, Lawrie Johnson and Joy Thompson amid the rarities! It's a pleasure to dip into this little gem, and it has added to my enjoyment of the amazing Sydney bush.

—Tim Entwisle
Botanic Gardens Trust, Sydney

ANZANG

Nature and Landscape Photographer of the Year - 2005

ANZANG Nature organises an annual international nature and landscape photographic competition and subsequent exhibition at state museums and other high profile venues. To enter the competition photographs must be of subjects taken within the bioregion of **A**ustralia, **N**ew **Z**ealand, **A**ntarctica and **N**ew **G**uinea. Cash prizes totalling over **EIGHTEEN THOUSAND AUSTRALIAN DOLLARS** are available for winning entries.

ANZANG Nature wishes to encourage excellence in nature and landscape photography. Profit from the competition and exhibitions will be donated to nature conservation organisations that are actively purchasing and managing natural habitat in the region for the express purpose of providing sanctuary to native flora and fauna.

There are nine sections in the competition

1. Animal Behaviour.
2. Animal Portrait.
3. Botanical Subject.
4. Underwater Subject.
5. Wilderness Landscape.
6. Threatened or Endangered Animals or Plants.
7. Black and White Photography.
8. Interpretive Photography.
9. Junior Photography.

Entries close 1/5/05

WESTERN AUSTRALIAN museum

ANZANG

Juvenile Black-naped Tern, Graeme Guy
ANZANG Nature and Landscape Photographer of the Year - 2004

Northland Green Gecko, John O Sullivan

For competition rules, entry forms and further information contact:

- Website: www.anzangnature.com
- Email: compete@anzangnature.com
- Telephone/Fax: +61(0) 8 9321 3685
- Postal address: ANZANG Nature
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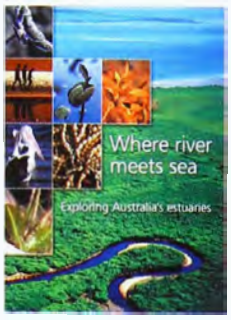
  PERTH Western Australia 6001



Where River Meets Sea: Exploring Australia's Estuaries

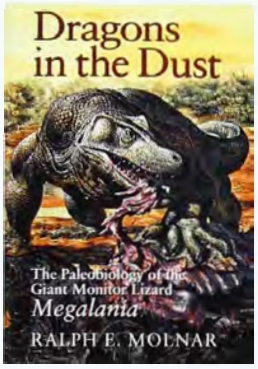
By Dieter Tracey, Lynne Turner, Jan Tilden and Bill Dennison. Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management, Indooroopilly, Qld. 2004, 294 pp. $49.95 rrp.

THE STATED AIM OF THIS HANDBOOK IS TO "ENHANCE ESTUARY LITERACY AMONG AUSTRALIANS, building our knowledge and interest in championing the cause of estuary protection and management". It is pitched at the public, green groups and environmental managers. One hopes that the key messages also rub off on policy makers and exploiters, since estuaries are vulnerable to human activities and those near population centres are degraded.

This book discusses types of estuaries, their habitats and functional processes, and gives a regional overview of management issues, some overseas case-studies and a resource guide. The chosen classification scheme draws on the interaction of wave, tide and river energy in shaping estuaries, and is easily grasped. Simple conceptual diagrams, supplemented by excellent photos, effectively summarise estuarine components and processes.

The book is user-friendly, provides a welcome overview of Australia's estuaries, and would certainly enhance estuary literacy among Australians. However, one wonders whether there is sufficient detail about individual estuaries to assist managers. There is little about the ecology of fish and invertebrates, the discussion of 'estuary health', 'indicators' and 'monitoring' is questionable, and the wording is occasionally confusing. Moreover, given the management emphasis, a firm acknowledgement of environmentally damaging population and economic growth could have been made.

—ALAN JONES
AUSTRALIAN MUSEUM



Dragons in the Dust: The Paleobiology of the Giant Monitor Lizard *Megalania*

By Ralph E. Molnar. Indiana University Press, Bloomington, Indiana. 2004, 224 pp. $69.95 rrp.

THE RECENT DISCOVERY OF DOWNSIZED HUMANS IN FLORES CREATED MUCH SPECULATION about their relationship with the only large predator on this island: the Ora, or Komodo Dragon. Presumably, many of these humans ended their lives as lizard lunches. Spare a thought, then, for the first Aboriginal people to reach eastern Australia, where they encountered a far more formidable beast: the giant goanna *Megalania prisca*. During camping trips, I have had several memorable disputes with two-metre (five-kilogram) Lace Monitors over ownership of the sausages on my barbecue; a lizard this size can be a frightening creature. In contrast, *Megalania* grew to seven metres in length and weighed around 1,000 kilograms. Few of us would dispute ownership of the sausages, or indeed the campground, with such an awesome beast.

Australia's fossil reptiles, although spectacular, have attracted less popular and scientific attention than have the charismatic mega-mammals. Ralph Molnar has done a masterful job of synthesising a wide range of information, not only about *Megalania*, but also the Pleistocene environment in which it lived. He is not afraid to speculate on the giant lizard's ecology, and even its sex life. There is much we will never know about these extinct giants, but Molnar tells a wonderful detective story about the remarkable diversity of approaches, and types of evidence, by which scientists have obtained insights into the lives of these vanished superstars of the Australian bush.

—RICK SHINE
UNIVERSITY OF SYDNEY

Astonishing Animals

By Tim Flannery and Peter Schouten. The Text Publishing Company, Melbourne. 2004, 206 pp. Paperback $50 rrp.

ASTONISHING ANIMALS IS A BEAUTIFULLY ILLUSTRATED ACCOUNT OF SOME OF THE WORLD'S most unusual vertebrates. The book begins with a brief introduction to the evolution of life on Earth and is followed by six fairly loosely defined sections. "The Vertical Terrain" includes some of the world's most spectacular birds. "Motion Specialists" features mammals that glide, a fish that walks and even a wallaby that has an aversion to grounding its tail. The third and largest section, "Food and Feeding", presents a diverse array of mammals, birds and fishes, and highlights (among other things) what a diet of just worms or cassowary droppings can do to a species' appearance. Animals that try to hide are the topic of "Shape-shifters", while the fifth section focuses on "Habitat Specialists" and includes an almost blind dolphin that swims on its side and never sleeps. The final section, "The Vertical Ocean", is the realm of the deep-sea fishes, surely the most bizarre creatures chosen, and possibly the most artistically challenging.

We are told in the introduction that one species account is purely fictitious. But so extraordinary are all the animals in this book that telling which one it is may be a bit of a challenge!

—SANDY INGLEBY
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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Contact: Lana Allcroft

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FORESTVILLE NSW 2087
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Web: *www.wires.org.au*
Contact: Carol MacDougall

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Ph: 02 4739 1528
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Contact: Tony Ellis

BIROS

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Web: *www.birdssa.asn.au*
Contact: Dr David Robertson

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VIC 3094
Ph: 03 9435 4781
Web: *www.vicnet.net.au/~vicento*

Society for Insect Studies
12 Park Avenue
ROSEVILLE NSW 2069
Ph: 02 9417 6171
Contact: Hon. Treasurer

MICROSCOPY

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BLAXLAND NSW 2774
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Contact: Tony Ellis

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Web: *www.amonline.net.au/tams/*
Contact: Alison Byrne

Membership: $88.00 Family $70.00 Single $52.00 Concession

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Ph: 08 8203 9802
Web: *www.waterhouseclub.org.au/tchc*
Contact: Mary Lou Simpson

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Contact: Kate Cox

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Field Naturalists Club of Victoria
Locked Bag 3
BLACKBURN VIC. 3130
Ph: 03 9877 9860
Web: *www.vicnet.net.au/~fncv*
Contact: Mimi Pohl

Royal Society of SA
SA Museum
North Terrace
ADELAIDE SA 5000
Ph: 08 8223 5360
Web: *www.agwine.adelaide.edu.au/industry/RSSA/*
Contact: John Love

REPTILES & AMPHIBIANS

Hawkesbury Herpetological Society Inc.
PO Box 30
EMERTON NSW 2770
Ph: 02 9832 9013
Contact: J.A. Banks

QLD Frog Society
PO Box 7017
EAST BRISBANE
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Ph: 07 3366 1868
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q&a

RAOUL SLATER, LOCHMAN TRANSPARENCIES

Red-necked Wallaby joey (*Macropus rufogriseus banksianus*).

Marsupials vs Placentals

Q: *Why is it beneficial for marsupials to have young in a pouch from a small size, as opposed to having them develop internally as eutherians (placental mammals) do?*

—Penelope Hacker
Ashgrove, Qld

A: There are pros and cons to both systems. Placental mammals give birth to well-developed young, which attach to the mother's womb via a placenta, derived from both maternal and foetal tissues. The young receive nutrients from, and expel wastes into, the mother's bloodstream via the placenta. Lactation, or production of milk by the mother's mammary glands, occurs after birth, for a similar length of time as the pregnancy.

Marsupials also have a placenta, but it is derived only from the developing young, with the young nourished in the womb by the mother's 'uterine milk'. Pregnancies are short, and lactation times are much longer than the pregnancy time. Marsupial young develop slowly compared to similar-sized placentals, and few marsupial young are born in a reproductive season. However, miscarriage rates and loss of newborns are higher in placental mammals, so recruitment is similar.

In times of environmental hardship, the marsupial mother can abandon her young, or the young can die, without her investing much energy into their development. Her chances of survival for another attempt at reproduction are better than a placental mammal's chances. In bad times a placental mother must endure a risky miscarriage, or lose unweaned young, having invested much more energy into reproduction. However, if the placental mother survives, the shorter lactation times allow her to speedily take advantage of improved conditions, whereas there will be a disadvantageous lag time for marsupial mothers.

There are also immunological advantages for the marsupial option. The exchange of material across the placenta of placental mammals, and the expulsion of the placenta during birth, exposes the mother to the possibility of immunologically reacting to tissues of the young. This can jeopardise later pregnancies, as the mother's immunity will identify subsequent young as foreign, and miscarriage or stillbirth can result. Marsupials do not have this problem as the placenta only develops from foetal tissues.

—Bronwyn McAllan
University of New England
Armidale, NSW

Identical Twins

Q: *Do identical twins have identical fingerprints?*

—Tom Hickey
Griffith, ACT

A: The short answer is no. The fingerprints of identical (monozygotic) twins are not identical. This is because fingerprints are influenced both by an individual's genes and by aspects of the prenatal environment (such as nutrition, blood pressure, position in the womb and growth rate of the fingers at the end of the first trimester).

Some aspects of fingerprints, such as the type and size of fingerprint patterns, are highly heritable and will be very similar between identical twins. However, other aspects such as the minutiae (ending ridges, bifurcating ridges etc.) differ markedly.

Forensic science and biometric security systems consider both the fingerprint pattern and the pattern of the minutiae on the fingerprint, enabling them to differentiate between the fingerprints of identical twins.

—Sarah Medland
Queensland Institute
of Medical Research

Spider Egg Sacs

Q: *I found these egg sacs in one of my pot plants. What would have laid them?*

—Eileen Collins
Chiltern, Vic.

A: These little silk packages are spider egg sacs. They belong to

These cup-shaped egg sacs are the work of the Tear Drop Spider.

a distinctive orb-web-weaving spider called *Argiope protensa*. This spider is sometimes known as the Tear Drop Spider on account of its silvery appearance and elongate body shape. The cup-like shape of these egg sacs, along with their greenish tinged silk adornments and the protective covering silk network, is more-or-less typical of several *Argiope* species. However, the Tear Drop Spider's egg sacs are unusual because of their smaller size and the larger number made (up to nine by one female).

Tear Drop Spiders are widely distributed, ranging from Australia to Papua New Guinea and New Zealand. They build their webs among shrubs and long grasses, in reed beds and even among crops, occasionally clustering in large numbers. They can tolerate moderately dry conditions and their silvery bodies help to prevent overheating as they sit in their webs by day. The webs sometimes have an irregular ribbon of white silk at the centre, equivalent to the silk cross seen in webs of their relatives, the St Andrew's Cross Spiders. These bright white silk ribbons reflect UV light, which may attract flying insects toward the web.

—Mike Gray
Australian Museum

Answers to Quiz in Nature Strips (page 19)

1. *Orange*
2. *Cassini*
3. *Three*
4. *Ultrasound*
5. *Madagascar*
6. *Fur*
7. *Micrometre*
8. *June 2004*
9. *Cygnets*
10. *Francis Crick*

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 *Talking Wildlife*. Spring's Pic Teaser was the distal end of an arm of the sea star (*Asterodiscides truncatus*).

Tangled up in blue

Juvenile dolphins are very inquisitive and this probably further increases their exposure to entangling litter.

"Tangled up in Blue", the morose refrain from Bob Dylan's lament of lost love, also applies to dolphins.

Do dolphins experience the pangs of lost love? We have no way of knowing, but Dylan's words apply literally as dolphins increasingly become tangled up in the litter of human indifference.

The plight of whales and dolphins falling victim to the infamous high-seas driftnets has been well publicised. Less well known are the problems faced by coastal species.

In the course of my long-term research project on the Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*) living in the Adelaide area, I have documented more than a dozen cases of entanglement. Discarded fishing line is easily the most common cause of entanglement but braided line, rope, elasticised sail tie and netting have all been removed from dolphins in the past few years.

While the durability and strength of nylon line transforms it into an effective knife, slowly cleaving the dolphin's flesh at the point of entanglement, line or rope trailing behind the dolphin picks up more litter and material such as seaweed, increasing drag and hampering swimming.

Entangled dolphins must be captured to remove the offending material. One dolphin calf has been entangled four times, once so extensively that it laced together his mouth and tail and made diving almost impossible. Each time he becomes entangled, the groove sliced into his tail fluke by the fishing line becomes wider and deeper, making him ever more susceptible to entanglement.

Reports of entanglements are now so common in the Adelaide area a special unit has been established to deal with them. This is made up of myself and other members of the Australian Dolphin Research Foundation, park rangers, the water police, a commercial net fisherman, a marine mammal veterinarian and RSPCA representatives.

Being hauled into a boat to have marine litter removed is no doubt traumatic for the dolphins, but they are the lucky ones.

Once we've located and netted the dolphin (and also its mother if it is still a dependent calf), divers quickly secure it to prevent drowning in the net. We then lift the dolphin into an inflatable boat for treatment by the vet, photograph it and release it as quickly as possible.

Being captured in a net and hauled into a boat to have marine litter removed is no doubt a traumatic experience for the dolphins concerned. But they are the lucky ones.

Entanglements on some dolphins are not detected and these animals die what must be a slow and painful death by starvation or infection. A young animal recently autopsied by the Dolphin Trauma Unit, a multidisciplinary group coordinated by the South Australian Museum, had its tail fluke almost severed by braided fishing line.

Adelaide is rather special in having so many dolphins living virtually in the heart of the city, and there would be few places around Australia's vast coastline where dolphins are monitored to the degree they are here. Still, the only real way to reduce dolphin entanglements is to reduce the amount of litter entering the marine environment. Legal penalties for littering are certainly helpful but education on the entanglement issue—not just for dolphins but for whales, seals, birds and other animals as well—is critical. The highest priority in any educational project must be to increase anglers' awareness of the lethality of discarded line.

Entanglement is only one of the threats facing Adelaide's dolphins. During the past few years several have been shot, stabbed or speared; some have been hit by speeding boats; and all have ingested toxic pollution, particularly heavy metals. As if these threats were not enough, the habitat they depend on has been damaged by stormwater, industrial discharges and sewage effluent. Juvenile dolphins are particularly vulnerable. They are also very inquisitive and this probably further increases their exposure to entangling litter.

The survival of Bottlenose Dolphin communities presently living adjacent to urban areas will depend on how quickly we can reduce negative impacts on the marine environment we profess to love so dearly. Failure to do so will inevitably invoke another Dylan song, that mournful dirge of bleak urban existence, "Desolation Row". □

BY MIKE BOSSLEY

Dr Mike Bossley has been studying dolphins in the Adelaide area since 1987. His work is supported by the Australian Dolphin Research Foundation and the Whale and Dolphin Conservation Society.

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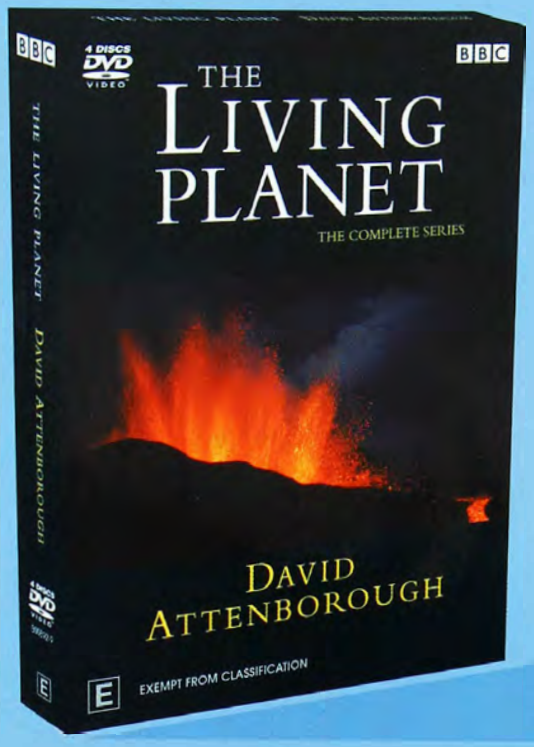

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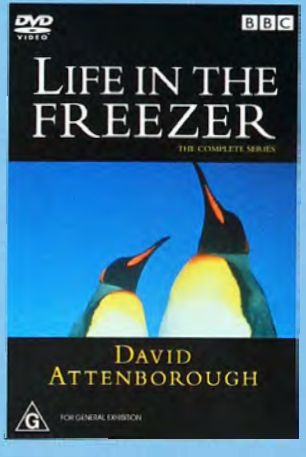

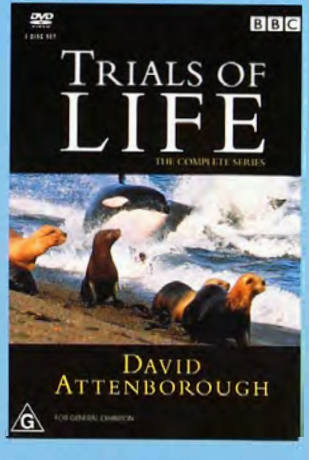

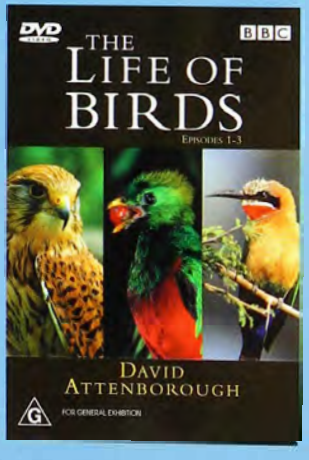

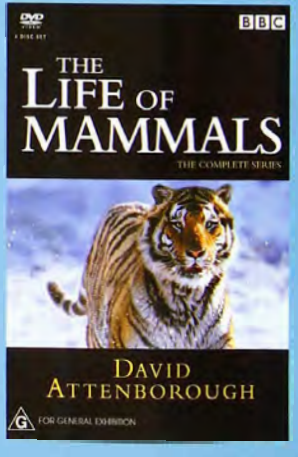

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