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ISSN 1324-2598

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With the assistance of the Embassy of the Republic of Peru

NatureAustralia

SUMMER 2003–2004 Volume 27 Number 11

Published by the Australian Museum Trust
6 College Street,
Sydney, NSW 2010.
Phone: (02) 9320 6000
Fax: (02) 9320 6073
Web: www.natureaustralia.net
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Phone: (07) 3399 1885
email: ken-hill@bigpond.com

Subscriptions
Phone: (02) 9320 6119
Toll-free (1800) 028 558
Fax: (02) 9320 6073
email: subscribe@austmus.gov.au

Annual subscription (4 issues)
Within Australia $A36.30 Other countries $A45
Two-year subscription (8 issues)
Within Australia $A69.30 Other countries $A83
Three-year subscription (12 issues)
Within Australia $A97.90 Other countries $A116
Prices include GST where applicable

Proudly printed in Australia by Penfold Buscombe

New subscriptions can be made by credit card on the Nature Australia toll-free hotline (1800) 028 558 or use the form in this magazine. If it has been removed, send cheque, money order or credit card authorisation to the address above, made payable to the Australian Museum in Australian currency.

NATURE AUSTRALIA welcomes articles on the natural and cultural heritage of the Australian Region. Opinions expressed by the authors are their own and do not necessarily represent the policies or views of the Australian Museum. All articles in *NATURE AUSTRALIA* are peer reviewed. *NATURE AUSTRALIA* is printed on archival-quality paper suitable for library collections.

Published 2003 ISSN–1324–2598

NATURE AUSTRALIA is proud winner of the 1987, '88, '89, '90, '91, '92, '93, '99, 2000, 2002 and **2003 Whitley Awards** for Best Zoological Periodical, and the 1988 & '90 Australian Heritage Awards.

FRONT COVER

Ground-nesting seabirds such as this Brown Booby (*Sula leucogaster plotus*) are vulnerable to Yellow Crazy Ants.
PHOTO BY CHRIS SURMAN

up front

The Simpson Desert and its inhabitants have been under siege since the arrival of Europeans. They have had to endure disease, Rabbits, Cats, Foxes, overgrazing by livestock, changed fire regimes and drought. All this has taken its toll and, since 1788, 26 medium-sized mammals have become extinct or endangered in arid Australia. Mike Letnic, an ecologist with the Parks and Wildlife Commission of the Northern Territory, is trying to end this decline by constructing a time line of major ecological events. By identifying the dominant threats and extinctions and, importantly, the timing of both, he hopes to be able to prevent further loss of species. His work is already providing some interesting results for it seems that, in the Simpson Desert, it is after floods during the times of plenty when species are most at risk. Cats and Foxes thrive and bushfires have the potential to destroy vital spinifex habitat. So it seems that the time we need to protect our desert animals the most is when the times are good.

One of the most popular events each year is when the Humpback and Southern Right Whales migrate along the eastern coast of Australia. But imagine if the largest animals ever to have lived on the planet spent some time along the coast of Australia. Well, it now seems that they do. An important Blue Whale feeding ground has been discovered along the coast close to the Victorian–South Australian border. At the start of December the whales start arriving and they have come to feed on tiny crustaceans called krill. The krill concentrates in the area because of a coastal upwelling called the Bonney Upwelling. After five full seasons of studying these amazing animals, there is still plenty scientists hope to learn but Peter Gill and Margie Morrice's account of the story so far makes for great reading.

Also in this issue we take a look at the way birds are forcing us to question our long-held belief that humans hold a unique place in nature. We examine the struggle to save Christmas Island from the Yellow Crazy Ant, something well worth paying attention to as this deadly ant has recently made it to our shores. We question whether reptiles really did dominate the Australian landscape two million to 10,000 years ago, present a new theory that puts Granny in the driving seat of human evolution, and meet a spider that has a very definite preference for blood.

—JENNIFER SAUNDERS
Publishing Manager

PETER GILL & MARGIE MORRICE

A Blue Whale diving for krill.

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letters

Flying Rats

Offering a poster of Rainbow Lorikeets to Perth residents is like offering a poster of Cane Toads to Queenslanders and Northern Territorians. Flocks of Rainbow Lorikeets, probably from aviary escapees, were a colourful rarity in my childhood but have now established themselves across Perth. They shriek across the skies in increasing numbers, exclude the local green 'Twenty-eight Parrot' (subspecies of the Australian Ringneck) from nesting hollows, and have earned themselves the nickname 'flying rats'. Sorry, but this is one poster that didn't get a place on my kitchen wall.

—Sally Lake
Highgate, WA

Marsupial Lions Snatch & Run

In a thought-provoking article in *Australasian Science* (September 2003), Antoni Milewski (University of Cape Town) proposes an alternate version of how the Pleistocene Marsupial Lion (*Thylacoleo carnifex*) might have acquired its daily meat. Rather than a big-cat style of predator, he conceives of a specialist that raids marsupial pouches or bites chunks from undead prey. He seems to base this on the unsuitability of *Thylacoleo*'s incisors as killing instruments and the propensity of some macropods and bandicoots to eject their pouch young when pursued.

Like most theories this throws up as many questions as it purports to answer. For instance, although kangaroos do jettison joeys when pursued by Dogs or equivalent dogged pursuers (*Thylacines*?), would they do the same if rushed by an animal whose bones suggest an ambush specialist? Would a species that dumped baby every time it was startled last very long? And whilst the physiology of macropods makes such a manoeuvre possible, we can only surmise about the ability of Diprotodons to do likewise.

As to taking bites out of unsuspecting megafauna, wouldn't that be a dangerous thing for a none-too-speedy carnivore to do? I mean, what if they took it personally?

Perhaps we have a problem with mammalian carnivores that don't kill with their teeth. I believe *Thylacoleo* used it's jaws as a third hand, to secure the prey while allowing the thumb claw on either hand to do the killing. A powerful neck could have dragged the prey's head back to expose the vulnerable throat. Even the forward-pointing incisors would be an advantage, allowing the animal to breathe easier while maintaining its death grip.

—Peter Williams
Branxton, NSW

Rankled over Rank

Captain Cook did not sail along the coast of Australia, as stated in the article "Respecting our Forest Veterans" and the Up Front section (*Nature Aust.* Winter 2003). He was only a Lieutenant at the time. No-one refers to Matthew Flinders and George Vancouver by their rank. Why can't you just say James Cook? Fortunately James Cook University got it right.

—Lawrence J. Cohn
Doncaster, Vic.

Puddy Cats

The Nature Strips item on when Cats arrived in Australia (*Nature Aust.* Winter 2003) confirmed my own opinion. Many years ago in the Great Victoria Desert I showed some scratches on the bark of a tree to my Aboriginal assistant. When I asked what made them, his answer was "Puddy cat". I knew then

T. & P. GARDNER/NATURE FOCUS

Perth Pests: Rainbow lorikeets.

When did Cats arrive in Australia?

that, if Cats had arrived hundred of years before the British settlers, the first Australians would have given them a name, and not used the British pussy cat.

—Vincent Serventy
Wildlife Preservation Society of Australia

demountable classroom where one of us teaches. Apart from their decorative and stimulatory function, they cover the mould that the Department of Education never seems to get around to removing!

—Karen & Steve Tucker
Terrigal, NSW

Congratulations

We have been enjoying *Nature Australia* since 1975. Each issue is eagerly awaited and read cover to cover. Of course, unlike other magazines, we simply can't throw any of the old ones out. The readability and range of interesting topics is excellent. The posters also are admired, and go to good use decorating the walls of a

I am 13 and a young aspiring field biologist and documentary maker. I like to get out into the bush and experience everything hands on, but school Monday to Friday and my father working on the weekends doesn't leave much time for this. However, with your magazine it is the next best thing to being there. The photography is brilliant and the articles well written. Congratulations on a fabulous job.

—Sam Brown
Ararat, Vic.

For the Record

The photograph of Killer Whales herding herring on page 15 of the Spring 2003 issue of *Nature Australia* was taken by Leif Nottestad.

—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 *Snowball Earth*. The winner this issue is Sam Brown.**

Summer

Compiled by Geordie Torr and Martyn Robinson

Christmas beetles (*Anoplognathus* sp.).

JEAN-PAUL FERRERO/AUSCAPE

It's Christmas time

For most people, summer = cicadas. But these noisemakers aren't the only insects associated with long, hot nights. Certain species of scarab beetle (in the genus *Anoplognathus*) are known as Christmas beetles because they usually arrive around the end of the year, to fly clumsily around streetlights.

The numbers of some Christmas beetle species may have increased in recent decades as a result of forest clearing, which creates ideal conditions for their grass-root-eating larvae. This is good news for the beetles, but bad news for the remaining eucalypt trees, whose foliage the adult beetles eat. When conditions are right, the beetles can strip even a large gum bare.

GUNTHER SCHMIDA

Sadly, however, the bright, metallic beetles of yesteryear have disappeared from many of their old haunts. In this case, it seems that we've built over or sprayed the grassy areas where their larvae fed, for example in the suburbs of Sydney.

On Lord Howe Island the 'Christmas beetle' is a green stag beetle in the genus *Lamprina*. Interestingly, South Africans also call one of their insects a Christmas beetle, but it's what we would call a cicada. For more about Christmas beetles, head to **http://wildlife.faunanet.gov.au/factfile.cfm?Fact-_ID=164**

A fish out of water

When Western Australia's wet winter gives way to a hot, dry summer, the acidic pools inhabited by the tiny Salamanderfish (*Lepidogalaxias salamandroides*) begin to disappear. By January, most are totally dry and seemingly lifeless.

But what happens to all the fish? Well, they're still there. The Salamanderfish toughs out the drought by burying itself deep in the sand and mud—up to 60 centimetres below the surface where it's still damp—and 'breathing' through its skin. A robust, wedge-shaped skull helps it dig through the sand.

But this isn't the Salamanderfish's only unusual attribute. In fact, so strange is this fish that scientists have had difficulty figuring out how it's related to other fishes and have placed it in a family all of its own—the Lepidogalaxiidae.

Although it doesn't appear to have any more of a neck than other fishes, it can turn its head up, down and from side to side in a very unfish-like manner. This is handy as, uniquely, the Salamanderfish lacks eye muscles and can't move its eyes in their sockets. The fish also sports elongated pelvic fins, which allow it to waddle, salamander-style, up shallow creeks to colonise new acidic swamps and lakes.

When the rains return in winter, Salamanderfish rapidly emerge from their subterranean refuges to reproduce. The males are thought to use their anal fin, which is bigger than that of females, to help them transfer sperm. Fertilisation is internal, the males gluing themselves to the females with a sticky mucus.

Salamanderfish.

Salt-encrusted bush, Lake Eyre.

All in all an unusual fish, in or out of water. To learn more, visit **www.tolweb.org/tree?group=Lepidogalaxiidae&contgroup=Osmeroidei**

Salty summer

The summer sun's habit of sucking the water from pools and lakes makes life difficult for the creatures that live in them, but it can have a quite beautiful side effect. If the water body is salty, the evaporating liquid leaves behind accumulations of crystals. These mineral salts, mainly halite (rock salt) and gypsum, take many forms, depending on the prevailing conditions and the chemical composition of the water. They can be simple crusts, amorphous slabs, or a variety of unusually shaped crystals including block-like cubes (in the case of halite), or rosettes, arrowheads and diamonds (gypsum).

In pure forms, the crystals are colourless or white but when they build up in large masses, they can trap impurities resulting in interesting pink, red, or even black deposits. When the rains return, these 'temporary minerals' disappear back into solution, and you then have to wait until next summer to see them again. You can see them year-round, though, at **www.mii.org/Minerals/photosalt.html**

FROM THE COLLECTION

*This is the only specimen of a Lake Eyre Dragon (*Ctenophorus maculosus*) in the Australian Museum's reptile collection. It was collected at Lake Eyre in South Australia by F.J. Mitchell—the person who described the species in 1948—and was received from the South Australian Museum in 2001 in exchange for some other specimens.*

Lake Eyre Dragons are only found on the margins and salt crusts of salt lakes in the Lake Eyre region. Living in such a harsh environment has led to some nifty adaptations. First up is a set of 'eyelashes'—spiny scales around the eyes that are thought to shade them from the glare of the dazzling white sheets of dried salt. Moisture is incredibly scarce where these little lizards live, and they're able to survive on whatever water they can eke out of their food—mostly ants, although they'll pounce on any insects or spiders unfortunate enough to be blown out onto the salt. They can also change colour, darkening in the morning to warm up quickly and then turning lighter to reflect the midday heat.

In summer, the lizards usually stand with their toes or sometimes their entire feet off the ground so that the heel and wrist joints are the only points of contact. This bizarre stance prevents them from overheating or burning the soles of their feet.

For more information, visit **www.abc.net.au/schoolstv/animals/LAKEEYREDRAGONS.htm** *or see them in the flesh at the Alice Springs Desert Park (or head out to Lake Eyre itself).*

STUART HUMPHREYS/NATURE FOCUS

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

nature strips

COMPILED BY GEORGINA HICKEY

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

Great Wall Flowers

Question: What do bloodthirsty, rampaging Mongol hordes and the flow of plant genes have in common? Answer: They've both been impeded by the Great Wall of China.

When populations of a species become separated by a geographical barrier, their genetic compositions gradually diverge. Eventually they will become so different that they can no longer interbreed...and new species are born.

Such barriers may include rivers, mountains, or patches of unsuitable habitat, but man-made obstacles may also have an effect. A team of Chinese researchers, led by Hongya Gu (Peking University), decided to put their Great Wall to the test.

First they selected three sites—two bisected by six-metre-high sections of the wall and the other (their control) bisected by a narrow path. They then collected samples from a variety of plants from either side of the wall and path, and compared their genetic makeup.

Plants separated by the Great Wall had indeed diverged significantly more than those separated by the path, and this was most notable in species that relied on insects (rather than the wind) for pollination. These changes are likely to have taken place since erection of the wall over 600 years ago. They also found that the amount of genetic variation within species on the same side of the wall was higher for insect-pollinated plants. Clearly insects only do a good job of transporting pollen locally, not over the wall like the wind.

—G.T.

Doing the Faecal Fling

Many caterpillars that build and live in leaf shelters have the curious habit of ballistically ejecting their droppings over a metre from their homes.

They do this with the help of a hardened structure that

The Great Wall of China has kept more than marauding tribes at bay.

MICHAEL POLAK/LONELY PLANET IMAGES/OXFORD SCIENTIFIC FILMS/AUSCAPE

acts like an anal latch and that only opens when there is sufficient build-up of blood pressure to blast the pellets away.

But why fling frass (as insect poo is called)? Is it a matter of housekeeping to keep the caterpillars safe from disease? Is it to prevent overcrowding so the caterpillars don't have to waste valuable energy building new shelters when the toilet overflows? Neither, according to Martha Weiss from Georgetown University, who conducted experiments with the Silver-spotted Skipper (*Epargyreus clarus*). She found no significant differences in survival rates for caterpillars raised in clean/dirty or empty/crowded conditions. But she did find a difference in the rate at which caterpillars were preyed upon by the wasp *Polistes fuscatus*.

To test this idea, Weiss presented wasps with leaflets bearing two similar leaf shelters, each with a caterpillar inside. On one of the leaflets she placed 25 droppings, while on the other she placed 25 glass beads the same size and colour as the droppings. She found that wasps were four times more likely to attack caterpillars with frass than those with beads.

Weiss concluded it was the smell of the droppings that the wasps were attracted to. So the best way for caterpillars to throw enemies off the scent is to...ready... aim...

—V.W.

KITCHIN & HURST/ALSCAPE

Pumas (*Felis concolor*) are one of many mammal species that possess a penis bone. But what function could it serve?

Penis Bones

The expression 'getting a boner' (meaning to have an erection) applies literally to many different mammals but, ironically, not to humans who coined the phrase. You see, humans lack a penis bone, or baculum.

Among those mammals that do possess a baculum (present in carnivores, bats, insectivores, rodents, colugos and some primates), size varies enormously and disproportionately to the size of its owner. A 550-gram marmoset, for example, has a baculum measuring just two millimetres, while a tiny 63-gram bush baby has one around 13 millimetres long. But the real enigma is why they have a penis bone at all.

Because of the energetic costs associated with growing and maintaining penis bones, it is assumed that bacula do have an adaptive function in at least some species. Over time, a number of hypotheses have been advanced. The first proposes that the baculum provides extra rigidity to the erect penis to facilitate intercourse, useful in species where mounting occurs before full erection (some members of the dog family), or for strongly sexually dimorphic species like Walruses where it could help large males 'shoehorn' themselves into much smaller females.

The second hypothesis proposes that the bone helps those animals that remain 'locked' together after ejaculation (some dogs) by preventing the urethral canal

from being squeezed shut and impeding sperm flow. The third idea suggests that the additional penile rigidity helps stimulate the reproductive tract of the female, inducing ovulation (as in some cats) and increasing the likelihood of successful fertilisation.

Determined to get to the root of the issue, Serge Larivière (Delta Waterfowl Foundation, Manitoba) and Steven Ferguson (Lakehead University, Ontario) compared baculum size, degree of sexual dimorphism, duration of copulation and occurrence of induced ovulation, across 53 species of North American carnivores, correcting the data for any similarities due to relatedness.

Unfortunately, the results were inconclusive. They found that baculum length was independent of both sexual size dimorphism and copulation duration, refuting the first two ideas. Baculum length was also found to vary little between induced and spontaneous ovulators, putting the kybosh on the third hypothesis as well.

Make no bones about it, they say, it's back to the drawing board on this one.

—R.S.

COURTESY PAVEL SOROKIN

Hunting male Saigas for their horns has had a devastating effect on their population.

Ugly Neanderthals

What is it that makes some human faces so attractive? Due to the use of recent computer morphing programs, in which human males may manipulate and select, over several 'generations', the female faces they rate as most attractive, the ideal female face has 'evolved'. The key features of this face are a smaller than average chin, smaller than average nose and a higher than average forehead. Interestingly, these features also distinguish the human species (*Homo sapiens*) from Neanderthals (*Homo neanderthalensis*).

Line up the eye sockets of a modern human skull with those of a Neanderthal skull of the same height, and you will find that the Neanderthal has a shorter chin and nose, and higher forehead. This is no coincidence, says Alessandro Cellerino (CNR, Italy), who believes that the human inbuilt preference for 'beautifully proportioned' faces was the main mechanism that prevented early modern humans and Neanderthals from interbreeding.

According to the model of 'disruptive sexual selection', two populations living together evolve in opposite directions due to different selection criteria. In other words, if early humans thought Neanderthals were ugly, then humans were probably just as ugly in the eyes of Neanderthals. But it takes all sorts. There is some evidence that early humans and Neanderthals may have interbred occasionally (see "Neanderthal Cocktail", *Nature Aust.* Spring 2000). If so, perhaps those individuals were just part of the unfussy minority.

—G.H.

From Rut to Ruin

Less than a decade ago, the steppes of central Asia were inhabited by great herds of nomadic Saiga antelope (*Saiga tatarica*). Yet in the socio-political turmoil following the collapse of the Soviet Union, the Saiga has been

hit by an epidemic of poaching. Saiga horn, harvested from the males, is used in Chinese medicine for the treatment of fever, and can fetch up to $US100 per kilogram. Numbering well over a million just a decade ago, Saigas have now declined by 95 per cent—the most sudden and dramatic population crash ever seen in a large mammal population.

Hunting males for their horns has had a catastrophic effect on the entire population, as Eleanor Milner-Gulland (Imperial College London) and colleagues have shown. Although an adult male usually maintains a harem of 12–30 females, male-biased poaching has resulted in harems with more than 100 females. Frankly, the males just can't keep up and females have become more aggressive in what appears to be a reversal in reproductive behaviour. Dominant females have begun to steer subordinate females away from the males, preventing most first-year females from conceiving.

Biologists fear that, without intervention, the Saiga will soon go the way of the Dodo. Hopefully a recent grant from the UK Government's Darwin Initiative for further studies on Saiga reproductive behaviour will help bring these antelopes back from the brink.

—K.H.

CSIRO MARINE RESEARCH/NATURE FOCUS

The Patagonian Toothfish has made a surprising appearance 10,000 kilometres north of home.

Bipolar Fish

A large male Patagonian Toothfish (*Dissostichus eleginoides*), normally found only in subantarctic waters and off Patagonia, has snuck its way more than 10,000 kilometres north to Greenland.

A fisherman from the Faeroe Islands was perplexed when the 1.8-metre, 70-kilogram, deepwater giant turned up in his catch of Greenland Halibut, so he froze it and sent it to Peter Rask Moller (University of Copenhagen) and colleagues.

The species, which has replaced dwindling supplies of cod as a popular table fish around the world, was previously unknown from the northern hemisphere. In

fact, the farthest north a Patagonian Toothfish had ever been caught before in the Atlantic was off the coast of Uruguay.

So how could a fish, which only survives in temperatures of 2–11° C, traverse the treacherously balmy waters of the tropics? The researchers suggest it is a stray that hitched a ride in cold, deep-sea currents. In the tropics, once you get down to depths of 500–1,000 metres, the temperature drops to less than 10° C, providing a comfortably cool corridor for cold-loving fish.

Moller and his coworkers say the find could also help explain the distribution of some species and families of fish that are found at both poles but not in the warm tropical waters in between.

—A.T.

Trunk Calls

The deep, booming, infrasonic calls of elephants are thought to facilitate long-distance communication between herd members. Female African Savanna Elephants (*Loxodonta africana*) are familiar with the calls of up to 100 different individuals, and react distinctively to the calls of family members as compared to others. Their calls can theoretically travel up to ten kilometres in ideal conditions. But sound characteristics change over distance, so how much does an elephant understand from a call made from a long way away?

Karen McComb (University of Sussex) and colleagues investigated how well elephants can identify individuals from calls made at varying distances. In playback experiments, the researchers found that elephants recognised their own family members' contact calls from as far away as 2.5 kilometres, but more commonly identified them at 1.0–1.5 kilometres away. Farther than that, the elephants listened but showed no signs of recognising the caller.

Recordings and sound analysis revealed that different parts of the elephant's call deteriorate at different distances. The parts of the call that retain the most fidelity over long distances are not, it turns out, the infrasonic components below 30 Hertz (barely audible to humans), but the frequencies we can hear easily—around 115 Hertz.

This particular frequency band is created when the call

African Savanna Elephants speak through their noses.

is filtered through the cavities of the vocal tract. The narrower the spacing between peaks, the longer the vocal tract that created the call. In female elephants, the spacing between these peaks predicts an unusually long vocal tract of nearly three metres, suggesting that the elephants use both their pharyngeal cavity and their trunk to filter calls and provide individually distinctive calling information. So it seems that for elephants at least you just can't beat a trunk call for long-distance communication.

—D.C.

Shark Gel

Sharks are known, and feared, for their sixth sense—the ability to detect electrical fields generated by the movements of fish and perhaps the frantic flailing of nervous swimmers. Now Brandon Brown (University of San Francisco) has discovered another remarkable ability of sharks: gel found in their snouts acts like a semiconductor, enabling sharks to detect minute changes in temperature.

He collected the clear gel by squeezing the snouts of a Blacktip Reef Shark and a Great White.

Gel-filled canals connect pores on the surface of the snout with electrosensors known as 'ampullae of Lorenzini'. Brown collected the clear gel by squeezing the snouts of a Blacktip Reef Shark (*Carcharhinus melanopterus*) and a Great White (*Carcharodon carcharias*). When he warmed the samples to measure the resulting change in electrical field, he found that an increase of just 1°C delivered a voltage of around 300 microvolts. Taken with results of previous experiments that showed the electrosensors respond to a mere 0.05 microvolts, this suggests that sharks could detect temperature changes well under one thousandth of a degree.

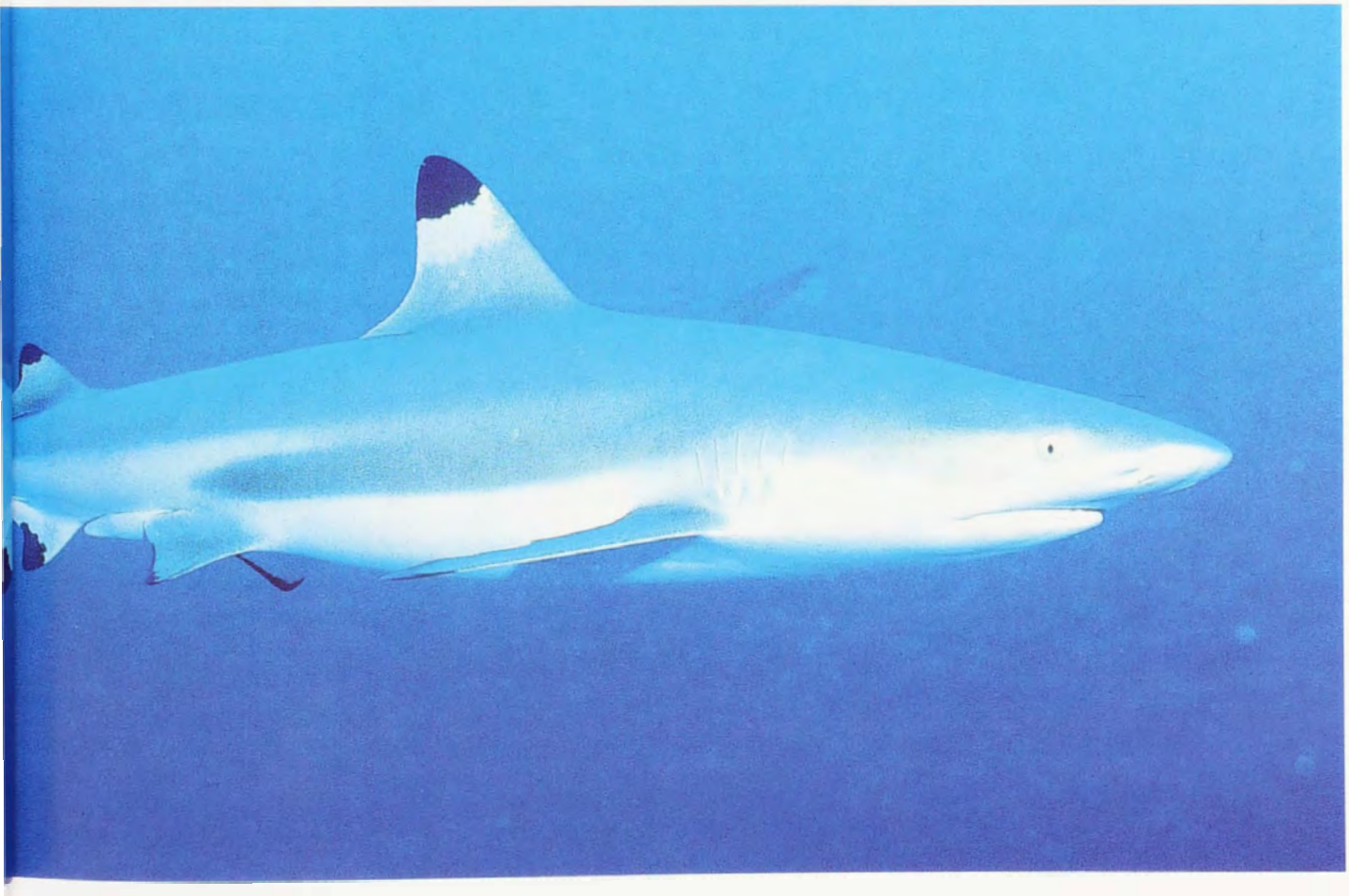
Brown says when a shark swims into an area that is suddenly warmer or colder, the gel transforms the temperature change into an electrical signal, which the sensors pick up and then send as a message to the brain. Such an adaptation could help the predators to identify thermal fronts, nutrient-rich areas where warm and cold waters mix and where smaller fishes gather to feed in large numbers.

—R.S.

Pruning the Human Family Tree

Archaeologists are either lumpers or splitters, depending on their tendency to minimise, or maximise, the number of hominid species recognised. Recently splitters have hogged the headlines, bringing the total

Blacktip Reef Sharks have sensitive snouts.



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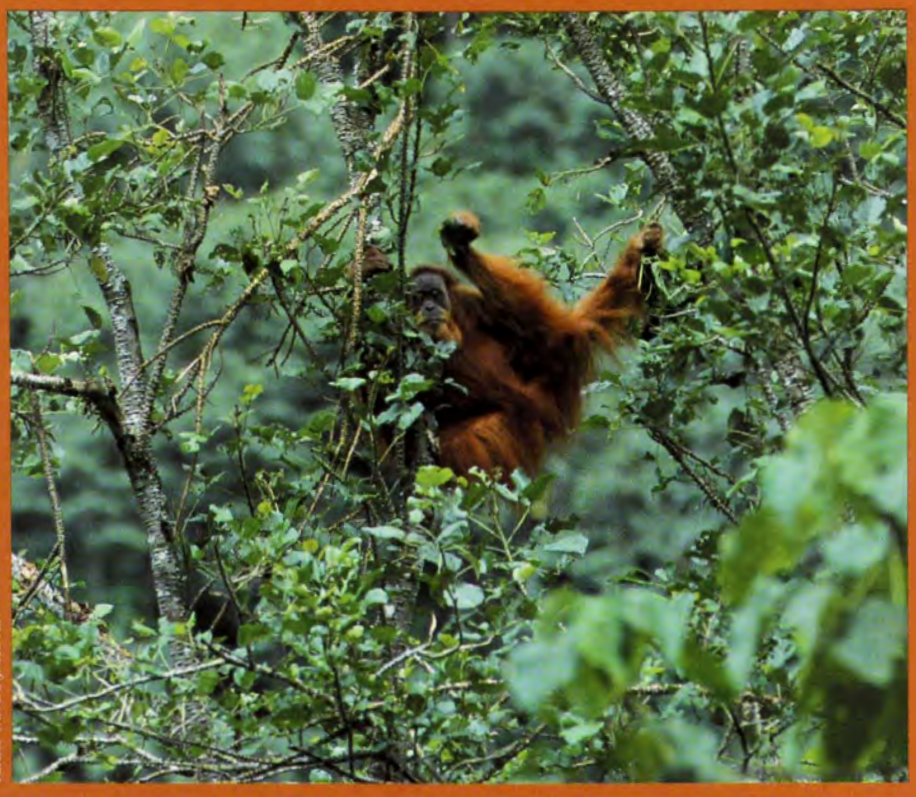


PERRY VAN DUIJNHOVEN

An adolescent male Orangutan uses leaves as gloves to protect his hands from the thorny branches.

Cultured Apes

In recent years a number of animals, most notably Chimpanzees, have been shown to demonstrate behaviours that are culturally based. Now a new study has revealed that Orangutans (*Pongo pygmaeus*) are cultured too.

The discovery arose out of an observation that animals on one side of a river barrier used sticks as tools to pry out seeds from spiny fruit, while those on the other side of the river did not. So a team of Orangutan researchers, led by Carel van Schaik (Duke University), got together to compare observations taken throughout coastal Borneo and northern Sumatra.

To their amazement, they identified 24 culturally transmitted behaviours, including using leaves as protective gloves, snag riding (an Orangutan sport where the apes ride a pushed-over branch, grabbing vegetation before they hit the ground), building sun or rain shelters for nests, and using sticks as tools to extract insects from tree trunks, seeds from fruit, or to scratch themselves.

The researchers were wary of jumping to conclusions because cultural transmission requires more than just the mother—infant bond, but also extensive social contact, and Orangutans are the least sociable of all the great apes. There were also concerns that the observed differences might be nothing more than straightforward adaptations to varying habitats, without social transmission.

However, they found that habitat had no significant impact on behavioural similarities, and that animals from geographically close sites showed greater similarities than those from more distant locations. They also found that the greatest behavioural repertoires were found in Orangutans with the most social contact, that is, those that had the greatest opportunity to learn from each other.

These findings push back the evolutionary origins of culture in the human line to at least 14 million years ago, when Orangutans first branched off from the rest of the apes.

—R.S.

number of described species to about 20. But recent studies are questioning this trend.

An upper jaw and lower face from Olduvai Gorge (Tanzania), for example, may help prune one twig in the human family tree. Robert Blumenschine (Rutgers University) and colleagues showed that this 1.8-million-year-old specimen, dubbed OH 65, had a mix of features found in two previously described species—one already present in the Olduvai deposits (the type specimen of *Homo habilis*, made famous by the Leakey family) and one not recognised in this area before (*Homo rudolfensis*, from Koobi Fora, Kenya). The team suggests that the new specimen and the one from Koobi Fora are really just normal variations of *Homo habilis*, and that the name '*Homo rudolfensis*' should be dropped.

Tim White (University of Berkeley) also argues that there are too many species, but believes this may have come about from a misunderstanding of geological processes. Take *Kenyanthropus platyops*, the 3.5-million-year-old 'flat-faced man from Kenya', described in 2001 on the basis of a skull made up of over 4,000 pieces of bone. According to White, the specimen gets its distinctive features not from its genes, but from what he calls 'expanding matrix distortion'. During fossilisation, the matrix expands in a non-predictable fashion, splintering the bone into fragments and distorting the original shape. White suspects that *Kenyanthropus* is really just another form of

'Lucy' (*Australopithecus afarensis*).

The case for shaving the bush and trimming the tree is gaining favour again—but for new reasons.

—R.F.

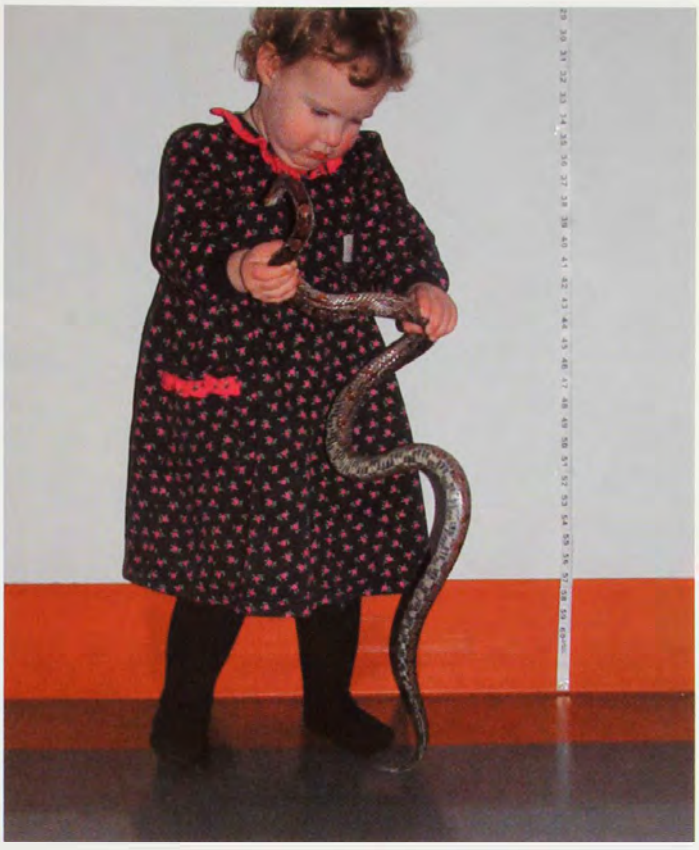
An Ideal Serpent

"How long should a snake be?" sounds as unanswerable as the epigram "How long is a piece of string?" However, Scott Boback and Craig Guyer (Auburn University, Alabama) have demonstrated that there might indeed by an ideal length for a snake—a size that maximises overall efficiency of its elongated body plan.

First they looked at the sizes of a large global sample of snake species. The most common body length was around one metre, with numbers tapering off rapidly either side of this peak.

Next they graphed the size ranges of snakes on islands. Large islands have many snake species encompassing a wide size range, while smaller islands have fewer species with a narrower size range. Extrapolating, they found that when an island is so small that it supports only one snake species, the expected size of this lone species is almost exactly one metre. Real 'one-snake islands' support this mathematical prediction.

Finally, the researchers examined what happens when mainland snakes invade islands and escape from competition with other snakes, which might have prevented them from evolving to their 'ideal' size. When snakes over a metre



North American Corn Snake (*Elaphe guttata*). Is there an ideal length for a snake?

ERWIN & PEGGY BAUER, AUSCAPE

COURTESY TROOPER WALSH

(Top) The Komodo Dragon is the world's largest lizard. (Bottom) Kraken, a captive female Komodo Dragon, plays with a rubber ring.

long underwent such ecological release, they shrank, while smaller snakes grew larger.

The metre is usually known as the standard (but arbitrary) unit of length in the metric system: once a bar of platinum alloy in Paris, but now defined as the distance light travels in a vacuum during 1/299,792,458th of a second. Herpetologists might argue that the ideal snake would provide a more meaningful basis for defining a 'standard metre', but some loss of precision would be inevitable, and it seems unlikely that a serpent will ever become the new universal reference.

—M.L. & J.S.

Playful Dragons

The Komodo Dragon (*Varanus komodoensis*) isn't known for its jocular nature. As the world's largest lizard, the Komodo's reputation has been forged by its predatory habits, cannibalistic tendencies and the fact it is not above preying upon the occasional human. Yet observations of a young captive Komodo called Kraken have revealed that dragons may have a light-hearted, even playful side to their personalities.

Kraken's whimsical antics, while on display at the National Zoo in Washington DC, prompted Gordon Burghardt (University of Tennessee) and colleagues to investigate play behaviour in Komodo Dragons. During the two-year study, Kraken was video-taped in a series of 31 tests, where she was given a variety of novel objects to interact with, including a rubber ring, a Frisbee, a tennis shoe, a bucket filled with paper towels and a handkerchief. These objects were laced with different scents, including perfume, rat blood and corn oil so Kraken could distinguish between prey and non-prey items.

Kraken showed a variety of responses to the different 'toys', including play-like

behaviour such as tug-of-war with the keeper's handkerchief and spontaneous pawing of the Frisbee. Yet when the same objects were laced with the scent of blood, Kraken exhibited a predatory response, secreting copious amounts of saliva, whipping her tail and protecting the 'prey item'.

The researchers believe these observations show that play behaviour is not just limited to warm-blooded animals with large brains. If there is such a thing as reptilian revelry, it's not surprising the Komodo Dragon is the first to display it. Known for its complex behaviour and intelligence, the dragon is the most likely lizard to reveal a fun-loving alter ego—despite its fierce repute.

—K.H.

Large tracts of untouched jungle and woodlands may not be able to save the Gorilla and Chimpanzee from extinction.

Apes on the Brink

Scientists have been preaching for decades that habitat protection would secure the future of our species' closest relatives. Now revelations that even large tracts of untouched jungle and woodlands may not be able to save the Gorilla and Chimpanzee from extinction have sent shock waves around the world.

Most of the planet's wild Gorilla (*Gorilla gorilla*) and Chimpanzee (*Pan troglodytes*) populations survive in relatively large areas of pristine forests in Gabon and the Republic of Congo in western equatorial Africa. However, surveys of nest sites across Gabon's forests from 1998 to 2002 indicate that ape populations have shrunk more than 50 per cent in less than two decades, and the researchers recommend their status be upgraded from Endangered to Critically Endangered.

Two main factors are responsible for the population crashes, according to the 23 United States, European and Gabonese researchers behind the findings. Hunting of apes for bushmeat has risen considerably following the penetration of mechanised logging into once remote areas. And there has been a dramatic rise in the number of deaths caused by Ebola, a contagious and deadly virus that affects both apes and humans.

No-one is quite sure what causes outbreaks of Ebola, but the virus is thought to reside in some as yet unidentified 'reservoir' species, such as a fruit bat. And humans are believed to contract the virus from eating infected apes. If only the locals could be made more aware of this fact.

—K.McG.

Mungo Man Dates Mungo Lady

Lake Mungo in semi-arid New South Wales—with

its human artefacts and extraordinary preservation of burials—has been central to the debate on timing of the first Australians. Original estimates of 30,000 years for 'Mungo Man'—the world's first recorded ritual ochre burial—were later upped to 42,000–45,000 years, and then again to 62,000 years in 1999. This last estimate was way out of whack with an estimate of 20,000–26,000 years for 'Mungo Lady', whose burnt remains were found nearby and represent the world's first recorded cremation. Not comfortable with this spread of dates, geomorphologist Jim Bowler (University of Melbourne), with a team of archaeologists and dating experts, analysed new sediment samples from levels reliably located at the burial sites.

These latest estimates suggest that Mungo Man and Mungo Lady were buried at about the same time (and were perhaps even an item?) 38,000–42,000 years ago. Deep below Mungo Lady's cremation site was an assemblage of stone artefacts found in sands last exposed to sunlight 46,000–50,000 years ago. These dates are similar to suggested ages for occupation in south-western and northern Australia. If the deeply buried artefacts have not moved downwards and do relate to occupation, Aboriginal ancestors were living in an environment characterised by increasing aridity. Windblown silt, dust, weakly developed soils and lake-floor clay indicate fluctuating lake levels, followed by dramatic drying of the lakes nearly 40,000 years ago.

Mungo Man's new date re-ignites debate on the time and dispersal of the first humans into Australia.

Contrary to suggestions that Aboriginal ancestors drove the extinction of Australia's giant animals around this time, the new evidence reinforces the importance of climate as a contributing factor, putting both humans and megafauna under serious stress in their search for food and water (see "Lost Giants", *Nature Aust.* Winter 2002).

Occupation beyond 43,000 years in Australia is still contested, and Mungo Man's new date re-ignites debate on the time and dispersal of the first humans into Australia.

—R.F.

Not too Flashy

The male Spotted Bowerbird (*Chlamydera maculata*) is in a bit of a quandary. He builds a decorative bower to attract the interest of females, yet he needs to avoid the attention of his male competitors. If rival males think his bower is too flash, they will put him in his place by demolishing his ostentatious arrangement. So how can you be showy, without showing off? It appears the Spotted Bowerbird struts a fine line between magnificence and modesty.

Joah Madden from the University of Sheffield studied this trade-off in a population of Spotted Bowerbirds from Taunton National Park, central Queensland. He manipulated the number of *Solanum* berries exhibited in the bowers and then filmed the birds' reactions.

When Madden added

JIM BOWLER, PUBLISHED WITH PERMISSION FROM INDIGENOUS TRIBAL GROUPS

Excavation of Mungo Man, western New South Wales.

G.I. BERNARD-OXFORD SCIENTIFIC FILMS/AUSCAPE

The Aquatic Spider is the only spider that spends its entire life under water.

Aquatic Spiders

That big, hairy spider in your nightmares is almost certainly a she. The females of most terrestrial, web-building spiders are larger than males—probably because smaller individuals have better mobility and males are more active (see "Incy Wincy Spider", *Nature Aust.* Autumn 2003).

However, in the Water Spider (*Argyroneta aquatica*), the only spider that spends its entire life under water, males are an average 30 per cent heavier than females. Dolores Schütz and Michael Taborsky (University of Bern, Switzerland) wondered if this sexual size reversal was somehow related to the spider's aquatic lifestyle.

The spiders, which are largely nocturnal, breathe under water from air bubbles trapped in hairs on the body. They retreat to diving bells, made of silk and filled with air bubbles, to digest their prey, moult, copulate and raise offspring. Males rove around in search of prey, in contrast to females, which spend most of their time in their diving bell, catching prey from there. Given the apparent importance of mobility in determining the size of males in terrestrial spiders, the scientists decided to test whether large size helped the males move more quickly under water.

They placed spiders into water-filled cylinders with and without a cord down the middle to assist them dive. They then turned on a lamp above the cylinder and timed the spiders as they fled from the light. Males and females scrambled down the cord at similar speeds, but with the cord gone, males were much better at free-diving than females. This, the authors say, is most probably due to the males' larger size, which is better at overcoming water resistance, but it may also be related to their longer first pair of legs, used in propulsion. Either way, both these traits probably evolved to make the male spiders, which are out and about more than females, more efficient movers.

The authors also wondered whether perhaps it wasn't just that the males were big, but that the females were small. Sure enough, they found that female size was constrained by the cost of building their air bells.

—G.T.

A Striped Cleaner Wrasse doing its thing for a Many-spotted Sweetlips (*Plectorhinchus chaetodonoides*).

berries, neighbouring males were seen sabotaging the bowers. Moreover, once a male discovered he had more berries than he had originally collected, he actively removed the excess berries to avoid destruction from other males. When Madden took berries away from bowers, the male owners quickly replaced them, but only to previous levels. It appears males know when to stop collecting.

Although berries attract females and potentially lead to greater mating success, overindulgence will cost a boastful bird his bower. By modulating their display in accordance with their neighbours, male Spotted Bowerbirds make a little razzle dazzle go a long way.

—K.H.

Take Me To Your Cleaner

On tropical reefs, fish queue up to have their parasites removed by cleaner wrasse. Now it seems these small, cheerful animals have a profound influence on fish diversity.

A single cleaner fish provides its intimate service more than 2,000 times a day, with some 'clients' enjoying up to 144 such encounters. It's well known that where you find lots of fish, you also find cleaners, but researchers had always wondered whether cleaners went to areas because there were lots of fish, or whether fish were attracted to a particular reef because of the cleaners.

Alexandra Grutter (University of Queensland) and colleagues removed Striped Cleaner Wrasse (*Labroides dimidiatus*)—the main cleaning species—from some of the reefs around Lizard Island, and observed the changes in the resident and visiting fish population over the next 18 months. Resident fish stay put, while visitors (often large, commercially important species such as Snapper, Coral Trout and sharks) move about from reef to reef. Because visitor fish can choose their reefs, you could expect that if cleaners determine where fish go, more mobile fish would go to where the cleaners are.

After a year and a half, there were twice as many visitor species and four times as many visitor individuals in reefs with cleaner fish, whereas resident fish numbers remained the same. Visitor fish were clearly moving to where the cleaners were, suggesting cleaners play a crucial role in local fish abundance and diversity.

Why resident fish were unaffected is not clear. Perhaps over a longer period they would eventually suffer, or, being smaller, they may simply be less affected by parasites (see "The Big Die Young", *Nature Aust.* Spring 2003).

Intriguingly, cleaner fish could be introduced to damaged or artificial reefs to create instant ecosystems. Redouan Bshary (University of Cambridge) showed that, when Striped Cleaner Wrasse were added to Egyptian reefs, fish diversity increased in just two to four weeks, whereas it took 4–20 months after cleaners were removed for a change in diversity to be seen.

—A.T.

QUICK QUIZ

1. *What do you call the larvae or caterpillars of Bogong Moths?*
2. *Which country was the fossil bird* Archaeopteryx *discovered in?*
3. *What is an atlatl?*
4. *Name the largest island in the Gulf of Carpentaria.*
5. *What does NASA stand for?*
6. *How many body parts does a spider have?*
7. *What animal is on the old Australian two-cent coin?*
8. *Which is the only macropod to regularly inhabit burrows?*
9. *What is another name for the Pygmy Chimpanzee?*
10. *Give the common numerical term for sodium monofluoroacetate.*

(Answers on page 83)

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

ANZANG

Nature and Landscape Photographer of the Year 2004

ANZANG

ANZANG Nature is organising an annual international nature and landscape photographic competition and subsequent exhibition at state museums and other high profile venues. To enter the competition photographs or digital images 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 SEVENTEEN 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
8. Digital Camera Photography
9. Junior Photography

Entries close 1st May 2004.

For competition rules, entry forms and further information contact

- Website: www.anzangnature.com
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Spitters and swallowers

With little provocation, spitfires will transform from a benign tangle to a lashing tumour of rearing heads and bristling tails.

THE EXCHANGE OF BODILY FLUIDS used to be an art form on Sydney trains when I went to high school. In summer the open doorways blasted BO and testosterone over the rest of the commuters because at the doors, all the toughest, acne-necked youths would be hanging their bodies out, defying each lurch of the train to fling them down onto the gravel. It might have looked heroic, but few did it so willingly between 3.30 and 4.30 pm. That was when all the trains that hurtled past each other were congested with mucus-packed schoolboys. To be gob-smacked at the doorway by a judiciously timed slag from a train screaming past in the opposite direction could just about blind you if it didn't cripple you with embarrassment.

Humans don't hold a monopoly on expectoration; there are plenty of spitters elsewhere in the animal world. Llamas, cobras, archerfish, scorpion flies...but there are probably spitters at your own back door. Spitters, and swallowers!

We certainly have them at our place. 'Spitfires', gum-loving babies of sawflies (*Perga dorsalis* and others)—those rarely seen, four-winged, stingless wasps of the woodlands.

Appalling to the senses and revolting of habit, spitfires need little introduction to Australian children who have collectively tortured, cremated, squashed, guffawed and sickened at more writhing knots of the greasy grubs than you could poke a stick at. Who then could possibly believe that these much-maligned insects could be so fascinating?

Spitfires take their popular name from the unconventional way they respond to such proddings. With little provocation, a fist-sized bunch of these grubs will transform from a benign tangle to a lashing tumour of rearing heads and bristling tails. And, as naturalist Crosbie Morrison once so eloquently put it, "To add point to this menacing attitude they spit out a filthy green slime which smells strongly of all that is worst in the scent of the eucalyptus on which they feed".

The "green slime" is really nothing more than an extract of their gummy diet, a brew of highly concentrated eucalyptus oils that is squeezed out of their mouths when they flex and curl themselves head over heels. On a hot day when the oil in their foregut is thin, they can squirt it out as far as 20 centimetres. In winter, however, they have to make do with just vomiting it up slowly over their heads. If left to themselves, they will slowly suck the oil back to be used on another day.

Needless to say, with manners like that, spitfire larvae have few enemies apart from some currawongs, cuckoo-shrikes and choughs that eat them, and small parasitic wasps, one of which, rather than negotiate a path through the spitters, lays its eggs on leaves likely to be eaten by spitfire larvae. Once inside, the parasitic wasp grubs consume the spitfires from the inside out.

Young sawflies hatch in about four weeks from a package of around 20 eggs. These are laid in a fine hole cut into a leaf's midrib by the jigsaw on the end of the mother's long egg-laying organ. From that hatching moment on until they leave the tree to pupate some six months later, they stay together in a close-knit bundle. All feeding is done at night after the fearsomely effective daytime ring (like the defensive circles adopted by wagon trains under attack) is broken by 'leader larvae' that tap out a signal for the bundle to spread out. Social cohesion is then maintained by touch and a Morse-code of rear-end tapping.

Separate groups in a tree will combine forces on contact and in many instances a tree may be quickly defoliated by their ravening attentions. When this happens the whole writhing assemblage moves down the trunk, at an average speed of one metre an hour, to look for a new tree with leaves. If, during the migration, a single grub strays from the pack, it taps out a lost signal with the tip of its abdomen on the trunk or ground. The horde goes berserk and hammers

Steelblue Sawfly

Perga dorsalis

Classification
Family Pergidae (about 140 Aust. species).

Identification
Adult, stout-bodied wasp, 25 mm long. Steel-blue/black with orange/yellow patches on shoulders and middle of back. Females with jigsaw-like tip to long egg-laying organ. Like all sawflies, lacks both sting and 'wasp waist'. Larvae (spitfires) up to 80 mm, black with white bristles, yellow tail tip, 3 pairs legs. Gregarious.

Distribution and Habitat
Woodlands of Vic., coastal NSW and north to south-east Qld.

Biology
Eggs laid in bundles along leaf midrib in autumn. Larvae hatch after 4 weeks, pupate in ground late spring, and emerge following or subsequent autumn. Larvae eat eucalypt leaves. Adults do not feed.

BY STEVE VAN DYCK

A writhing knot of spitfire larvae (*Perga dorsalis*).

HENSEY CLYNE

out a response that eventually directs the lost soul back to the security of the pack. This uncanny tapping is audible to humans.

In late spring the sawfly larvae descend as a group to form cocoons about 40 centimetres below the soil surface. They waterproof the insides of the cocoons with a slurry of eucalyptus oil and soil, and emerge in autumn (not necessarily the following autumn) as handsome flying wasps. Newly emerged females (three-quarters of the population) are already full of eggs and don't appear to require the services of a male, nor in their seven-to-nine-day life as an adult do they feed.

The Maranoa-Taroom region of Queensland is well known for a species of sawfly (*Lophyrotoma interrupta*) that, in certain years, causes enormous problems for graziers and their stock. At these times spitfire larvae are so numerous that the complete defoliation they cause brings about their own starvation and they fall in large heaps at the base of trees. For some unknown reason Cattle find these piles irresistibly delicious and rush from heap to heap, fighting and horning one another to get at living, dead or pulverised grubs. But the spitfires contain toxic peptides that cause severe mortalities.

Concern about these spitfire toxins is the only thing holding back release of an Australian melaleuca-loving sawfly (*Lophyrotoma zonalis*) into Florida, USA where the introduced Australian Broadleaf Paperbark (*Melaleuca quinquenervia*) has overtaken about 250,000 hectares of wetlands. One US Department of Agriculture poster, directed at children, promoted the sawfly as a biological agent like this: "*Melaleuca, how peculia,/It's way too fast you grow!/But axe and spades won't save the 'Glades';/Try yucky maids all in a row!*"

But let's hope the US takes more care assessing toxic imports than we who flung open our gates to Cane Toads! Applause for clever biological control might be worth a few risks but in the end you might cop more than just egg on your face. Even phlegmy schoolboys will tell you to beware of open doors!

FURTHER READING

Morrison, C., 1943. Along the track. Wild Life *5(5): 192. United Press: Melbourne.*

Weinstein, P., 1991. Undermining spitfire defence strategies. Aust. Nat. Hist. *23(11): 848–857.*

DR STEVE VAN DYCK IS SENIOR CURATOR OF VERTEBRATES AT THE QUEENSLAND MUSEUM.

Green-thighed Frog

I learnt that at least 50–100 millimetres of rain must fall over a day or two before it is 'really good' Green-thighed Frog weather.

YAP, YAP, YAP, YAP... ON IT GOES, all night long. The call of the male Green-thighed Frog. It probably takes a lot out of him to keep this high-powered yapping going for hours on end, but then again, this one night may well be the only chance he'll get to call and breed all year.

My interest in the Green-thighed Frog (*Litoria brevipalmata*) was sparked by a desire to tick it off my twitch list. Although known to occur on the coast and adjacent ranges from south-eastern Queensland to the Gosford area of New South Wales, this frog is very rarely seen because it apparently only calls after heavy rains in summer.

So, one weekend after it had poured non-stop for a week, friends and I headed off to Ourimbah, on the central New South Wales coast, in search of frogs. Incredibly, at our very first stop, we heard a chorus of frog calls from down in a gully, including the yap, yap, yap of a Green-thighed Frog. Talk about luck! But to actually see the frog, I had to wade chest deep through a pool of water full of logs to where it was calling. I managed to catch that holy grail of a frog, but it's never been that easy since.

To actually see the frog, I had to wade chest deep through a pool of water full of logs to where it was calling.

The Green-thighed Frog gets its common name from the lime green wash found in the inner thighs, groin and armpit area. This particular shade of green is unknown in any other frog species. Whether the colour is used in species recognition, for predator defence, or for any other purpose, is unknown.

After several years of surveys in the Ourimbah area, I learnt that at least 50–100 millimetres of rain must fall over a day or two before it is 'really good' Green-thighed Frog weather. Some other species of frogs restrict calling and breeding to rainy days, but for them smaller amounts of rain are sufficient. That's because they are willing to breed in small puddles and pools. Green-thighed Frogs, however, much prefer big water bodies, often the size of a small backyard swimming pool, which will last for weeks and ensure the tadpoles have time to grow into froglets.

Green-thighed Frogs lay 300–600 eggs that form a raft on the surface of the breeding pond. After around 24 hours they sink, and the tadpoles start to wriggle and break out of the eggs. This is very quick for a frog, but their subsequent rates of development are extremely variable. A clutch I kept had some individuals turning into froglets after only 40 days, while others were still tadpoles without front legs after 120 days. A variable rate of development is probably a bet-hedging strategy to cope with unpredictable climate.

We know little about what the newly emerged froglets and adults do when not breeding. I tracked a few frogs with radio-transmitters in the Ourimbah area and found that they all stayed in the thicker forested area around the breeding ponds. They spent the days hiding under leaf litter or in low vegetation, avoiding predatory snakes, birds and bigger frogs, and the nights jumping around the leaf litter looking for invertebrates to eat. They seemed to spend most of their time on the ground, but I have seen them a metre or two up a tree

BY FRANK LEMCKERT

fern. In Queensland they appear to use more open-forest habitats and some further tracking work to see how they use this environment would be interesting.

The Green-thighed Frog is listed as Vulnerable in New South Wales and Queensland, and has recently been recommended for a national listing as Threatened. The major threat to this frog has been, and still is, land clearing for agriculture and residential developments. It is most commonly found in the coastal lowlands, which are prime grazing lands and now also much sought-after for housing. Although the cleared patches I have recorded around several breeding sites suggest the Green-thighed Frog can cope with some degree of disturbance, for successful conservation, the breeding sites should be best left undisturbed and connected to other breeding sites by forest patches. Such a recipe is the key to conserving many species. □

FURTHER READING

Lemckert, F.L. & Slatyer, C., 2002. Short-term movements and habitat use of the green-thighed frog, Litoria brevipalmata *(Anura: Hylidae).* Aust. Zool. *32(1): 56–61.*

FRANK LEMCKERT IS A RESEARCH SCIENTIST FOR STATE FORESTS OF NSW WHERE HE STUDIES FROGS AND THE IMPACTS OF FORESTRY ACTIVITIES AND OTHER DISTURBANCES.

Where leaf-tails lurk

The first leaf-tail evolved more than 60 million years ago, when rainforest dominated Australia.

PHOTO: TIM LOW

Australia's largest gecko, the Northern Leaf-tail, can be distinguished from all other leaf-tails by the curved spines on its body.

BY TIM LOW

BACK IN THE 1970S, DURING MY high-school years, I became a Queensland Museum volunteer. I well recall the day when the Curator of Reptiles, Jeanette Covacevich, pointed to a jar of pickled leaf-tail geckoes and said she would soon revise the group. In those days only two leaf-tail species were known, one from the ridges around Sydney and another from rainforests farther north. But Jeanette could see from the specimens that others awaited discovery. Her review, published in 1975, brought the number of species to four. But that is only the beginning of this story.

Surveys of rainforest remnants in mid-eastern Queensland brought to light other leaf-tails lurking in small pockets of habitat. In 1993 Covacevich worked with Patrick Couper (Queensland Museum) and Craig Moritz (now University of California, Berkeley) to name another four species. Five more have been recognised over the years, bringing the total to 13, the most recent species only acquiring its name in 2003. As well, the original leaf-tail genus (*Phyllurus*) has been split in three, to reflect different evolutionary lineages. Seldom in vertebrate taxonomy have so few become so many so quickly.

Leaf-tails are remarkable animals—on many levels. For a start they are spectacular, most of them sporting prickly spade-shaped tails that afford superb camouflage against lichen-dotted logs and rocks. They are also bigger than most geckoes, the Northern Leaf-tail (*Saltuarius cornutus*) reaching a whopping 25 centimetres, making it Australia's largest. Thirdly, although they are the main group of geckoes in our rainforests, six species are highly restricted—the Mount Elliot Leaf-tail (*P. annulicola*), for instance, occurring only on one peak near Townsville. Fourthly, and perhaps most importantly, they are a very ancient group whose pattern of distribution and speciation offer unique clues about the history of our rainforest and the changing climates that shaped it.

DNA work shows that the first leaf-tail evolved more than 60 million years ago, when rainforest dominated Australia. It was apparently widespread, but as the rainforest shrank and swelled with climate swings, colonies of leaf-tails isolated on moist ranges diverged again and again into new forms. Around Sydney the Southern Leaf-tail (*Phyllurus platurus*) survived a drying climate by retreating into sandstone crevices. This lizard, which sometimes enters homes, is an animal equivalent to the Wollemi Pine (*Wollemia nobilis*), reminding us that rainforests once clothed the Sydney basin.

Most other leaf-tails keep to rainforest, and several are restricted therein to boulders, rock faces, scree, and the rocky margins of montane streams. Leaf-tails are classic relict species, their scattered distribution implying a past when rainforest was continuous between Sydney and northern Queensland.

Surprisingly, some large tracts of rainforest, including those in the D'Aguilar Range near Brisbane, have no leaf-tails at all. Leaf-tails must have lived here in the past because they still occur farther north and south. Their absence tells us that rainforest here during the driest of times must have shrunk to almost nothing. The mountains here lack rocky outcrops that might have served as drought refuges. Ironically, the D'Aguilar Range seems ideal for leaf-tails today, carrying far more rainforest than many sites farther north that support them.

The Mackay area is exceptional in boasting four different leaf-tails living close together. The Eungella Leaf-tail (*Phyllurus nepthys*) is found on the Clark Range, the rare Blackwood Leaf-tail (*P. isis*) occupies a mountain and a gully farther east, a third species (*P. ossa*) lives on peaks to the north, and a fourth (*P. championae*) on mountains to the south. Although found within 100 kilometres

of each other, DNA testing implies that these species diverged a staggering 31–38 million years ago. Before then there must have been continuous rainforest around Mackay, carrying one kind of leaf-tail. Speciation would have proceeded after a drying climate eliminated the lowland rainforest, leaving four small populations isolated on mountains. Through all the climate changes since then, the four populations have remained apart.

The evidence furnished by leaf-tails implies that aridity first struck Australia more than 30 million years ago. And some dry phases, presumably the Pleistocene ice ages, were very dry indeed. Studies of rainforest skinks and snails strongly reinforce these conclusions. But in painting this picture one has to ask if any more leaf-tails await discovery. Conrad Hoskin (University of Queensland), who discovered the two newest species, has scoured most significant rainforest remnants in Queensland, and he would be surprised by any more discoveries in that State. But he has his eyes on the Hoop Pine rainforests of southern New Guinea. Patrick Couper, meanwhile, is planning a closer look at the leaf-tails in northern New South Wales. The work begun by Jeanette Covacevich back in the 1970s may not be over yet.

FURTHER READING

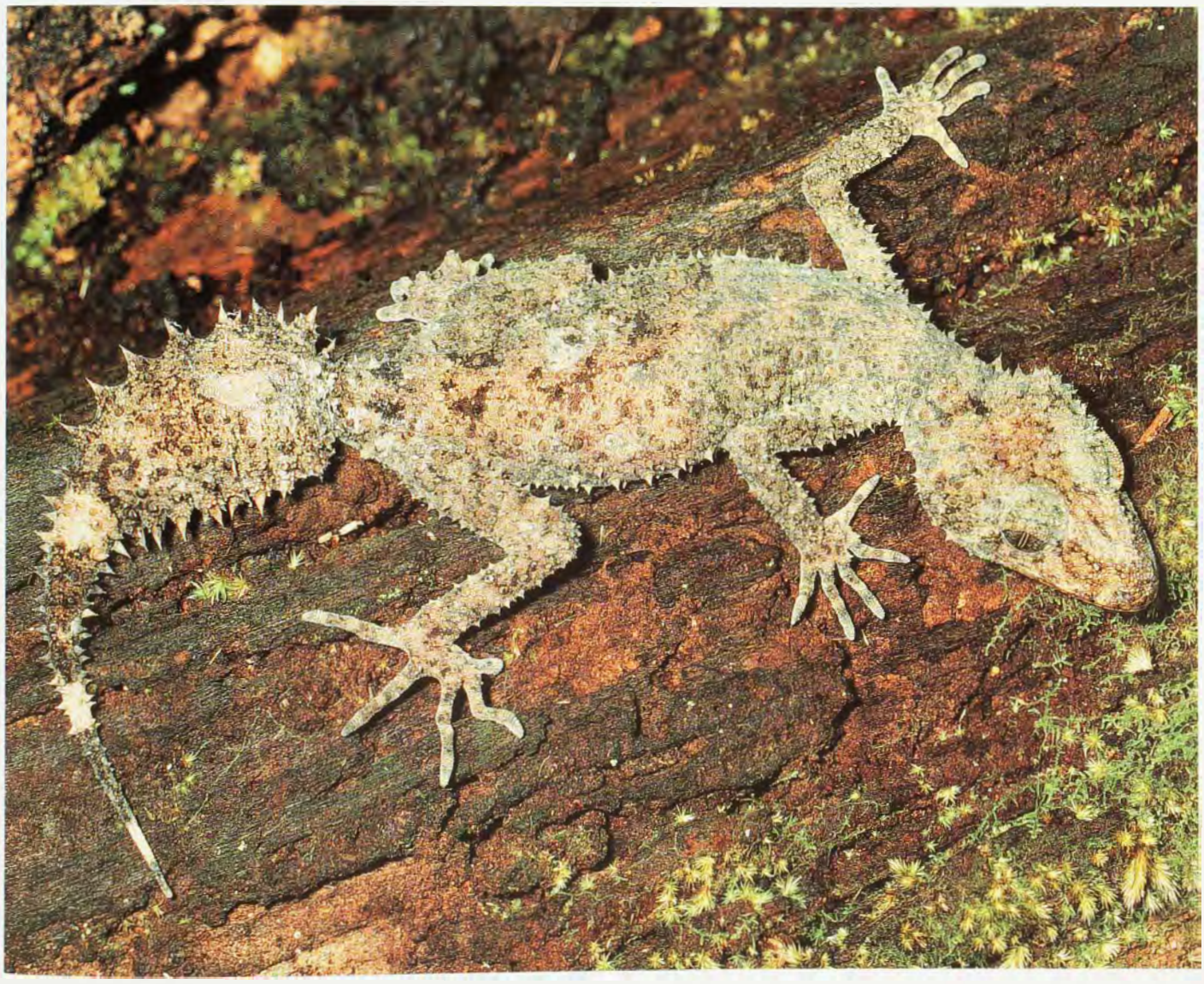
Couper, P.J., Covacevich, J.A. & Moritz, C., 1993. A review of the leaf-tailed geckos endemic to eastern Australia: a new genus, four new species, and other new data. Mem. Qld Mus. *34(1): 95–124.*

Couper, P.J., Schneider, C.J., Hoskin, C.J. & Covacevich, J.A., 2000. Australian leaf-tailed geckoes: phylogeny, a new genus, two new species and other new data. Mem. Qld Mus. *45(2): 253–265.*

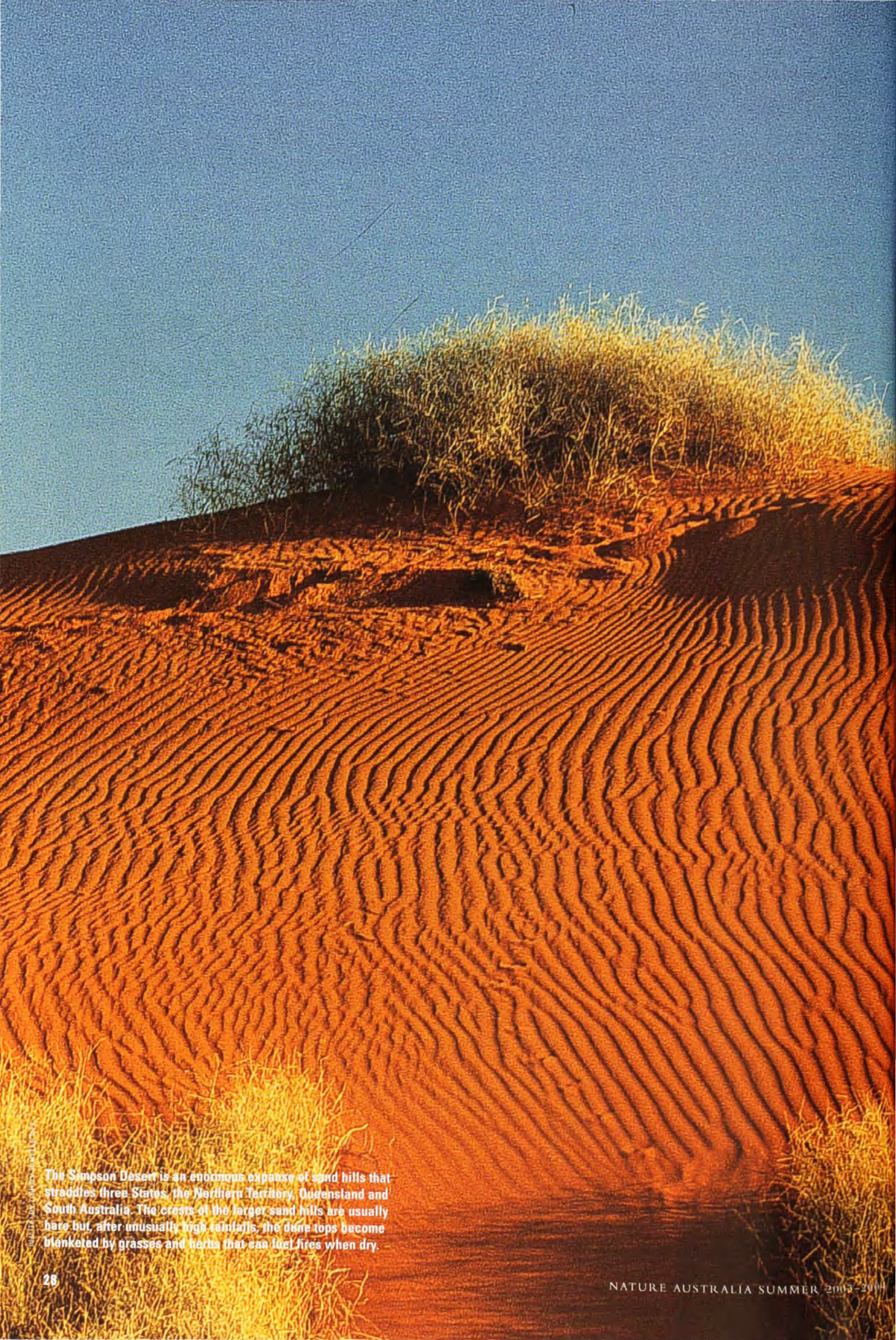
Covacevich, J., 1975. A review of the genus Phyllurus *(Lacertidae: Gekkonidae).* Mem. Qld Mus. *42(1): 91–96.*

Hoskin, C.J., Couper, P.J. & Schneider, C.J., 2003. A new species of Phyllurus *(Lacertidae: Gekkonidae) and a revised phylogeny and key for the Australian leaf-tailed geckoes.* Aust. J. Zool. *51(2): 153–164.*

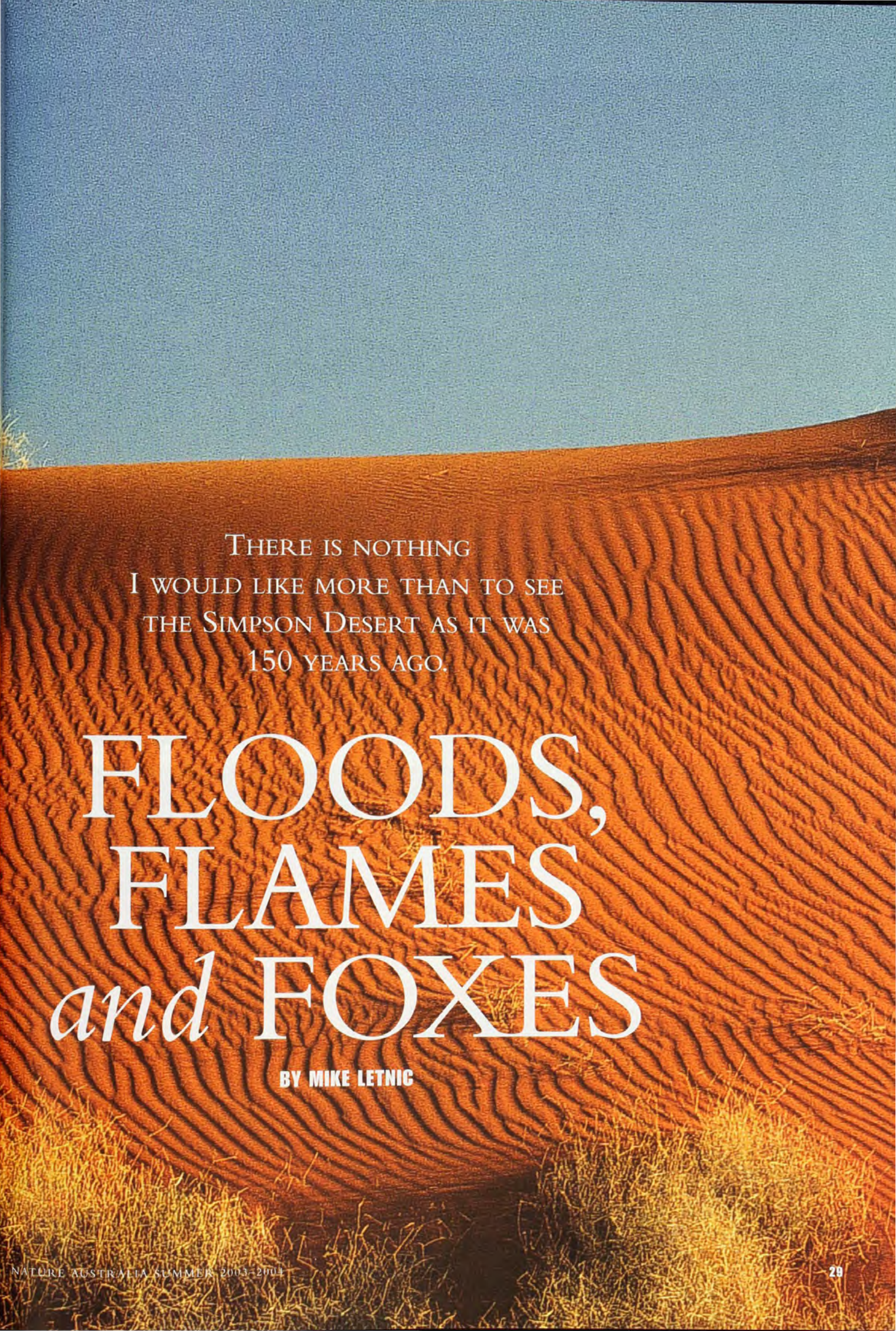
TIM LOW IS A BRISBANE-BASED ENVIRONMENTAL CONSULTANT AND AUTHOR. HIS MOST RECENT BOOK, *THE NEW NATURE*, WON THE WESTFIELD/WAVERLEY LIBRARY AWARD FOR EXCELLENCE IN RESEARCH.



Although it is common in montane rainforest west of Mackay, the Eungella Leaf-tail remained unnamed until 1993.



The Simpson Desert is an enormous expanse of sand hills that straddles three States, the Northern Territory, Queensland and South Australia. The crests of the larger sand hills are usually bare but, after unusually high rainfalls, the dune tops become blanketed by grasses and herbs that can fuel fires when dry.



There is nothing I would like more than to see the Simpson Desert as it was 150 years ago.

FLOODS, FLAMES *and* FOXES

BY MIKE LETNIC

BREATHLESS AND PARCHED in the searing midday heat, I trudged through loose red sand towards the only tree for miles—an enormous gnarled Coolibah—nourished by the permanent waters of a spring. Kneeling to take a drink, I swore loudly as something sharp pierced my knee. With the tweezers from my pocketknife, I removed the offending object, a tooth tinged pink with my blood.

It was November 1999 and I was poking around a rare oasis in the Simpson Desert, in Australia's red centre, as part of my Ph.D. project into the decline of native mammals. The tooth that lodged in my leg once belonged to a Rabbit-sized marsupial, the Burrowing Bettong or Boodie (*Bettongia lesueur*), a species now confined to desert islands off Australia's west coast. The Boodie is one of 26 medium-sized mammal species that have become extinct or endangered in arid Australia since European settlement in 1788.

THE BOODIE

is one of 26 medium-sized mammal species that have become extinct or endangered in arid Australia since European settlement.

Looking closely at the ground in front of me I could see that the sands surrounding the spring were flecked uniformly with white. These flecks were tiny pieces of bone and teeth. Some of the teeth were charred, suggesting they had been burnt or cooked, and were most likely the remains of prehistoric Aboriginal meals. Along with a collection of stone artefacts, rusty cans, broken bottles, a camel carcass and cow dung, these fragments represented just one of the layers of history that have accumulated around the spring.

Identification of the mammal remains reveal that at least 13 species have disappeared from this area of the Simpson Desert (see table). Scientists have suggested various factors to account for the decline of mammals in arid Australia, including disease, Rabbits, Cats, Foxes, overgrazing by stock, changed fire

H HIMANN

The Marsupial Mole was once recorded in south-western Queensland in the Simpson Desert. Today it is only found in the sand hills of the Great Victoria and Great Sandy Deserts.

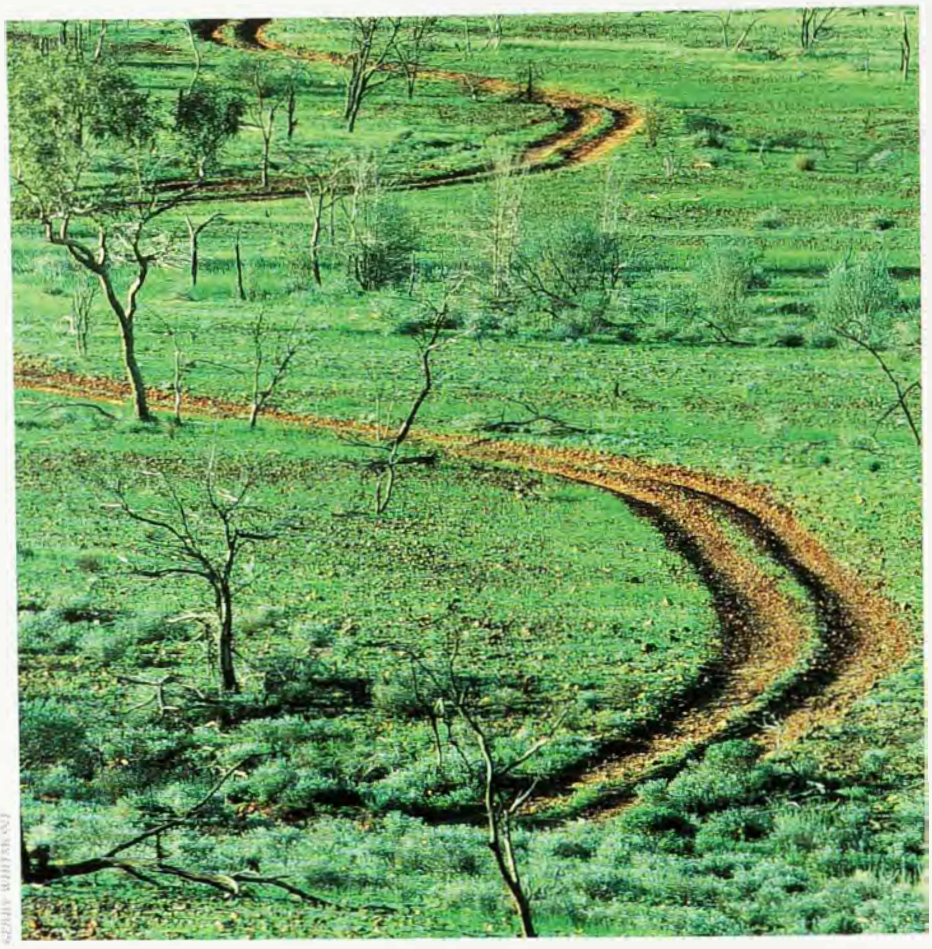
The Burrowing Bettong is a Rabbit-sized herbivore that once created complex networks of burrows in the Simpson Desert. Nowadays it only occurs on desert islands off the coast of Western Australia and in mainland areas where they have been reintroduced following the eradication of Foxes.

regimes and drought. The aims of my study are to construct a timeline of ecological events, species declines and introductions, wildfires, floods and droughts. With this information and field studies spanning periods of drought and flood, I hope to identify the threats, and particularly their timing, to Australia's arid mammal fauna, so that we can work out how to prevent further extinctions.

UNFORTUNATELY TIME MACHINES don't exist. There is nothing I would like more than to see the Simpson Desert as it was 150 years ago. The land was then managed by Aboriginal people who burnt the country to renew the growth of useful plants and to hunt native animals. About 100–120 years ago this tradition of managing the land came to an abrupt end with settlement by European pastoralists. They stopped the small-scale burning and brought with them Cattle and, inadvertently, Rabbits, Cats and Foxes. The desert has never been the same.

Written accounts of early naturalists provide us with some indications of when the mammal declines occurred. They tell us that some species like the Marsupial Mole (*Notoryctes typhlops*), an insectivore that once burrowed through sand hills of the Simpson Desert, and the Lesser Stick-nest Rat (*Lcporillus apicalis*), a large herbivore that lived in castles of twigs glued together by faeces and urine, appear to have declined before 1930, less than 50 years after pastoral settlement began in the 1880s. Others like the Bilby (*Macrotis lagotis*), which can still be found in isolated pockets of western Queensland, carried on a little longer until the 1940s and 1950s. However, many other species such as Red Kangaroos, bats, Short-beaked Echidnas, small native rodents and tiny insectivorous marsupials like dunnarts and planigales still occur in the desert.

In other parts of inland Australia much of the blame for mammal declines has been attributed to overgrazing by Rabbits and Sheep. In the semi-arid lands of western New South Wales and central Queensland, overgrazing by Sheep, Rabbits and kangaroos during droughts has repeatedly seen the landscape stripped back to its bare bones, causing massive soil erosion when vast clouds of dust are blown off the land. Here, overgrazing has irreparably affected the productivity of the land, particu-



Following a good fall of rain this normally desolate gibber plain is carpeted with verdant grass. Once it has browned off, the grass has the potential to fuel extensive fires. Past bushfires are likely to have killed the trees visible in the foreground.

Subfossil remains indicate the Shark Bay Mouse was once widely distributed across Australia, but today its stronghold is Bernier Island in Shark Bay.

larly during the droughts of the late 19th and early 20th centuries. Some scientists suggest that the loss of vegetation and soil was so great that most native mammal species had vanished by the end of the 19th century. The European Fox was introduced into Australia around this same time and is likely to have dealt out the *coup de grâce* to any surviving pockets of endangered mammals.

In the sparsely settled Cattle and non-pastoral lands of central and northern Australia, by contrast, threats from overgrazing, Rabbits and Foxes have been more sporadic. There on the frontiers of settlement, grazing is limited by the availability of scarce waters and has not been nearly so intense. Much of my Simpson Desert study area has never been utilised for commercial grazing, and many of the areas that have been grazed have only been so since the 1970s, ruling Cattle out as the cause of native mammal declines.

Looking over the historical record it

Disappearing Acts

Mammals that have disappeared from the Simpson Desert since European settlement. All of the species listed have undergone large declines in their range. The status of species reflects their listing under the *Federal Environment Protection and Biodiversity Conservation Act 1999*.

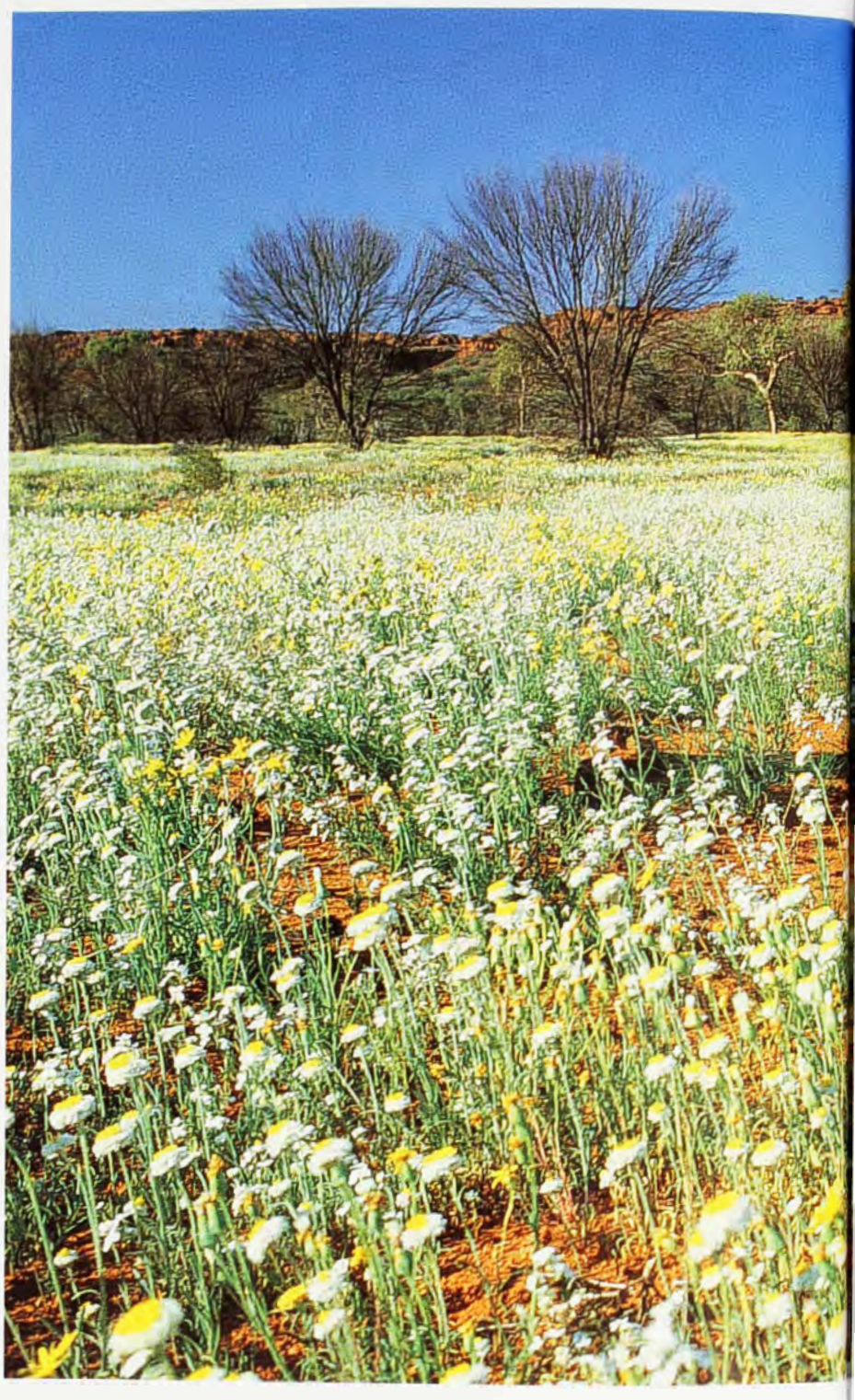
Species	Scientific name	Status nationally
Shark Bay Mouse	*Pseudomys fieldi*	Vulnerable
Short-tailed Hopping Mouse	*Notomys amplus*	Extinct
Lesser Stick-nest Rat	*Leporillus apicalis*	Extinct
Ghost Bat	*Macroderma gigas*	
Marsupial Mole	*Notoryctes typhlops*	Endangered
Golden Bandicoot	*Isoodon auratus*	Vulnerable
Lesser Bilby	*Macrotis leucura*	Extinct
Bilby	*Macrotis lagotis*	Vulnerable
Burrowing Bettong	*Bettongia lesueur*	Vulnerable
Desert Rat-kangaroo	*Caloprymnus campestris*	Extinct
Spectacled Hare-wallaby	*Lagorchestes conspicillatus*	Vulnerable
Common Brushtail Possum	*Trichosurus vulpecula*	
Western Quoll	*Dasyurus geoffroii*	Vulnerable

seems that Rabbits are also unlikely to have caused mammal extinctions in my study area. Historical accounts indicate that Rabbits, while common in the southern parts of the Simpson Desert, have always been quite rare in the northern Simpson, as they are today.

According to bounty records, Foxes arrived in the northern Simpson Desert around 1915. However, kept in check by Dingoes and the absence of food in what is normally drought-stricken country, they are mostly quite rare and appear to pose little threat, at least during drought. Foxes only become common after heavy rains when their chief foods, rodents and locusts, are plentiful.

I WAS ABLE

to observe, first-hand, the almost instantaneous greening of the desert and subsequent population booms.



BY FAR THE MOST IMPORTANT influence on the ecology of Australia's deserts is climate. A 100-year record of rainfall for the Simpson Desert reveals sequences of normally low-rainfall years interrupted with years of extremely high and extremely low rainfall. This is the pattern of the El Niño/Southern Oscillation (ENSO). ENSO is the product of shifting currents in the Pacific Ocean and its two phases—El Niño and La Niña—dominate the climate of eastern and northern Australia.

El Niño brings droughts that devastate agriculture, occurring when the waters off northern Australia are relatively cool. During El Niño years, the pace of life in the Simpson Desert slows almost to a halt. Most bird species emigrate and plant life withers. My field study began in October 1999 at the height of drought when the dunes were blanketed only by a sombre yellow coat of needle-sharp spinifex and the Cattle, their skin draped loosely over protruding ribs, were starving. During drought, you occasionally see small mammals and kangaroos but never in any significant numbers, and predators (Dingoes, Foxes and Cats) all but vanish.

La Niña is when the desert blooms. These are the years of high rainfall when the ocean off northern Australia is abnormally warm. In April 2000, and again in December 2000, I felt La Niña's wrath as cyclones drifted unpredictably across the continent, dumping rain in the desert. On both occasions myself and other researchers were forced to evacuate our study area.

Stranded by rising floodwaters in April 2000, we were airlifted by helicopter to Boulia, the nearest town. The following December, once bitten and twice shy, our team made a last-minute dash ahead of an oncoming rain depres-

GREG WHITMONT

The Simpson Desert has a boom-and-bust ecology. Ephemeral and annual herbs are opportunists that are best seen following rains, particularly unseasonal winter falls.

sion across waterlogged flood plains. In each case I was able to observe, first-hand, the almost instantaneous greening of the desert and subsequent population booms. Boom periods begin with the germination of short-lived ephemeral plants and in exceptional years end with plagues of native rodents and predators. After the April rains it took just a few days for waterbirds such as whistling ducks and waders to congregate in newly created wetlands, as did thousands of frogs that had sat out the dry under ground.

Experiencing a rodent plague in the desert is an unforgettable experience. By night the ground is alive with scurrying mice. Stockmen tell stories of their camps being invaded by voracious Long-haired Rats (*Rattus villosissimus*). These occasional visitors to the desert after floods will eat almost anything, even shoes. During plagues large numbers of owls, hawks, kites, Dingoes, Cats and Foxes converge on the desert to prey on booming populations of rats

ESTHER BEATON

At the time of European settlement the Bilby was found throughout much of arid and semi-arid Australia. Its range has since contracted and it now only occurs in the western deserts and in isolated areas of the channel country in Queensland.

and mice. Populations of the Mulgara (*Dasycercus cristicauda*), a marsupial and ravenous predator of rodents, also increase rapidly at these times.

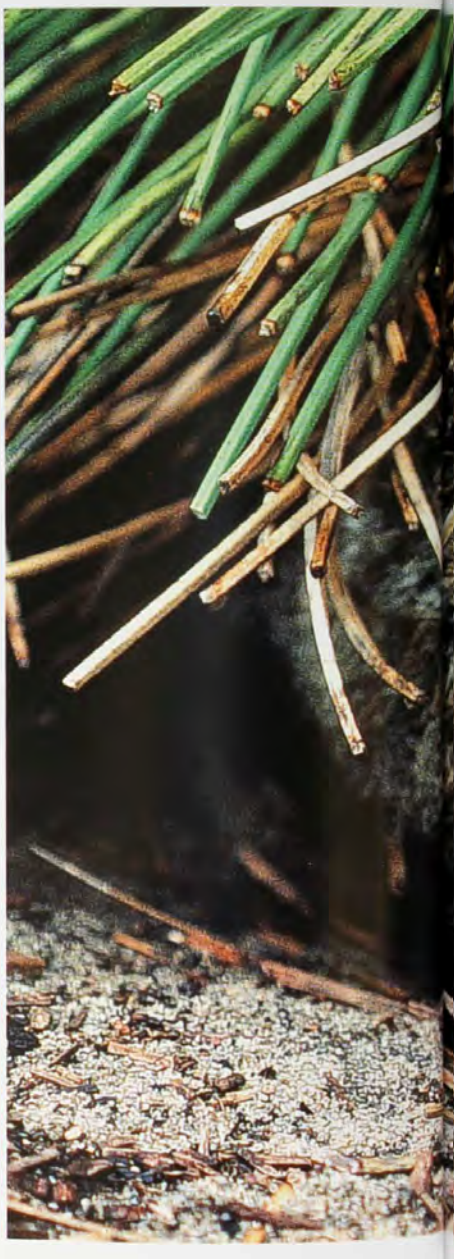
Eventually the boom becomes bust. Rodent reproduction begins to slow down as a result of diminishing resources and/or social stress, to the point that predators 'catch up', eating the rodents faster than they can reproduce. Such intense carnivory known as hyper-predation can force populations of mice, rats, dunnarts and Mulgaras to decline catastrophically. This pattern of boom and bust has gone on for a long time, no doubt, but the occasional presence of introduced predators, particularly Foxes, appears to have tipped the balance against many native species.

Bushfires also occur in the years after flooding rains, coinciding with elevated levels of predation. Millions of hectares of highly flammable spinifex, swollen in size after good growing seasons, can be consumed by a single fire. In 1917, 1951, 1975 and 2001 bushfires burnt thousands of square kilometres of the Simpson Desert.

On New Year's Day 2002 I saw columns of black smoke tower over the desert as bushfires raged across the dunes. Most small mammals that burrow under ground escaped the heat of the bushfires, but six months later few were able to survive their bleak aftermath.

In the wake of bushfires little food remains for mammals, as most of the vegetation and surface seed is destroyed. Perhaps most critical for native mammals occupying burnt landscapes is the absence of shelter from predators. In unburnt habitats, dunnarts and rodents seek shelter from approaching predators in the safety of dense spinifex hummocks but in the vast expanses of red sand laid bare by bushfires, mammal populations are decimated.

Combining my own field research with historical evidence, it is clear that the threats affecting the native fauna of the Simpson Desert and that of Australia's semi-arid lands are very different. In the Simpson, droughts appear relatively benign, because the native mammals there have evolved adaptations to cope with aridity. Also during drought, introduced predators and herbivores are few. Threats to native mammals appear greatest in the wake of La Niña's floods. It is during these times of plenty that Cats and Foxes thrive and bushfires have the potential to destroy vast swathes of spinifex habitat. The medium-sized mammals of the Simpson Desert are likely to have become extinct not during a drought but on the tail end of a



flood because of hyper-predation and destruction of habitat by bushfires.

To improve the effectiveness of wildlife conservation and reintroduction programs in arid Australia we will need to increase our focus on managing wildlife during post-flood periods. With our ever-improving knowledge of ENSO and long-term climate forecasting, early warning of floods, rat plagues and bushfires is possible. This knowledge could be used to begin predator control before Fox numbers have the opportunity to build up. The extent of inevitable flood-related bushfires can also be reduced by patch burning during low fire-risk seasons. It might seem strange to worry about the future of Australia's desert mammals when the times are good, but some time or other the bubble has to burst and boom will come to bust. My work in the desert will hopefully prevent it from busting completely.

The Spectacled Hare-wallaby, a Rabbit-sized herbivore, has fared well compared to many other medium-sized native mammals from arid Australia. While no longer in the Simpson Desert, they still occur in tropical arid grasslands and woodlands in Queensland, the Northern Territory and Western Australia.

FURTHER READING

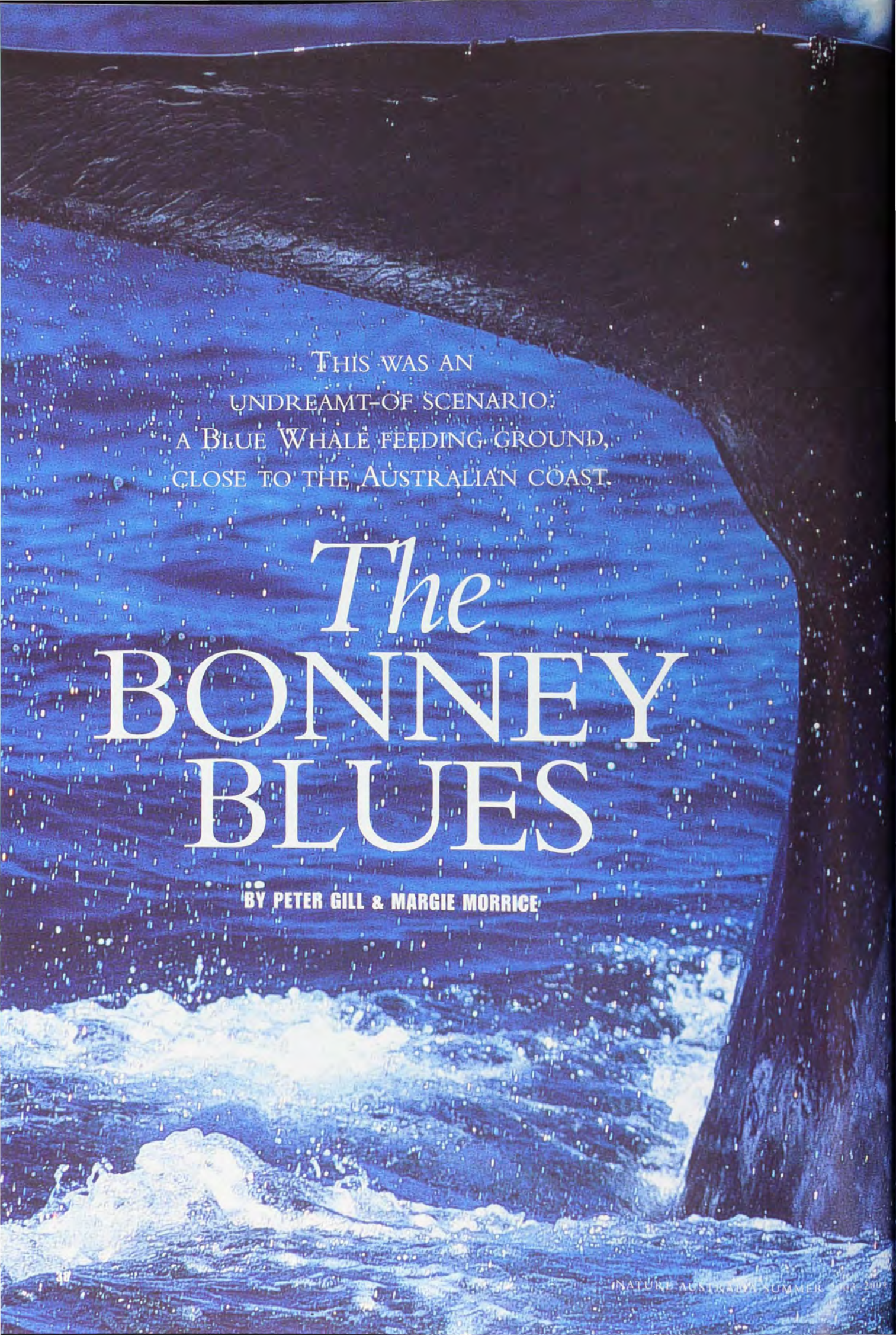
Finlayson, H.H., 1961. On central Australian mammals. Part IV. The distribution and status of central Australian species. Rec. S. Aust. Mus. *14: 141–191.*

Letnic, M., 2002. Long distance movements and the use of fire mosaics by small mammals in the Simpson Desert, central Australia. Aust. Mamm. *23: 125–134.*

Lunney, D., 2001. Causes of the extinction of native mammals of the western division of New South Wales: an ecological interpretation of the nineteenth century historical record. Rangeland J. *23: 44–70.*

Morton, S.R., 1990. The impact of European settlement on the vertebrate animals of arid Australia: a conceptual model. Proc. Ecol. Soc. Aust. *16: 201–213.*

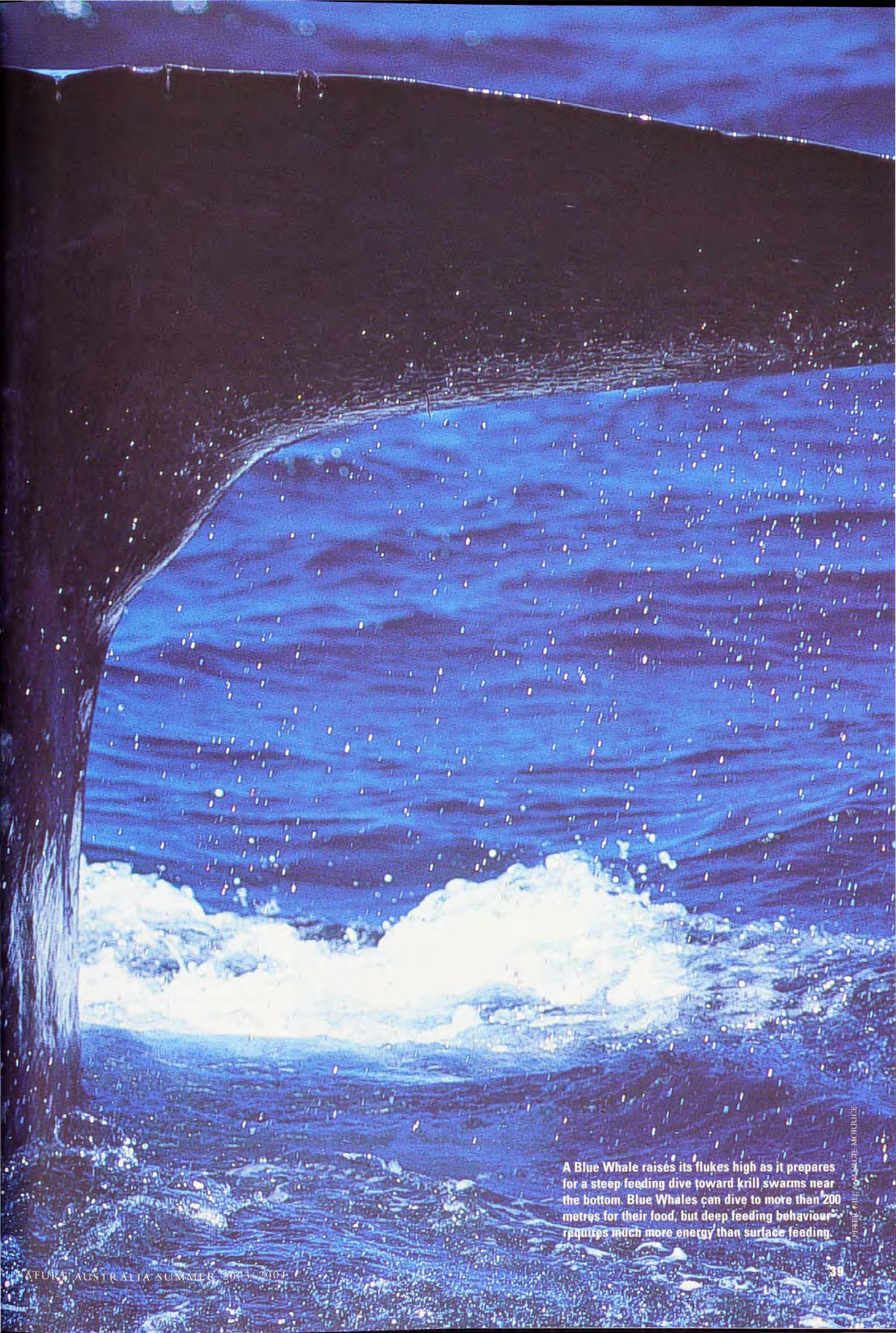
MIKE LETNIC IS AN ECOLOGIST WITH THE PARKS AND WILDLIFE COMMISSION OF THE NORTHERN TERRITORY. HE IS UNDERTAKING HIS PH.D., ON THE DECLINE OF NATIVE MAMMALS FROM THE SIMPSON DESERT, THROUGH THE UNIVERSITY OF SYDNEY.



This was an undreamt-of scenario: a Blue Whale feeding ground, close to the Australian coast.

The BONNEY BLUES

BY PETER GILL & MARGIE MORRICE



A Blue Whale raises its flukes high as it prepares for a steep feeding dive toward krill swarms near the bottom. Blue Whales can dive to more than 200 metres for their food, but deep feeding behaviour requires much more energy than surface feeding.

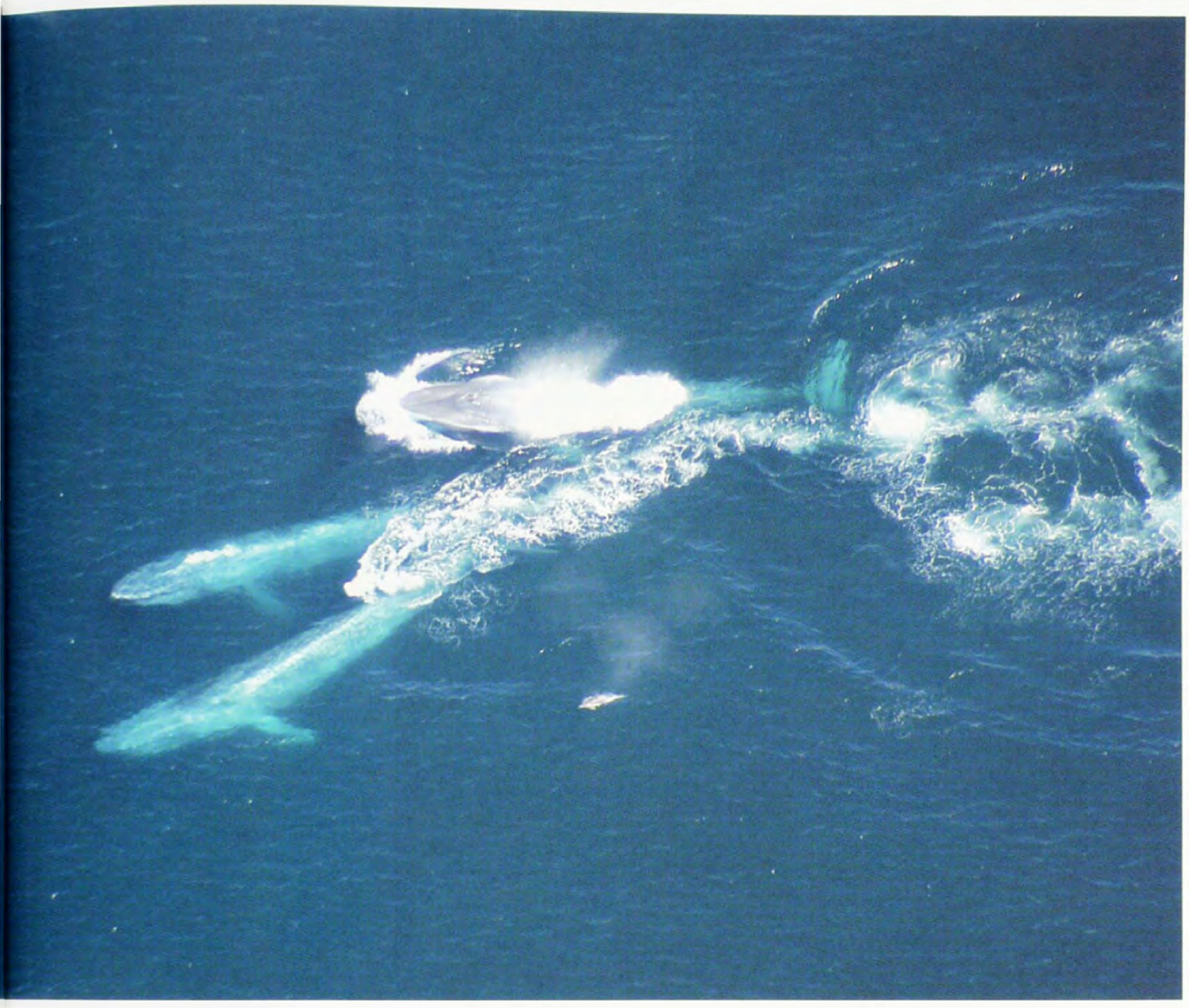
PHOTO: GUY SCHMICKLE MORRICE

"IN CONTEMPLATING THIS, THE greatest whale of the ocean, one can but admire its...enormous yet symmetrical proportions, and the muscular development which enables it to excel in velocity all its congeners". The subject was the Blue Whale (*Balaenoptera musculus*), the largest animal ever to have lived, and the writer was the 19th-century American whaler Charles Scammon. Although he made his name and fortune killing Gray, Sperm and Northern Right Whales, he was also a pioneer naturalist. Blue Whales could only be admired by such men: they were too large, fast and powerful to be caught using rowed open boats and hand harpoons.

Towards the end of the 19th century, harpoon cannon and steam-fired catcher vessels finally caught up with speedy giants such as Blue and Fin Whales (*Balaenoptera physalus*), and during the 20th century, they became the mainstay of commercial whaling. Using factory ships, this rapacious industry was able to penetrate remote Antarctic feeding grounds. More than 360,000 Blues were killed in the Southern Ocean alone, and turned into such mundane products as edible oils and soaps, now all provided by vegetable oils. Half-hearted management proved futile, and even after protection finally came in 1965, Blue Whales were still killed illegally. Most of them were Pygmy Blues, a southern hemisphere subspecies. Of more than 200,000 'true' Blue Whales that once roamed Antarctic waters, only 1,000 or so survive, while Pygmy Blues, which are smaller and have a more temperate distribution, are thought to be

Skipper Tim Edkins hauls in a krill-sampling net during yacht-based research early in the study. The Blue Whales feed on the coastal krill species *Nyctiphanes australis*.

PETER GILL



PETER GILL & MARGIE MORRICE

Three adult Blue Whales engage in rarely seen 'racing' behaviour, surging along at high speed while vigorously interacting with each other. This may be a prelude to mating, which is thought to take place in tropical waters.

more numerous. Low numbers of Blue Whales also occur in the Indian, Atlantic, and North and South Pacific Oceans. The largest known population—about 2,000—is now off California and Mexico.

In Australia, Blue Whales have always been regarded as a rarity. Open-boat whalers out of Eden, New South Wales, saw but rarely killed them. Some Pygmy Blues were killed by Humpback whalers between 1954 and 1963, but until recently, there was no indication that any Blue Whales were regular visitors to Australian waters. Among whale enthusiasts, their scarcity and size have given them almost mythical status.

In 1997, while browsing through scientific reports from the 1996 meeting of the International Whaling Commission (IWC), one of us (Peter) found a report of an IWC cruise in late 1995 that had searched for Blue Whales along the southern coast of Australia. Some were found off Rottnest Island, Western Australia. Surprisingly, there were also many sightings near the Victorian–South Australian border, with feeding seen on several occasions. These were mostly identified as Pygmy Blue Whales, with a possible 'true' Blue also sighted. Distinguishing between the two subspecies at sea is very difficult, and acoustic and genetic differences are not properly resolved yet. So for the present, it is probably safest to simply refer to them as 'Blues'. Asked whether there were any unusual oceanographic features there that might explain their presence, CSIRO oceanographer George Cresswell replied: "Yes, the Bonney Upwelling".

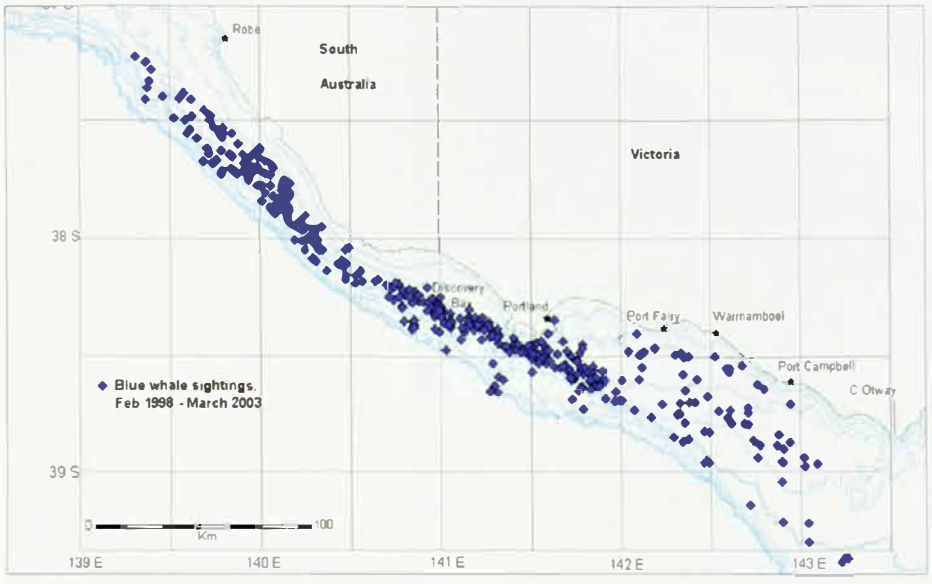
Every November, high-pressure weather systems that lie over the Australian continent during winter, drift south into the Great Australian Bight, bringing strong south-easterly winds to waters off western Victoria and south-

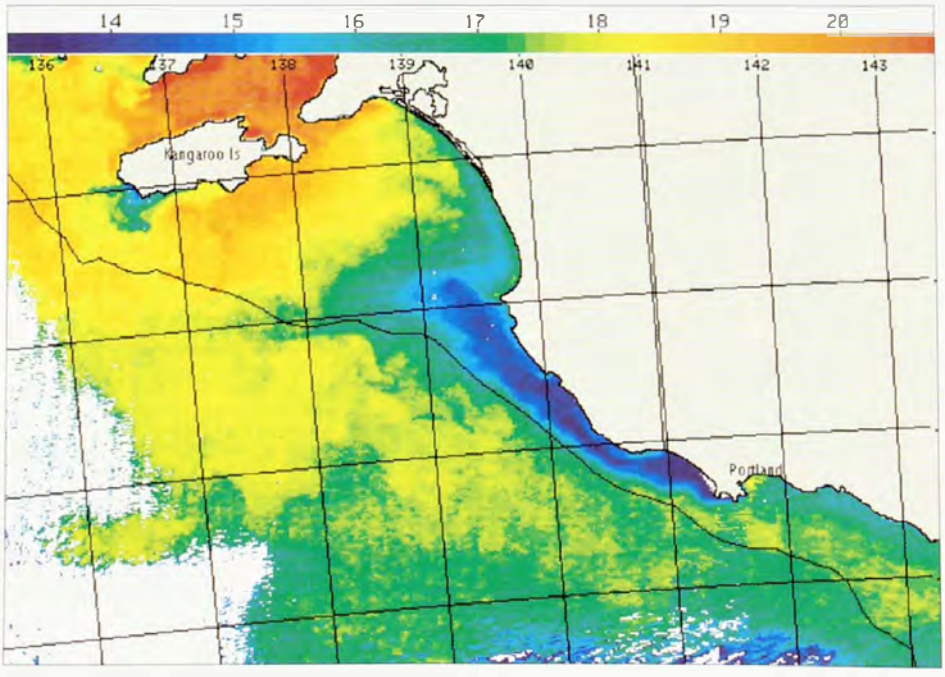
AMONG WHALE

enthusiasts, their scarcity and size have given them almost mythical status.

eastern South Australia, and driving a north-westerly-flowing current alongshore. This pattern lasts until late March to early May. The Coriolis Effect (the rotational effect of the Earth's spin) causes the warm, nutrient-poor surface water of this current to drift to the left (south), away from shore. It is replaced by cold, low-salinity bottom water, rich with organic and mineral sediment. When this rich mix reaches sunlit surface layers, tiny phytoplankton photosynthesise and reproduce, causing an explosion of life, a 'plankton bloom'. This soup is the basis of the food web in the Bonney Upwelling ecosystem. Coastal upwellings are rare in Australian waters, and the Bonney Upwelling, which is part of a greater upwelling system from north-western Tasmania to the Eyre Peninsula, is possibly the most productive.

In February 1998, we decided to search for the whales ourselves. We sailed from Adelaide to Discovery Bay near the Victorian–South Australian border, and sure enough, there they were—Blue Whales feeding at the surface over a period of several days. This was an undreamt-of scenario: a Blue Whale feeding ground, close to the Australian coast. It was time to start a proper ecological study in this area, to establish the extent of the whales' feeding area and its relationship to the upwelling, how the whales use this habitat to obtain their food, and the possible threats to Blue Whale recovery in this region.





ILLUSTRATIONS: PETER GILL & MARGIE MORRICE

(Top) Blue Whale sightings in the study area since early 1998, all of which lie on the continental shelf (water less than 200 metres deep), where upwelling brings nutrients to the surface. (Bottom) Infra-red sea surface temperature (SST) image showing the Bonney Upwelling surface plume, which originates at Cape Nelson, near Portland. Temperature scale (degrees celsius) is at the top. Upwelling also occurs to the east of Portland, explaining the presence of whales there, but rarely reaches the surface. Some upwelling is also seen off Kangaroo Island. The white and blue patches to the south are cloud.

THE FIRST QUESTION WE NEEDED TO answer was, what were the whales eating? The coastal krill *Nyctiphanes australis* is the key species in this ecosystem. Krill (crustaceans similar to prawns) often occur in areas where nutrients are concentrated, such as coastal up-wellings. While classified as 'zooplankton', they are highly mobile, rather than passively drifting, and form great socially cohesive swarms of many millions. This swarming habit makes them an attractive protein source for a variety of predators. *Nyctiphanes australis* has an added attraction—it often swarms right at the surface, making it easier to catch.

Blue Whales, like other rorquals (family Balaenopteridae), are filter-feeders. They have fringed flexible plates (baleen) hanging from their upper jaw, forming a fibrous filter. They also have expandable pleats along the underside of their head and throat. Blue Whales specialise in krill. When they feed, they engulf a great mouthful of water and food, which is held by the expanding throat pleats. This may be as much as 50 cubic metres (50 tonnes!) of water and prey, until the whale resembles a gigantic tadpole. The throat pleats then contract, water is expelled through the baleen, and the krill is swallowed.

The next step in the research was to find out when and where the Blue Whales occur, and to relate their occurrence, and that of krill, to the dynamic weather and oceanographic processes that drive this upwelling system. This might seem a huge task, but aerial surveys cover large areas quickly, and two helpful facts emerged early in the study: the surface-swarming habit of the krill makes it possible to spot them from the

A Blue Whale lunge-feeding on a krill surface swarm. The whale is moving rapidly from left to right, rolled onto its right-hand side, with its left flipper raised, while water cascades from the corner of its wide open mouth as it fills its expandable throat with water and krill.

air; and Blue Whales are easier to see from the air than any other species of whale. Seen from above, you realise why these large grey animals are called 'blue': when they submerge, they light up in a luminous blue, unlike any other species of whale. No-one has yet explained this phenomenon, which is probably related to the physical properties of Blue Whale skin pigmentation.

In this digital age, studying links between the atmosphere and the ocean has become an armchair occupation: Captain Scammon would be rightly amazed. In our office, we download daily weather maps, and regional satellite images of sea surface temperature (SST) and 'ocean colour'. Weather maps show the prevailing weather patterns, SST images show when and where cold water is welling to the surface, and ocean-colour images show where the densest concentrations of surface phytoplankton occur. Together, these images tell much about the timing, extent and dynamics of surface upwelling, and how biological processes relate to the physical environment. We also use moored temperature loggers, small devices that record oceanic temperature at various depths, to examine the dynamics of upwelling. Yachts, fishing vessels and inflatable workboats are used to back up our aerial observations, to study krill ecology, to identify whales and document behaviour, and to attach devices such as satellite transmitters, which hopefully will lead to discovery of the whales' migration routes and breeding grounds.

After five full field seasons, we are putting together a picture of seasonal events. Upwelling starts around mid-November, and Blue Whales arrive around the start of December. Our study area extends from Cape Otway in the south-east, to Robe in the north-west, and across the continental shelf. We know that Blue Whales feed both east and west of this area, but we can't cover all of south-eastern Australia; however, it is likely that the most

Blue Whale

Balaenoptera musculus

Classification

Order Cetacea, suborder Mysticeti (baleen whales), family Balaenopteridae (rorquals), 2 subspecies: Pygmy Blue (*B. m. brevicauda*) and 'true' (Antarctic) Blue (*B. m. intermedia*).

Identification

Up to 30 m (Pygmy Blue to 24.5 m); tall strong blow; slender body with very long back and very small dorsal fin set well back; silver-grey with dappled pigment spots, but appears luminous blue under water.

Habitat and Distribution

Found throughout the world's oceans; migrates between productive summer feeding areas (polar waters, upwelling regions) and largely unknown tropical breeding grounds; Pygmy Blue rarely found south of 55°S, 'true' Blue south to Antarctic ice edge.

Biology

Feeds almost exclusively on krill; usually solitary or in small groups; calves every 2–3 years (calf 6–7 m at birth, weaned at 7 months); lives 50+ years.

A rare Blue Whale stranding in Western Australia. This photo shows how the lower jaw hinges outward to become a huge scoop. It also shows the flexible throat pleats, which have ballooned up from the pressure of the water and sand. The jet-black baleen is just visible, hanging from the upper jaw, with part of the tongue protruding from under it.

intense upwelling occurs throughout our study area, due to the narrowness of the shelf here. The upwelling pattern varies between years, but the result is the same: Blue Whales consistently come to these waters, and they come to feed.

How do Blue Whales find their food? It's something we are still trying to work out. The whales must know from experience that krill are abundant in the upwelling region, but the distribution of krill is patchy, responding as it does to dynamic changes in oceanography. So the whales most likely have searching patterns that lead them to areas of local abundance, and may then use their eyesight, hearing and perhaps even sense of smell to home in on individual swarms. These can occur anywhere between the surface and the bottom, and form irregular three-dimensional shapes that range in size from a metre to over a kilometre across.

A Blue Whale feeding at the surface is the most powerful animal act imaginable: it rushes in a surge of white water, rolling onto one side and opening its enormous mouth to engulf as much of the swarm as possible; the huge throat pouch fills in seconds. Sometimes the whale will twist and turn in its approach, countering the krills' desperate and evasive manoeuvres. Sometimes it raises its flukes and dives vertically towards deeply submerged krill; what happens down there is anybody's guess.

We now have over 500 sightings of Blue Whales in this area, which is quite phenomenal considering that there were only 35 sightings in Victoria between 1869 and 1999, and fewer in South Australia. We have sighted 34 Blues in a single aerial survey, suggesting that at least twice that number may use the area. We have linked them to their prey, *Nyctiphanes australis*; their prey to the upwelling environment; and the environment to the changing patterns of the winds. But these links have only been sketched in; there is still an enormous amount to learn.

How many Blue Whales use the area? How long do individual whales remain? How much do they move around in search of prey? Do they feed at night? How do the krill respond to predation? Do the same whales come here every year? Are there certain areas of greater importance to them? Do seasons vary? When the whales leave the area in late April or May, where do they go? There are many other vital, unanswered questions, which we hope to address in this and future seasons. Our colleagues in Western Australia are working along similar lines off Rottnest Island.

Blue Whale—both subspecies—are listed as Endangered under Australian law, so their seasonal presence in our coastal waters is cause for celebration. Yet there is no evidence that any populations are increasing. In five seasons of study, we have only seen mothers with calves 15 times—not a sign of a strongly recovering population. Blue Whales may be vulnerable to a changing climate, and to a range of human activities. Of current concern are coastal shipping, and seismic surveys in the rich gas fields that underlie the upwelling, which have the potential to displace whales from favoured feeding areas. We are working with industry, government and environment groups towards precautionary management under which human activities can proceed, while ensuring that these giants of the sea are given every chance to survive and prosper into an uncertain future. It is our duty to look after them. Captain Scammon would surely agree. □

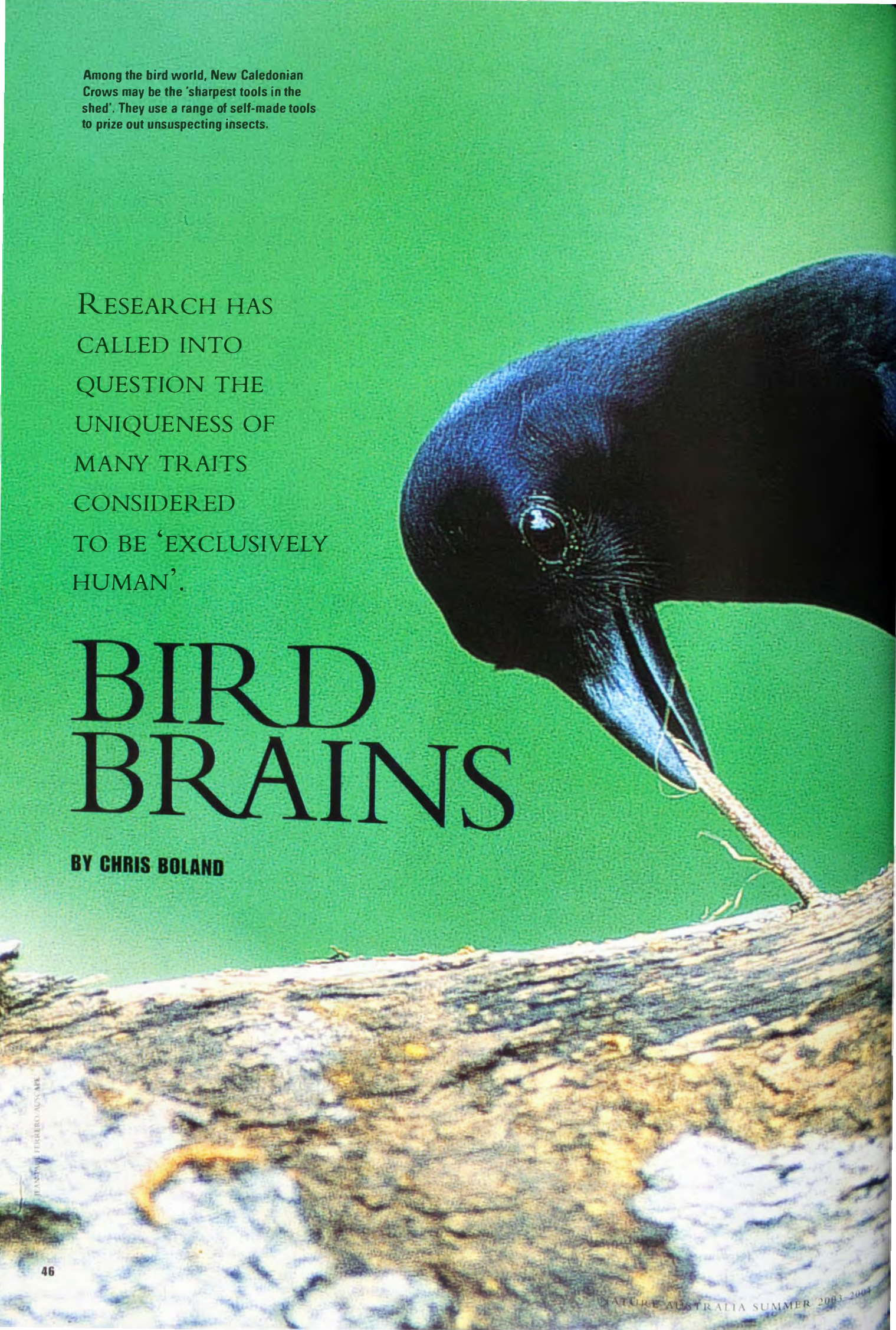
FURTHER READING

Calambokidis, J. & Steiger, G., 1997. Blue whales. *Voyageur Press: Stillwater, Minnesota.*

*Gill, P.C., 2002. A blue whale (*Balaenoptera musculus*) feeding ground in a southern Australian coastal upwelling zone.* J. Cetacean Res. Manag. *4(2): 179–184.*

Peter Gill and Margie Morrice are members of the Whale Ecology Group (Southern Ocean) at Deakin University, Warrnambool, Victoria, and work full-time on the ecology of the Bonney Upwelling Blue Whales.

The powerful blow of Blue Whales once alerted whalers to the whales' presence; now it helps researchers to locate the whales for study.



Among the bird world, New Caledonian Crows may be the 'sharpest tools in the shed'. They use a range of self-made tools to prize out unsuspecting insects.

RESEARCH HAS CALLED INTO QUESTION THE UNIQUENESS OF MANY TRAITS CONSIDERED TO BE 'EXCLUSIVELY HUMAN'.

BIRD BRAINS

BY CHRIS BOLAND

WHEN IT COMES TO intelligence, we humans can be a narcissistic lot. For centuries, many scholars have maintained that humans are the only intelligent organisms on Earth. Many traits have been considered to be 'exclusively human' examples of acumen—language, tool use, awareness of self and of others, deception... The list goes on. However, exciting new research on a number of animals, particularly birds, has called into question the uniqueness of these traits, forcing us to reconsider 'our place in nature'.

IN ONE OF HIS OFT-QUOTED ESSAYS, the 19th-century historian Thomas Carlyle declared, "Man is a tool using animal. Without tools he is nothing; with tools he is all." Therefore it came as a bit of a shock when in 1964 Jane Goodall first discovered Chimpanzees (*Pan troglodytes*) making and using tools in the Tanzanian wilderness. The Chimps were inserting grass stems into termite mounds so they could eat the termites that clung bravely to the probe.

But ornithologists were not overly surprised. Almost 20 years earlier, David Lack—the most influential ornithologist of the time—had shown that tool use was commonplace in populations of Woodpecker Finches (*Geospiza pallida*) residing on the Galapagos Islands. These tiny birds would routinely use twigs to spear or pry out grubs under bark.

HANS & JUDY BESTE/OCHMAN TRANSPARENCIES

Many people are well aware that Chimpanzees and other mammals use tools. But tool use is also widespread among birds. For example, Varied Sitellas (below) and Grey Shrike-thrushes (right) make twigs to pry out grubs from under the bark of trees.

Since then, the catalogue of tool-using animals has grown, and is replete with examples from our own region. Varied Sitellas (*Daphoenositta chrysoptera*), Crested Shrike-tits (*Falcunculus frontatus*) and Grey Shrike-thrushes (*Colluricincla harmonica*) all occasionally make similar tools to the Woodpecker Finch. White-winged Choughs (*Corcorax melanorhamphos*) rarely come across mussels in their range, but when they do some use rocks as hammers to crack open the recalcitrant shells. Other birds show a more sophisticated level of insight. For example, Black Kites (*Milvus migrans*) have been observed dropping bait into lakes to bring fish to the surface of the water, thereby making them easier to catch. A kite may also pick up a smouldering stick from an area recently burned by a bushfire and drop the stick on a patch of unburned grass. The bird then feasts on the small animals that flee from the subsequent fire.

Most tool-using behaviours are a means of extracting food, which may provide a clue as to how the mental abilities needed for tool use evolved. The predominant explanation is based on the proverb that "necessity is the mother of invention". Essentially, brain tissue is energetically expensive, so animals should have only evolved the necessary intellectual capabilities required to overcome the challenges they face in their environment. Consider a hypothetical duck grazing on a seemingly endless supply of grass. Being particularly brainy will not help the duck eat more grass—the duck that survives might be the most mobile, or perhaps the most aggressive, but not necessarily the most cerebral. In contrast, other species such as birds of prey live in a more challenging environment, where food may be distributed erratically and

KATHIE ATKINSON

White-winged Choughs can be very cunning. Young birds often pretend to help feed the chicks at another bird's nest in order to convince onlookers that they are valuable group members.

change over time. It may be hidden from view or highly mobile. The food itself may be quite intelligent. So, if there are not enough resources to feed all individuals, then only the smartest in each generation—the ones that are able to outwit their prey—will survive. In many birds 'survival of the fittest' might equal 'survival of the smartest'.

Tool-using behaviour can also emerge as a result of sexual selection. Male Palm Cockatoos (*Probosciger aterrimus*), for example, advertise their territory and court females by stamping their foot at their display tree. The cockatoos have enhanced this drumming display by using a drumstick made by cutting a fresh branch from a tree, and then trimming it to size and stripping it of any foliage and bark. The male repeatedly beats the drumstick against the tree, transmitting his sound for over 100 metres through the forest. Ringo Starr made a career out of this sort of behaviour.

IN MANY *birds 'survival of the fittest' might equal 'survival of the smartest'.*

New Caledonian Crows (*Corvus moneduloides*) boast many different tools in their tool kit. They use a hooked tool, made by removing all but one of the side branches from a twig. They fashion serrated rakes (using their beaks as scissors) from stiff, leathery pandanus leaves. They also make probes by modifying their own moulted feathers. Each tool is used in slightly different ways to pull grubs from deep within tree trunks. The crows carry their favourite tool from one foraging site to the next. They also store their tools for later re-use (not exactly in a tool shed, but on a secure place on their perch).

Problem-solving abilities have traditionally been thought to be beyond the reach of non-human animals. Nevertheless, birds are coming up with innovative solutions all the time. Recently New Caledonian Crows were shown to mould previously unseen wire into a hook to retrieve food (see "Go Gadget Crow!", *Nature Aust.* Winter 2003). Another remarkable example comes from Japanese Carrion Crows (*Corvus corone*), which were found to use passing cars to crack otherwise indestructible walnuts. When the traffic lights changed to red the birds hopped down to the

road and placed their walnuts in front of the waiting cars. When the traffic lights turned green, the birds flew to safety and watched as the motorists drove over the nuts, cracking them open. Then, when the light changed to red again, the birds came down to the road and ate freshly crushed walnuts at their leisure.

Literally hundreds of such reports have accumulated in the back pages of scientific journals. Recently a team of biologists from McGill University in Canada collated them and compared the frequency of feeding innovations with the size of the birds' forebrain (the brain area responsible for higher-order information-processing) relative to the hindbrain. The team uncovered a clear relationship: birds with relatively large forebrains are able to invent fresh solutions to ecological challenges, and to exploit the discoveries and inventions of others, more often than birds with relatively small forebrains.

A bird's forebrain is usually about five times larger than the average bird's hindbrain. The two groups of birds that are particularly well endowed with forebrain are the 'corvids' (crows, magpies, choughs etc.) and the parrots. These birds have forebrains more than 15 times larger than the average hindbrain. Birds of prey also have very large 'executive brains'. It's unfortunate that the birds many people are most familiar with—the humble chook (Domestic Fowl)—has one of the smallest forebrains imaginable, but this bird is the exception, not the rule.

ANOTHER IMPRESSIVE ATTRIBUTE of human intelligence is our memory. However, the animal with perhaps the finest memory on Earth is a bird. Many animals store food for later consumption, but Clark's Nutcracker (*Nucifraga columbiana*), a North American bird that belongs to the crow family, is probably the best of all. This amazing bird collects up to 33,000 pine seeds in November that it prudently buries in more than 2,500 cache sites across an area of over 300 square kilometres. Over the next eight months, it succeeds in retrieving over 90 per cent of the seeds, even though they may be covered by a metre of snow!

How do birds manage such tremendous memory demands? It seems that birds, like humans, store their spatial memories in the region of the brain

Black Kites have been observed carrying smouldering sticks to an unburned patch of grass. The 'fire birds' then gorge themselves on the animals escaping the ensuing blaze.

called the hippocampus. It has been known for decades that people with hippocampal injury suffer severe memory loss and learning deficiencies. In addition, recent work has demonstrated that nerve cells are generated in a mammal's hippocampus in response to memory demands. So after many years of service a London taxi driver's hippocampus is slightly larger than normal. This in itself is pretty amazing, but it's nothing compared to the far more malleable bird brain.

In birds, the formation of spatial memories triggers massive increases in the number of new nerve cells that migrate to the hippocampus. As a result, a bird's hippocampus may swell by as much as 30 per cent in only a few weeks in response to its memory requirements (such as relocating cached nuts). Since brain matter is so energetically costly to maintain, the hippocampus shrinks again when the memory demands have passed. How I wish I were a bird—with my hippocampus swelling on demand just before uni exams.

Intelligence in birds may also arise as a result of selection to overcome the complex and dynamic challenges of social living. Since sociality involves competition between group members, to be successful a social animal may need to be able to reflect on its own intentions, as well as those of others. Thus, a consequence of living gregariously may be the evolution of a distinctively Machiavellian or 'political' brain. And what better way to exercise a political brain than to be deceitful!

Perhaps the best example of deception among birds comes from the wonderfully charismatic White-winged Choughs (see "When Good Help is Hard to Find", *Nature Aust.* Autumn 1997). Choughs are cooperative breeders—that is, they live in groups composed of a breeding pair and up to 15 non-breeding 'helpers'. However, because young choughs are such feckless foragers, they are often too hungry to help. And because it is socially unacceptable to live in a cooperative group and provide little help, young choughs often act deceptively. For example, when an adult group member is watching, a young chough will place some food in the mouth of the begging chick—but it does not let the food go. Instead, it waits until the adult departs and then takes the 'candy' from the baby's mouth and eats it! All the while, the chough passes for a devoted helper among its feathered coadjutors.

A chough sitting on the nest can also help the group motive by preening the nestlings (a very visible but energetically cheap form of helping behaviour). Interestingly, a young chough is far more likely to preen the chicks after it has just deceived the rest of the group, thereby creating a double deception. It is also more likely to preen the chicks if another bird can see it do so. Watch a chough that has been sitting stone still on the nest while the rest of its group is foraging out of sight. As soon as some of its group members return into view, it comically springs up and frantically

MICHAEL & PATRICIA FOGDEN/OSF-AUSCAPE

Clever Carrion Crows (here shown stealing an egg from another bird's nest) will deliberately drop a walnut onto the road in front of passing vehicles. The bird then rushes onto the road to eat the nutritious nut, but only once the traffic lights have turned red!

DAVE WATTS/NATURE FOCUS

Black-breasted Buzzards (*Hamirostra melanosternon*) drop stones on the nests of Emus, Bustards and Brolgas to open their eggs.

starts to preen the chicks, as if to shout "Look at me, I'm helping!".

Why is a young chough more motivated to help when others are watching? It is probably concerned about its social status. Choughs need other choughs to like them; they can't breed without them. On average, seven choughs are required to support one chick through its first winter. If a chough wants to disperse and start its own group, it needs at least six other birds to join it. So to be attractive, choughs must be good helpers, or at least pretend to be good helpers.

Rob Heinsohn and his colleagues at the Australian National University have observed the fragmentation and recombination of 16 chough groups in recent years. In each case, the scenario unfolds in precisely the same manner. An adult female and her sisters will choose which males they wish to join their group. The females unite with as many male factions as it takes (usually groups of brothers) until they have at least seven birds in the group (the minimum group size needed to breed successfully). Thereafter, all other factions are turned away. This behaviour not only suggests that choughs are numerically competent, but shows they are capable of making sensible decisions. Not bad for birds that are affectionately known by some as 'silly buggers'.

There is an old phrase in science, particularly apt here, that expectation colours observation. In other words, we can only find the answers to the questions that we ourselves are prepared to ask. For centuries we have been philosophically blinkered to the idea that other animals may be intellectually capable too. But, as the Prince of Denmark says in Shakespeare's Hamlet, "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy". In recent years, scientists have dared to ask new questions of the animals on this planet. The answers seem to be telling us the same thing: that we humans are not alone when it comes to being bird-brained. □

FURTHER READING

Boland, C.R.J., Heinsohn, R. & Cockburn, A., 1997. Deception by helpers in cooperatively-breeding white-winged choughs and its experimental manipulation. Behav. Ecol. Sociobiol. *88: 295–302.*

Clayton, N.S., Griffiths, D.P., Emery, N.J. & Dickinson, A., 2001. Elements of episodic-like memory in animals. Phil. Trans. R. Soc. Lond. *356: 1483–1491.*

Hunt, G.R. & Gray, R.D., 2003. Diversification and cumulative evolution in New Caledonian crow tool manufacture. Proc. R. Soc. Lond. *270: 867–874.*

Lefebvre, L., Gaxiola, A., Dawson, S., Timmermans, S., Rosza, L. & Kabai, P., 1998. Feeding innovations and forebrain size in Australian birds. Behaviour *135: 1077–1097.*

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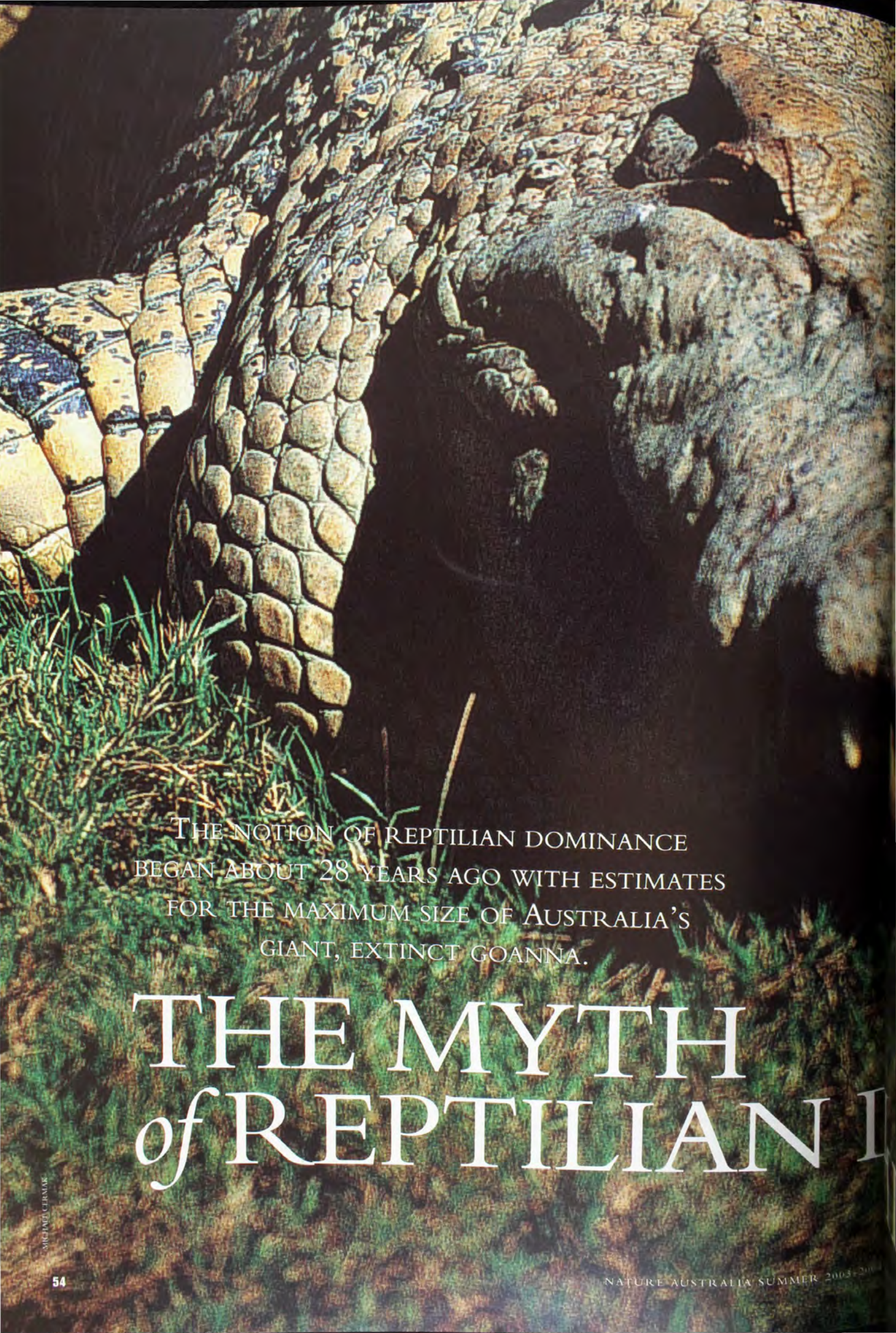


The notion of reptilian dominance began about 28 years ago with estimates for the maximum size of Australia's giant, extinct goanna.

THE MYTH of REPTILIAN

MICHAEL CERMAK

MINATION

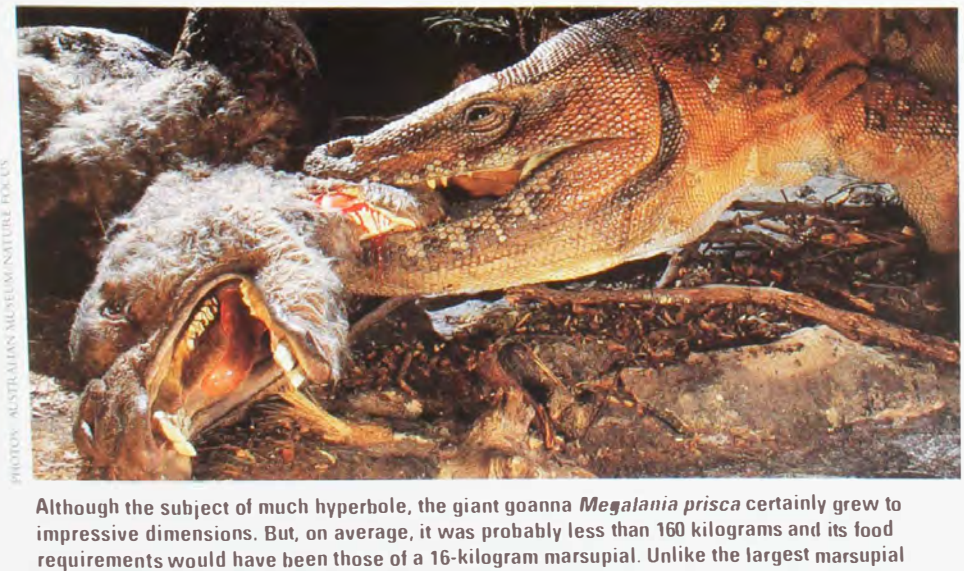
BY STEPHEN WROE

Many semi-aquatic reptiles, such as this Saltwater Crocodile (*Crocodylus porosus*), often take terrestrial prey, and so should be considered in debate over terrestrial ecology. But here Australia does not stand out.

IN A LAND WHERE ECOSYSTEMS teeter on the verge of collapse, the ecology of extinct communities and the forces that made or broke them are essential background reading. And, because of their importance as environmental indicators, understanding the roles played by extinct predators is of particular significance. Unfortunately, here in Australia, unravelling the history of carnivore ecology has proven difficult and tumultuous.

Until recently, scientists could not even agree over which carnivores dominated—mammals or reptiles. In the 19th century, Sir Richard Owen was convinced that during the Pleistocene, around two million to 10,000 years ago, Australia mirrored the great plains of Africa, where giant mammalian herbivores were regulated by ferocious mammalian carnivores. Only here of course the mammals had pouches. However by the end of the 20th century the vision of Pleistocene ecology was turned on its head. Millions of years after the heyday of outsized reptiles had ended, Owen's magnificent marsupial super-predators got retrospectively erased by cold-blooded monsters in a B-grade rerun of the 'Age of Dinosaurs'. The fact that this belated reptilian comeback took place within the last 65 million years (the 'Age of Mammals') gave the parable real shock value. It has been argued that low pro-

With a head the size of a Lioness's and a dentition dedicated to only two functions, killing and eating flesh, Australia's marsupial lion *Thylacoleo carnifex* was the most specialised mammalian hypercarnivore of all time and singularly unsuited to a scavenging role.



PHOTOS: AUSTRALIAN MUSEUM/NATURE FOCUS

Although the subject of much hyperbole, the giant goanna *Megalania prisca* certainly grew to impressive dimensions. But, on average, it was probably less than 160 kilograms and its food requirements would have been those of a 16-kilogram marsupial. Unlike the largest marsupial carnivore of the time, and like all living goannas, it was well equipped for life as a scavenger.

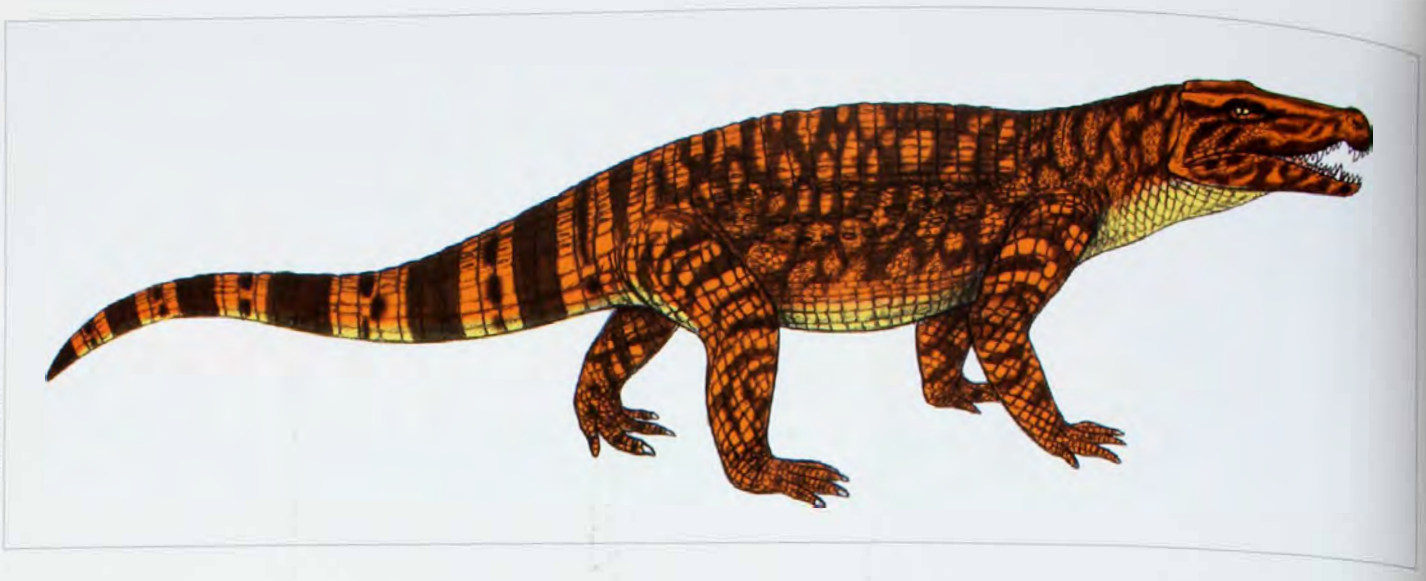
JOE MCDONALD/AUSCAPE

This South American dwarf caiman has most of the features used to argue for a terrestrial habit in the supposedly terrestrial Ice Age crocodile *Quinkana*, but although they may spend more time on land than most of their living cousins, dwarf caimans remain semi-aquatic animals.

ductivity in Australia explained this dominance of reptiles. The island continent just couldn't support big, fuel-hungry mammals, particularly meat-eating ones. Consequently, large carnivore niches were filled by more economical reptiles—or so the story went.

THE NOTION OF REPTILIAN DOMINANCE began about 28 years ago with published estimates for the maximum size of Australia's giant, extinct goanna, *Megalania prisca*. The numbers were impressive—seven metres long and 620 kilograms. Max Hecht, who generated these figures while at the University of New York, concluded that *Megalania* was the dominant predator of Pleistocene Australia. He reinforced his position by sidelining our biggest mammalian carnivore, the marsupial lion *Thylacoleo carnifex*. In a sense both Owen and Hecht were misguided. Although Owen described *Megalania* as a carnivore, he later came to view it as a herbivore. Hecht on the other hand was influenced by prior assertions that *Thylacoleo* was not a carnivore but a trumped-up, cucumber-dicer. By 1982 it was clear that they were both very wrong. But 1982 was too late—the 'myth of reptilian domination' was already firmly rooted in palaeo-folklore. By the end of the 20th century *Megalania* was somewhere between one and four tonnes!

Recently I have re-examined Hecht's mass estimates and discovered problems with his methods. For example, the fig-



ANNE MUSSER/NATURE FOCUS

Reconstruction of the supposedly 'terrestrial' crocodile *Quinkana fortirostrum*. Its land-lubbing lifestyle, however, is debatable.

ures of seven metres and 620 kilograms were based on extrapolations from a single toe-bone, which, according to Ralph Molnar (Queensland Museum), probably didn't even belong to *Megalania*. But more importantly, Hecht's numbers were only for maximum dimensions. Most species throw up freakish outliers, especially reptiles, which unlike mammals grow continuously throughout life. But real ecological dominance should be based on averages. Also, determining the actual impact of a species depends on how much individuals ate and their total biomass. Given that a reptile typically eats around one-tenth the amount of a similar-sized mammal, then unless *Megalania* was, on average, an order of magnitude larger or more common, its impact was clearly less significant than that of the pouched lion.

Although Hecht didn't estimate averages, he did present the necessary data and, using these, I calculated an average length for *Megalania* of 3.45 metres and an average weight of less than 160 kilograms.

Interestingly, while *Megalania* kept growing in mass, *Thylacoleo* got caught in a whirlpool of ever-shrinking guesstimates—ultimately our marsupial 'lion' was reduced to the dimensions of a Kelpie Dog. But recent predictions put the average *Thylacoleo* at around 100 to 130 kilograms (see "Move Over Sabre-tooth Tiger", *Nature Aust.* spring 2000). So, while it appears that *Thylacoleo* was around 40 per cent smaller on average, it was indisputably far more voracious and widespread than *Megalania*. Moreover, *Thylacoleo*'s range is less likely to have been constrained by the frequent cold snaps that punctuated the Ice Ages. Lastly, *Thylacoleo* probably took more live prey relative to carrion. When all these factors are considered there can be little doubt that the marsupial lion had a much greater impact on Australia's large vertebrate populations than the big goanna.

CARL BENTO/NATURE FOCUS

Although similar in terms of head–body length to a Leopard, comparing this Pleistocene marsupial lion to a Leopard is like comparing Elle MacPherson to a silverback Gorilla. At around 104 kilograms on average, *T. carnifex* was more than twice as heavy.

SINCE HECHT'S STUDY IN 1975, TWO more Pleistocene reptiles have been offered as pretenders in the big, terrestrial carnivore game. The first was a snake, *Wonambi naracoortensis* (see "The Serpentine Dreamtime", *Nature Aust.* Summer 2001–2002). John Barrie (University of Adelaide) estimated its maximum dimensions to have been just over six metres and 250 kilograms. Others have suggested it was a wallaby-eater with a head the size of a shovel. More recently, John Scanlon (South Australian Museum) offered a total maximum length of over five metres and maximum skull length of 13.5 centimetres (small as shovels go). Still, these figures are all maxima. I have calculated the average at well under 13 kilograms.

Barrie concluded that the combination of small teeth, weak jaws and the

likelihood that it couldn't constrict would have limited. *Wonambi* to taking small prey. We now also know that it couldn't fully unhinge its jaws, which means that unlike modern snakes it could not have swallowed items much larger than its own head. Lastly, it was rare and occupied a relatively restricted area. Barrie's best guess: it ate fish. *Wonambi* was no super-predator.

The remaining 'giant' flagged in support of reptilian domination for this period is the 'terrestrial' crocodile *Quinkana fortirostrum*. Molnar described it in 1981 based on part of a snout. Estimates by others put it at three metres long and 200 kilograms. Whether these are mean or maximum dimensions is unclear, but either way 200 kilograms seems unlikely for a three-metre crocodilian. At this length, Saltwater Crocodiles (*Crocodylus porosus*) average 94 kilograms and a 1.5-metre Salty averages only 9.5 kilograms.

Quinkana has been accepted as a landlubbing crocodile, although no postcranial remains are known. Arguments for a terrestrial lifestyle lean heavily on similarity in skull and tooth shape with a northern hemisphere genus, *Pristichampsus*. But according to Steve Salisbury (University of Queensland), whether *Pristichampsus* lived on land remains debated and its relationship to Australian species is unclear. In addition, four of the five features invoked to support a terrestrial habit for *Quinkana* are found in the living South American dwarf caimans (*Paleosuchus* spp.)... which, although sometimes more terrestrial than most other crocodiles, are still semi-aquatic. Other 'evidence' for terrestriality is the presence of some *Quinkana* in caves associated with terrestrial fauna. But these finds were close to major watercourses and living crocodiles may travel dozens of kilometres overland. According to Rick Shine (University of Sydney) they often hole up in caves when stressed. Perhaps *Quinkana* spent more time on land than most living crocodilians, but it wasn't terrestrial, and so cannot be fairly treated as a direct competitor with terrestrial mammalian carnivores.

This brings us to an interesting point. Clearly, aquatic reptiles impact on terrestrial faunas if they take terrestrial prey. In addition to *Quinkana* and the Saltwater Crocodile, Pleistocene Australia was home to another large semi-aquatic crocodile, *Pallimnarchus pollens*. It may well be that together the direct impact of these reptiles on terrestrial vertebrates was comparable to, or even greater than, that of mammalian carnivores. However, if we are going to consider the role of semi-aquatic reptiles, then this must be balanced against the fact that even today, on every inhabited continent, the largest predators on terrestrial vertebrates are cold-blooded. South America, in particular, is home to eight species of crocodile and two species of giant snake. My point here is that there is no compelling reason to believe that Australia was atypical with respect to the relative significance of reptilian and mammalian carnivores.

PETER SCHOUTEN/NATURE FOCUS

The largest *Wonambi* undoubtedly grew to over five metres, but it had relatively weak jaws, a restricted range and on average weighed in at closer to 12 kilograms. Bats, rats or fish were more likely prey than wallabies.

In summary, I suggest that over the past century, the role of Australia's fossil reptiles has been exaggerated, while that of our marsupial carnivores has been undersold. The image of an incongruous continent dominated by reptiles in the Age of Mammals has real curiosity value and this has helped propel the idea, but it is a castle in the air. Certainly the evolution of Australia's biota was constrained by a unique constellation of factors. Low productivity may be one of these, but many other influences must be considered. These range from extreme isolation to an extraordinary lack of geographic relief and unrivalled combustibility. Exploding the 'myth of reptilian domination' is a small step to understanding what has made life in Australia tick. We still have a long way to go. □

FURTHER READING

Wroe, S., 2002. A review of mammalian and reptilian carnivore ecology in Australian fossil faunas, and factors influencing their diversity: the myth of reptilian domination and its broader ramifications. Aust. J. Zool. *50: 1–24. [Free download available at* http://www.publish.csiro.au/journals/article.cfm?F=ZO01053.pdf*]*

Wroe, S., Myers, T., Seebacher, F., Kear, B., Gillespie, A., Crowther, M. & Salisbury, S., 2003. An alternative method for predicting body mass: the case of the Pleistocene marsupial lion. Paleobiology *29(3): 403–411.*

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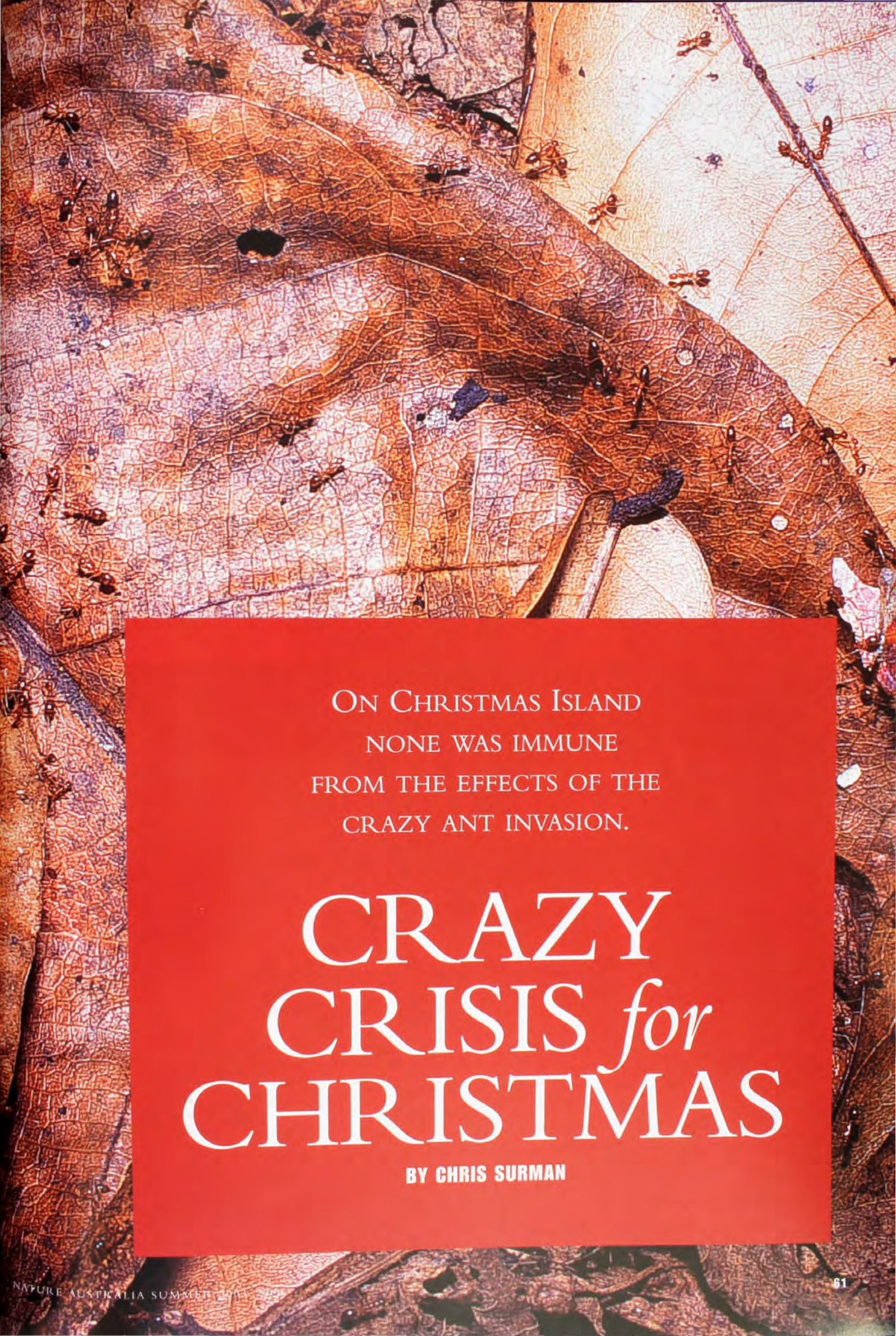
Yellow Crazy Ants swarm over the remains of a Red Crab in forest abutting the Circuit Road.



ON CHRISTMAS ISLAND NONE WAS IMMUNE FROM THE EFFECTS OF THE CRAZY ANT INVASION.

CRAZY CRISIS *for* CHRISTMAS

BY CHRIS SURMAN

IT IS JUST AFTER 3 AM IN NOVEMBER 2001 and, groggy from sleep deprivation, I stagger down to Flying Fish Cove. It is nearing the high tide on the last quarter of the moon. My torchlight illuminates rocks along the shoreline, which are covered in female Red Crabs vying for position to release their eggs. Up to my knees in lukewarm water, I focus on a group of crabs through the viewfinder of my camera. I wonder for how much longer this event will continue, for Flying Fish Cove is one of only a few places left where you can witness Red Crabs spawning in these numbers. The rest of the island has been taken over by a small invasive ant, the Yellow Crazy Ant (*Anoplolepis gracilipes*). Although I didn't know it at the time, this story has a happy ending, and is a remarkable example of how a team of dedicated people can reverse a potentially catastrophic ecosystem imbalance. It is especially portentous as Yellow Crazy Ant supercolonies are now emerging in much the same way across northern Australia.

THIS IS A *remarkable example of how a team of dedicated people can reverse a potentially catastrophic ecosystem imbalance.*

Christmas Island is located 360 kilometres south of western Java in the Indian Ocean. Protected from huge ocean swells by rugged sea cliffs, and covered in thick rainforest, Christmas Island is home to a unique fauna. Dominated below the forest canopy by land crabs and above by its seabirds, what the forest of Christmas Island lacks in diversity it makes up for by the level of endemism. Of the 13 species of land crabs that inhabit the island, two are found only here, the Red Crab (*Gecarcoidea natalis*) and Jackson's Crab (*Sesarma jacksoni*). The crabs occupy niches filled by vertebrates in forests elsewhere. Of the eight species of seabirds, again two are endemic—Abbott's Booby (*Papasula abbotti*) and the Christmas Frigatebird (*Fregata andrewsi*). Christmas Island also has its very own imperial-pigeon, goshawk, hawk-owl and thrush. All have developed traits that make them unique to this island ecosystem. Yet on Christmas Island, once thought of as a sanctuary for these species, none was immune from the effects of the crazy ant invasion.

WHAT ARE CRAZY ANTS? WHERE did they come from? What effects were they having on wildlife and the forest? To help us understand all this, I hooked up with Kirsti Abbott—a doctoral student from the Centre for the Analysis and Management of Biological Invasions at Monash University

CHRIS SCRIMAN

Christmas Island is one of the last strongholds of the massive Robber Crab. Growing up to five kilograms and living as long as 70 years, Yellow Crazy Ants impacted heavily on their populations.

Yellow Crazy Ants attending lac scales on a sapling at Waddel Hill. The ants farm the sap-sucking scale insects, providing a protection and distribution service in return for a sugary secretion from the scales.

in Melbourne. She is investigating the relationship between water-stressed plants, scale insects and Yellow Crazy Ant supercolonies.

As we descend beneath the shadows of the forest canopy, along a bumpy winding track leading to Abbott's experimental sites, I catch glimpses of the Christmas Island rainforest of old. Huge, buttressed tree trunks stand down from the canopy like the mighty, grey legs of some long-forgotten dinosaur. Between them there is a scattering of leaf litter broken occasionally by the tips of razor-sharp, limestone pinnacles.

Much of the forest structure is maintained by Red Crabs. Red Crabs are the forest's gardeners, turning the soil, clearing and recycling leaf litter, and eating fruits and seeds. By their sheer numbers, estimated at 60 million during the 1980s, Red Crabs keep the island clean. Because they consume seeds and fruits, few seedlings are able to germinate, and so the forest floor is free from clutter. Remove this primary herbivore from the system and voila! seeds germinate, leaf litter builds up and saplings of more invasive species quickly colonise these areas.

At Waddel Hill, one of Abbott's study sites, the usual forest structure has changed. There are countless sapling trees, and underfoot lies a thick, uncharacteristic carpet of yellowing leaves. Brushing aside an area of leaf litter, Abbott throws down a small plastic square. She counts the ants that cross this in 30 seconds. I listen to her frantic clicking of the counter as ant after ant scampers across the cleared patch. Fifty ants in 30 seconds define a supercolony. Abbott has just passed 140! This simple but effective test has been used throughout the island to monitor the spread of ant supercolonies.

Yellow Crazy Ants arrived over 80 years ago, most likely attached to cargo at about the same time they are thought to have made it to the mainland. Widespread throughout the Indo-pacific region, they have proven to be remark-

CHRIS SCREMAN

able colonisers, fanning out from their native West Africa. They owe their success to a number of behavioural traits that encourage the development of supercolonies. First, they spread from the primary colony by budding off with new females. Second, new colonies establish relatively close (within three metres) to each other. Third, each colony is multi-queened, with each queen producing thousands of eggs. Finally, each colony has no distinct territory, so that workers show no hostility towards members of other colonies of the same species. In this way, under favourable conditions, Yellow Crazy Ant colonies can spread to form massive supercolonies.

However, it is the mutualistic relationship between the Yellow Crazy Ant and the lac scale *Tachardina aurantiaca* (a sap-sucking insect in the family Kerriidae) that may hold the key to understanding the spread of these ants. The ants gain valuable energy from honeydew excreted by the lac scales as a byproduct of their sap-sucking. In return, the scale insects gain protection from their natural enemies, and are transported from plant to plant by the ants. Lac scales in areas where Yellow Crazy Ants have not invaded are virtually non-existent along the branches of trees. However, in supercolony areas, densities of adult lac scales can reach more than 25 per five-centimetre section.

THE CRABS

are overcome by formic acid, sprayed by the ants in defence when an intruder enters their territory.

Why did it take 80 years for Yellow Crazy Ants to take over? The crux of Abbott's main hypothesis is that the lac scale population exploded first, primarily as a result of plant water stress. Plants under stress produce a scale-friendly, nitrogen-rich sap. Abbott believes that these conditions may have prevailed on Christmas Island during the prolonged 1996–1997 drought. With more lac scales to provide honeydew for ants, Yellow Crazy Ants were then able to build up their colonies and spread to new areas as well as carry lac scales to new plants. So successful were they that ant-infested areas increased from three per cent in 1999 to 25 per cent in September 2002.

There is also another catastrophic process affecting the forest on Christmas Island—dieback. Increased densities of scale throughout 'anted' parts of the island have resulted in excess honeydew dripping onto the foliage of plants. This provides an ideal environment for the spread of sooty mould, which covers leaves and blocks leaf stomata, reducing photosynthesis and leading to dieback

Yellow Crazy Ant

Anoplolepis gracilipes

Classification
Class Hymenoptera, family Formicidae.

Identification
Medium-sized (length 4 mm), characterised by pale yellow/orange colour, long legs and antennae, and erratic movements.

Habitat and Distribution
Inhabits tropical regions throughout West Africa. Builds subterranean nests at bases of trees or rotting logs. Introduced to East Africa and islands throughout Indo-pacific.

Biology
Active 24 hours per day. Forms groups of many multi-queened colonies (supercolonies) over large (1-km^2) areas. New colonies formed by budding (new queens establish nests within 3 m) but also disperse through alate (winged) individuals. Farms honeydew from scale insects, and preys on most ground fauna. Sprays formic acid when disturbed.

CHRIS SUBLMAN

A typical view across uninvaded Christmas Island rainforest. In areas free of ants the Red Crabs maintain forest structure by clearing leaf litter and fallen fruit, giving the forest an uncluttered understorey.

in the canopy. The extra light in turn encourages the growth of seedlings and invasion of weed species. Burrowing by crazy ants to create nests at the bases of trees further increases the likelihood of plant disease.

AS WELL AS CONSUMING SUGARY material from scale, Yellow Crazy Ants are voracious predators. They attack other insects and scavenge the remains of birds or crabs.

Yellow Crazy Ants don't actually kill crabs by eating them alive. Instead, the crabs are overcome by formic acid, sprayed by the ants in defence when an intruder enters their territory. Eventually they become blinded by it, their eyes turning from a rich dark and glossy black to a dull grey. And as the effects of the formic acid continue to take hold, the crabs undergo water stress, literally frothing brown around the mouthparts.

Abbott and I walk into a heavily infested region on one of the upper terraces at her study site on Circuit Road. Crabs no longer inhabit the area, and have not done so for years. But it is the annual spawning migration, and thousands of crabs that live in the forest above this site must pass through it on their way to the lower-shore terraces and beaches where they will breed. As we walk through the thick leaf litter we notice crab carcass after crab carcass. Gone is the bright red of their carapace; instead they are a dull red-black. The smell of rotting flesh is overwhelming.

Occasionally we stumble across a moving crab but on our approach, we know it has lost the battle. Instead of scurrying away, it just plods on. And if you pick it up, it feels limp in your hands.

In other island ecosystems, Yellow Crazy Ants have had a major impact on seabird populations. Yellow Crazy Ants were first noticed on Bird Island, Seychelles, in 1991. By 1998 the ants had infested a colony of 60,000 Sooty Terns (*Sterna fuscata*), a ground-nesting species, causing them to abandon their nests. Small chicks of the Common

MICHAEL CERMAK

During September 2002 a helicopter was used to deploy Fipronil-laced ant bait over impenetrable areas of Christmas Island.

A curious juvenile Christmas Island Goshawk (*Accipiter fasciatus natalis*). Although known to prey on other birds, goshawks also forage upon invertebrates. One effect of the Yellow Crazy Ant has been a decline in invertebrate numbers in forest areas. The flow-on effect to endemic species such as the goshawk remain to be seen.

Noddy (*Anous stolidus*) and the tree-nesting White Tern (*Gygis alba*) were also killed by crazy ants. Although not quantified on Christmas Island, birds nesting in areas infested with Yellow Crazy Ants are likely to experience similar declines in breeding performance. The ants may also indirectly place pressure on those birds that depend on Red Crabs (such as the Christmas Island Hawk-owl) or insects (Christmas Island Goshawk and Thrush) for food.

As a population biologist, the severity of the problem faced by wildlife on Christmas Island was very clear. Surprisingly to many, both seabirds and land crabs are long-lived animals. It is a reproductive strategy that hedges against the occasional poor-breeding conditions. Red Crabs are thought to live as long as 20 years, Robber Crabs (*Birgus latro*) for 70 years, and boobies 20–30 years. Both crabs and seabirds delay breeding until they are three or four years of age. The parallels deviate somewhat here, as crabs produce thousands of eggs each year while most seabirds lay only a single egg. However, the unpredictability of the return of crablings, and the often-poor foraging conditions experienced by seabirds, means that in some years recruitment to the populations declines. Reproductive failure caused by the invasion of the Yellow Crazy Ant may well have tipped the balance.

The dramatic increase in the spread of crazy ant supercolonies on Christmas Island is now the subject of an intensive baiting program coordinated by Parks Australia and the Monash University team. Parks Australia staff have been distributing Fipronil-laced bait (made up of a granular fish meal) through many parts of the infested forest. Fipronil was found to have little detrimental effect on native wildlife, and no effect on water supplies. One of the greatest hurdles faced by the baiting program was the extensive areas of rugged terrain on Christmas Island impenetrable on foot, so an aerial baiting program was commenced in September 2002. Within a month of the baiting, ant activity in those areas dropped to almost zero. And it now appears that the mutualism between crazy ants and lac scales has broken down, removing the primary energy source ants once exploited with such drastic consequences.

My partner and our young son sit on Greta Beach. Once these cliffs were painted red with migrating crabs. We stare at a lone female Red Crab sheltering under a rock. We haven't missed the migration, it's just that the areas above are infested with ants. Back home 12 months later I cast my mind back to this scene. The ants on Christmas Island now appear to be under control, but what of the long-term implications for the Red Crab? And with reports of crazy ant supercolonies forming across northern Australia, a far greater expanse of wilderness is at risk. Hopefully the experience on Christmas Island will provide the expertise required to ensure that the outbreak on the mainland does not swarm out of control. □

FURTHER READING

Environment Australia, 2001. Parks and Reserves. Christmas Island National Park. Yellow crazy ants. http://www.ea.gov.au/parks/christmas/fauna/crazy.html.

Green, P.T., O'Dowd, D.J. & Lake, P.S., 1997. Control of seedling recruitment by land crabs in rain forest on a remote oceanic island. Ecology *78(8): 2472–2486.*

Haines, I.H. & Haines, J.B., 1978. Pest status of the crazy ant, Anoplolepis longipes *(Jerdon) (Hymenoptera: Formicidae), in the Seychelles.* Bull. Ent. Res. *68(4): 627–638.*

Rao, N.S. & Veeresh, G.K., 1991. Some observations on the biology and behaviour of crazy ant, Anoplolepis longipes *(Jerdon) (Hymenoptera: Formicidae).* Entomon *16(4): 261–267.*

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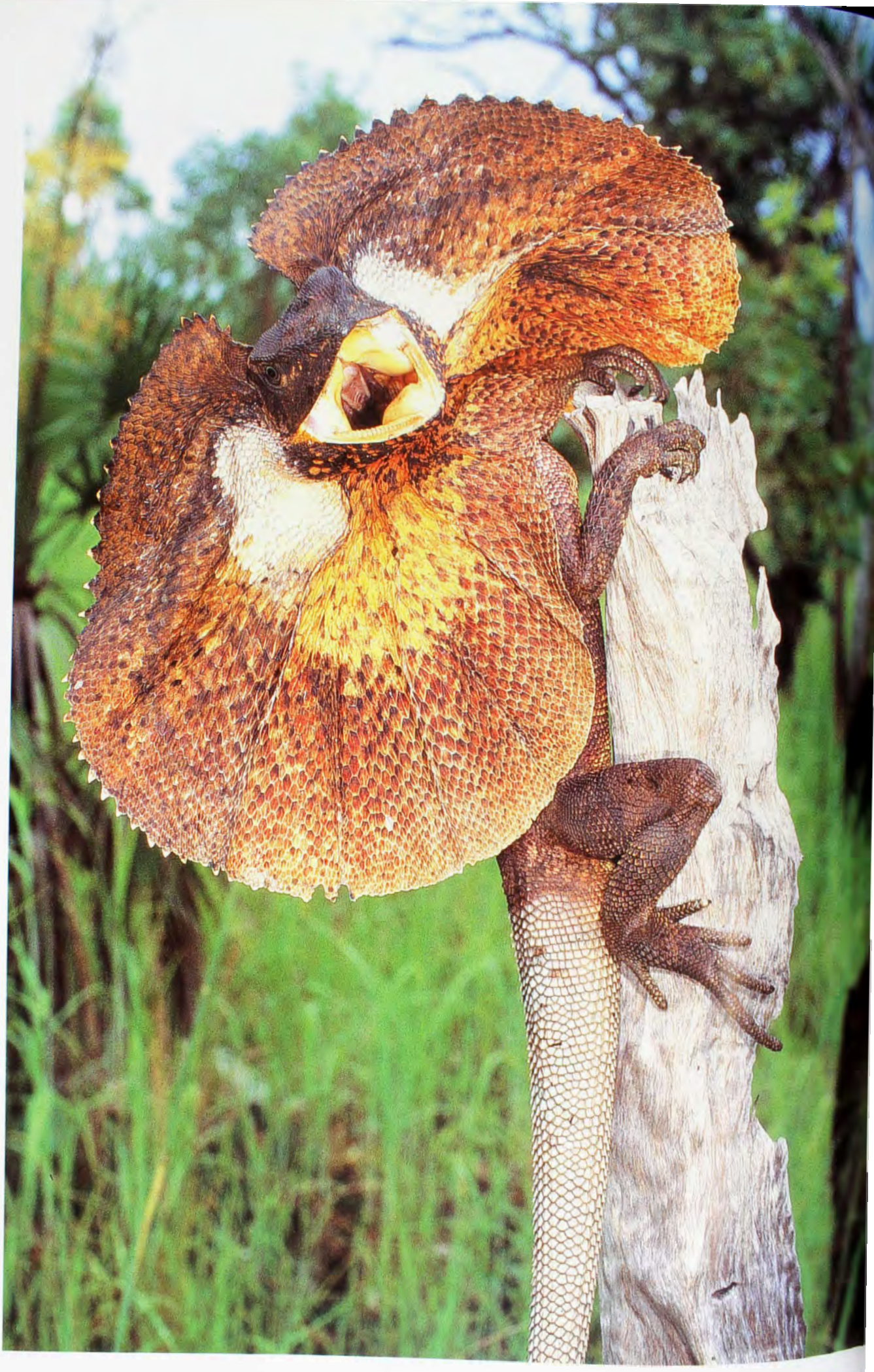

Frilled Lizard (*Chlamydosaurus kingii*).

Desert Spiny-tailed Gecko (*Strophurus ciliaris aberrans*).

reptile magnetism

BY GREG HAROLD

Western Spiny-tailed Gecko (*Strophurus strophurus*).

Nullarbor Bearded Dragon (*Pogona nullarbor*).

Pygmy Spiny-tailed Skink (*Egernia depressa*).

Blood-sucking spiders

Why would a spider want to drink blood in the first place?

PHOTOS: ROBERT JACKSON

A female *Evarcha culicivora* feeds on a blood-filled mosquito (*Anopheles gambiae*). These mosquitoes are native to equatorial Africa and feed almost exclusively on humans. They are also the main vector of falciparum malaria in Africa.

HEARING ABOUT THE FEEDING habits of *Evarcha culicivora* reminded me of a line from the 1931 film "Dracula". Soon after Renfield, a visitor from England, arrives at Dracula's castle, he struggles to get through an unnaturally large spider web spanning a staircase. A bemused Dracula offers a few words of wisdom: "The spider spinning his web for the unwary fly. The blood is the life, Mr Renfield".

Evarcha culicivora is living testimony to these words, for it is a jumping spider that sucks the life out of 'flies', especially mosquitoes that have been feeding on vertebrate blood, including that of humans. This tiny vampire lives around Lake Victoria in Kenya and Uganda where the air is filled with countless midges and mosquitoes. Robert Jackson, from the University of Canterbury in New Zealand, is an expert on jumping spiders (family Salticidae). When he first spotted *Evarcha*, he never imagined this tiny eight-millimetre spider with a grey-brown body and red face would lead him into the world of arachnid vampirism. For the last eight years he has been a regular visitor to Mbita Point on the shores of Lake Victoria, where the International Centre for Insect Physiology and Ecology (ICIPE) runs its Malaria Vector Program. With technicians at Mbita Point and students at the University of Canterbury, Jackson's main interest with *Evarcha* is in understanding vision-based cognition in miniature animals. ICIPE, on the other hand, is especially interested in *Evarcha* for its ability to kill mosquitoes that transmit malaria.

Jackson's curiosity in the spider was first aroused when he noticed it often had a blood-filled mosquito in its mouth. He suspected that the spider was after the blood inside the mosquito, rather than the insect itself. To test this he offered *Evarcha* a choice of prey: midges, male mosquitoes, and female mosquitoes that had and had not fed on blood (males don't eat blood). His hunch was right. *Evarcha* preferred female mosquitoes that were full of blood.

But why would a spider want to drink blood in the first place? Most spiders prey on insects and some feed on other spiders, but they are all fluid feeders that need to turn their prey into soup with digestive fluid before sucking up the dissolved liquid nutrients. Prey are usually paralysed with venom injected through a pair of fangs, so the spider can feed without a struggle. For a fluid feeder, prey that is full of rich and nutritious blood is mechanically ideal, since the meal is already liquid. In fact, it is like take-out, fast food, in that the spider just has to take it out of the prey and it has an instant meal. However, *Evarcha* does not have the mouthparts to pierce thick vertebrate skin and suck up blood. Instead, it captures and kills blood-fed mosquitoes (or 'winged syringes' as Jackson calls them) and siphons off the blood second-hand.

Of course, this rich source of food would not be available to *Evarcha* if it did not have the ability to pick out a blood-fed mosquito in a crowd of traditional spider food. Jumping spiders have excellent eyesight. Two large eyes at the front assess size, colour and shape, while six smaller eyes detect movement. Each of the large eyes has a fixed lens, which magnifies images enormously onto a small curved retina at the back of the tubular eye. Because the spider's retina is so small it can only capture a portion of the image, but by scanning with its eye tubes the spider may be building up a

BY SIMON D. POLLARD

more complete picture of what it is seeing. This takes time, but one idea being investigated is that the spider has evolved a way of speeding up the process, by searching for specific details in the image. Imagine looking at the Mona Lisa with binoculars. If you are expecting to see a painting, you only need to see the mouth to know it's her. Similarly, the shape of a leg or some other feature may be all the information a jumping spider needs before it knows what it is looking at. The smell of blood seems to be what makes the spider expect to see a mosquito, but what visual cues does *Evarcha* use to identify by sight its preferred prey, a blood-fed female mosquito?

To answer this question, Jackson and his colleagues appear to have been inspired by another famous figure of horror films, Dr Frankenstein. They present *Evarcha* with dead mosquitoes mounted in life-like poses on corks. The bodies are often a combination of different body parts taken from male and female mosquitoes. They then sit back to see which composite creatures the spiders try to attack. The experiments seem to be showing that the antennae and shape of the abdomen are especially important features. Males have hairy antennae with a feathery look. Females don't have hairy antennae. Blood-fed females have distended abdomens and *Evarcha* is more likely to attack these females than ones that have slender abdomens. However, a fat-bellied female with a male's feathery antennae is less likely to be attacked than a fat-bellied female with her own antennae, but more likely to be attacked than an intact male or an intact female with a slender abdomen.

Unlike Dr Frankenstein, Jackson and co-workers do not try to reanimate the dead; instead they animate virtual mosquitoes for *Evarcha* to watch on a miniature TV screen. The spider watches these digital mosquito chaemeras as if they were the real thing and this allows the researchers to manipulate them more precisely than stitching together mosquito body parts.

Although *Evarcha* leads a life with vampiric overtones, Dracula is at least metaphorically a spider, as he spins a web of deceit for the unwary Renfield and makes him his slave. Like his master, he develops a craving for blood, but like *Evarcha*, he prefers it packaged in a fly. He pleads to Dracula, "You will see that I get lives, not human lives but small ones, with blood in them". Well, no matter how you get it, the blood is the life, Mr Renfield. □

Evarcha culicivora **is a jumping spider that sucks the life out of 'flies', especially mosquitoes that have been feeding on vertebrate blood, including that of humans. This tiny vampire lives around Lake Victoria in Kenya and Uganda.**

FURTHER READING

Harland, D.P. & Jackson, R.R., 2002. Influence of cues from anterior medial eyes of virtual prey on Portia fimbriata, *an araneophagic jumping spider.* J. Exp. Biol. *205: 1861–1868.*

Pain, S., 2002. Bloodlust. New Scientist *14 December 2002: 44–47.*

Wesolowski, W. & Jackson, R.R., 2003. Evarcha culicivora *sp. nov., a mosquito-eating jumping spider (Araneae: Salticidae) from East Africa.* Annales Zoologici *53: 335–338.*

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Hunter, scavenger, grandmother, yam

The most dependable and regular food deliveries would have come from females foraging for plants like yams.

ALL FAMILIES HAVE THEIR SECRETS, and it is the same even for our oldest. For example, we thought heads of the earliest human families were men who went out hunting to bring back food for the wife and kids. Indeed meat from the hunt has been touted as the critical ingredient that set us apart from our primitive ancestors, fuelled larger brains and provided the recipe for family life as we know it. A proud father bringing home the family meat order is the central image of the 'hunting hypothesis', and accepted by many as the driving force for the evolution of higher intelligence, better technology, larger body size, dedicated mothering, dependent children, nuclear families, the sexual division of labour, and rapid expansion of human ancestors from Africa to eastern Asia. It all happened thanks to the first hunters, our founding fathers…or so the story goes.

Now the secret is out. Combining the results of archaeological and modern cultural studies, James O'Connell (University of Utah) and colleagues have revealed what really happened. First of all, the 'hunters' were most likely scavengers, snatching bits of carcass from fierce predators. And furthermore, what meat they managed to scrounge was not taken home, but processed on the spot or close by.

To gain insight into the ecology and behaviour of early humans about two million years ago, O'Connell's team studied the Hadza, a small population of traditional hunter-gatherers that live in arid savanna woodlands in Tanzania. While meat provides Hadza families with about half the total kilojoules needed over a year, hunting or scavenging big game is far from reliable on a day-to-day basis. Hadza men on average acquire only one large kill for every month of hunting days—certainly not enough to feed the family. And, if these modern hunters with greatly superior technological weaponry (bows with projectile-tipped arrows and spears) cannot achieve high hunting and scavenging success, then how could our ancient ancestors armed with a few rocks and faced by even fiercer predators?

To gain insight into the ecology and behaviour of early humans, O'Connell's team studied the Hadza, a population of hunter-gatherers that live in Tanzania.

Work with modern foraging groups also hints at how our ancestors might have butchered, packaged and transported scavenged or hunted prey. For example, some researchers have argued that limb bones would have been carried away by hunters with meat attached—a kind of inside-out carry-bag. But this is not what modern hunters do. Instead they strip meat off the large bones, which they find too heavy to lug more than a few metres. O'Connell and his team carefully analysed bones left behind by the Hadza at their temporary butchering stands. They studied the range of animals, the number of different bone parts, the damage and cut marks on bone, where the bones accumulated on the landscape, and how often large carcasses were acquired. They then compared this with 19 archaeological sites in the East African Rift Valley, dated between 1.2 and 2.6 million years old, all with large mammal bones (mostly cow-sized ungulates) and all but two with stone artefacts attributed to *Homo erectus* (= *ergaster*).

Most of the archaeological sites contained the heavy head and limb bones, which, according to modern studies, would indicate they were not that far from where the animals were originally killed. Bone breakage patterns, and the relative numbers of cuts and carnivore tooth marks, suggest scavenging rather than human hunting, and in some cases indicate that early humans aggressively snatched (rather than passively acquired) carcasses from predators. The high frequency of pelvic bones also suggests carnivores were driven off soon after the kill, simply because hips are very meat-rich (some more than others, as we all know) and the first bits to be consumed. In most cases, though, it is not clear whether early humans or other scavenging carnivores got to the kill site first. Sometimes, the first human meat thieves (all worthy of Darwin Awards) contributed themselves to the bone pile.

The original idea that these archaeological sites represented home bases was based not only on the erroneous limb-bones-as-carry-bags idea, but on the high number and taxonomic diversity of the bones, which were thought to have been collected from various habitats and amassed in one central (home) location. However, modern Hadza butchering stands also share these features. Moreover, both modern and old butchering sites are found near streams, and streams attract many thirsty animals and hungry

BY RICHARD FULLAGAR

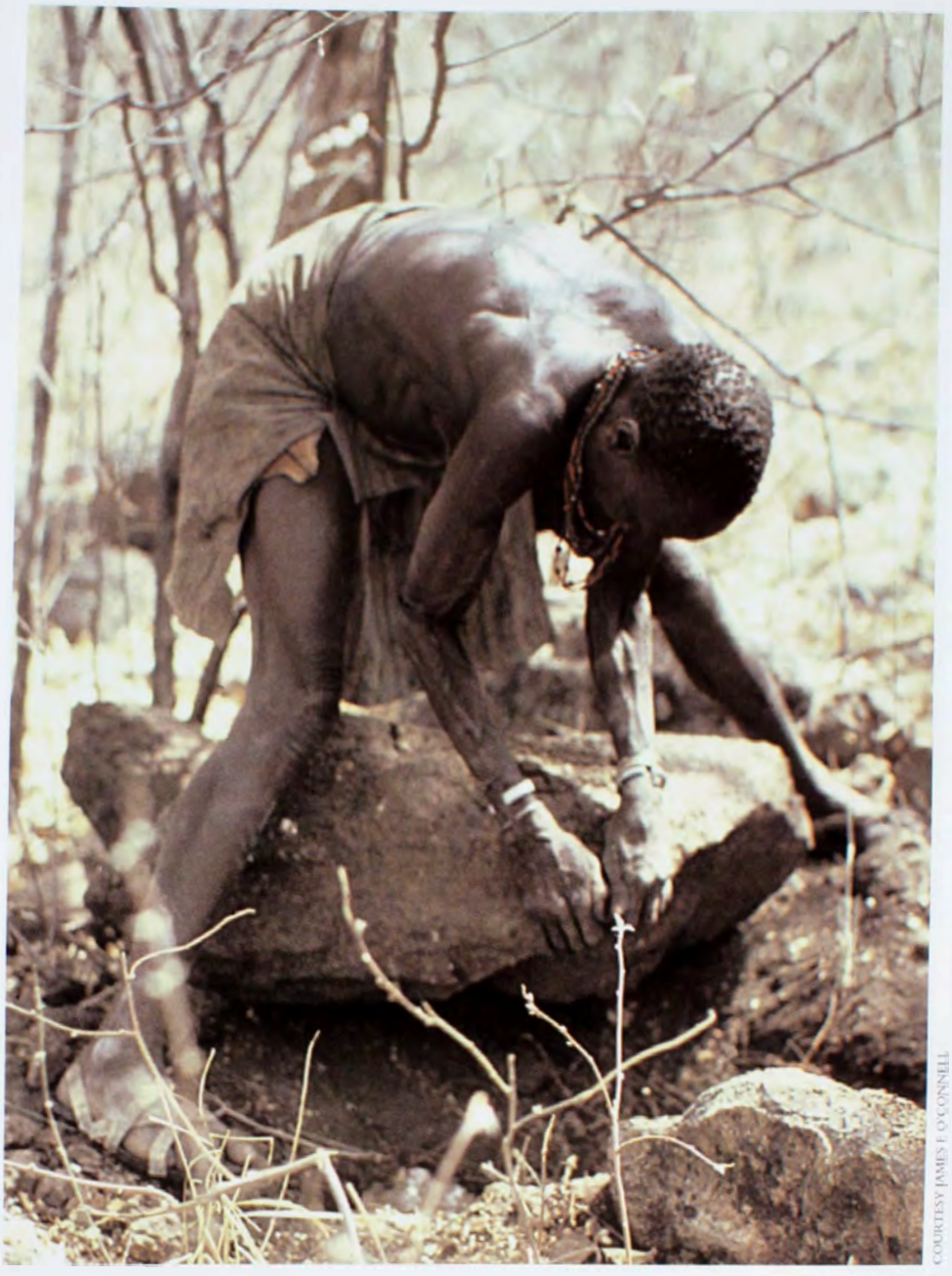
predators looking for an easy meal. Hadza never camp by streams because it is simply too dangerous to do so. We can therefore assume that the early archaeological sites were not home bases either.

The old theory argued that change to a cooler, drier climate led to the spread of game-rich savannas, which favoured big-game hunting, as indicated by the appearance of large and diverse bone accumulations in the early Pleistocene archaeological record. Moreover, male provisioning of meat led to big brains, intelligence, large size and other distinctively human traits. The new theory, however, argues that climatic change made for a patchier environment with scattered water holes, thus presenting more concentrated scavenging opportunities for early humans and, importantly, making them more archaeologically visible. In other words, early humans didn't all of a sudden start eating meat. They and their ancestors were probably picking at it for ages; it's just that evidence for it becomes more obvious around this time. And if true, then meat was probably not the prime mover in this phase of human evolution.

So, if men weren't 'bringing home the bacon', who were? Women. O'Connell and colleagues propose that the most dependable and regular food deliveries would have come from females foraging for plants like yams, which have been superabundant on the African landscape for millions of years. Female foraging patterns, particularly by grandmothers, would have freed daughters to have more children, and favoured the evolution of post-menopausal longevity (where women live beyond their reproductive years). Delayed maturity—a characteristic first indicated by tooth eruption schedules of *Homo erectus* children—and increased body size (from a longer period of growth) would have followed as natural consequences. Male hunting is normally invoked to explain the evolution of these distinctively human life-history traits, but they can be accounted for equally by female foraging.

Finally, why did men bother in the pursuit of meat if it wasn't to support the family? Perhaps it was less for the food than for the spectacle. Snatching meals from ferocious lions would have been a great way to prove a man's competitive ability to other males, earning him prestige, high status and, ultimately, mating partners (see "Show-offs and Pay-offs", *Nature Aust.* Autumn 2002).

These ancient family secrets may be disturbing for the male breadwinners of today. For example, how much of their act is just competitive display for status? Maybe the new theory will be shrugged off, as a bit of tinkering with the historical details. Certainly for half the world's population, the idea of Woman the Gatherer, as opposed to Man the Hunter, being the driving force for human evolution will come as no surprise.



COURTESY JAMES F O'CONNELL

A 65-year-old Hadza woman from Tanzania lifts rocks in pursuit of tubers. Foraging by women, especially grandmothers, may have been the driving force behind the evolution of modern humans.

FURTHER READING

O'Connell, J.F., Hawkes, K. & Blurton Jones, N.G., 1999. Grandmothering and the evolution of Homo erectus. J. Hum. Evol. *36: 461–485.*

O'Connell, J.F., Hawkes, K., Lupo, K.D. & Blurton Jones, N.G., 2002. Male strategies and Plio-Pleistocene archaeology. J. Hum. Evol. *43: 831–872.*

DR RICHARD FULLAGAR IS A SENIOR RESEARCH FELLOW IN ARCHAEOLOGY AT THE UNIVERSITY OF SYDNEY. HE IS PARTICULARLY INTERESTED IN ARCHAEOLOGICAL INDICATORS OF HUMAN BEHAVIOUR.

True blue

One of the richest colours, and historically most prized, of plant dyes is indigo.

COURTESY LUISA GELENTER

Indigo has been used as a dye for thousands of years.

IN THE LATE SEVENTIES, I DYED MY post-hippy shoulder bag orange by boiling it in a slurry of grey-green lichens. These were lichens that had once clothed the few granite rocks stranded in farmland around Yapeen, in central Victoria. I soon realised that the shoulder bag as a male fashion accessory, and lichens as the basis of a dyeing industry, were unsustainable, although I'm sure both will come back, eventually. What continues to intrigue me, though, is the fact that a green plant, or lichen, produces an orange dye.

It turns out that the green of chlorophyll, present in all green plants and lichens, retains its colour for only a few hours after extraction. Other chemicals, often masked in the living plant by chlorophyll, are longer-lasting, although many require the addition of a fixing agent, called a 'mordant', such as potassium aluminium sulphate (alum). One of the richest colours, and historically most prized, of plant dyes is indigo. It takes about a month of soaking and fermentation to extract a dark blue precipitate from the green stems and leaves of certain tropical *Indigofera* species. And that's just the start of the colour transformation.

Dried patties of indigo-precipitate can be stored for many years, but they are eventually crushed and rehydrated for a second fermentation during which the colour changes from blue to yellow. Cloth soaked for a few minutes in this solution emerges green, turning blue as soon as it leaves the alkaline solution and comes in contact with air. The cloth can be redipped up to five times for a darker blue, and once air-dried the colour will last as well as that of your favourite blue jeans (which were once dyed with natural indigo). No mordant is required.

Indigo, or indicum, is extracted from a few species of *Indigofera*, but mostly Dye Indigo (*I. tinctoria*) in India and Asia, and Anil Indigo (*I. suffruticosa*) in South and Central America. It has been used as a dye for millennia throughout Asia, but early Europeans, without access to indigo, had to find alternatives for this most majestic of colours. The purple robes of Roman rulers, for example, were coloured from the mucous glands of local molluscs (murexes)—1,200 individuals were required to produce each gram of purple dye. But once traders discovered indigo, Europeans couldn't get enough of it. Local plant substitutes such as 'woad' or 'pastel', from *Isatis tinctoria*, were inferior products, and the European empires of the time established indigo plantations in their American colonies, and in India. At its peak, 20,000 tonnes of indigo 'bricks' passed through Marseilles into Europe and north Africa each year. In 1897, India had 1.7 million hectares planted with *Indigofera tinctoria*. Relatively fade-proof, it became the colour of choice for the uniforms of many armies. In a bizarre twist, some of these same armies fought wars over local shortages or oversupplies of indigo.

The indigo trade in Australia was more subdued. The first Government Botanist of Victoria, Baron Ferdinand von Mueller, considered *Indigofera tinctoria* to be a native of northern Queensland. While there is a herbarium speci-

BY TIM ENTWISLE

men from Endeavour River dated 1882, the species is now considered to have been introduced into Australia, possibly by Macassan traders before European settlement (but such arrivals are notoriously difficult to prove). Blue is certainly a colour used only in more recent Aboriginal art, and the first inhabitants of Australia don't seem to have extracted indigo from *Indigofera tinctoria*, if it was here. Nevertheless, this species, and to a lesser extent *Indigofera suffruticosa*, are well 'naturalised' today in northern Australia. In the absence of *Indigofera tinctoria* from New South Wales, Governor King was advised from Britain to cultivate and extract dye from our common local species, Australian Indigo (*I. australis*). The dye extracted was described as "any other colour than indigo", and the industry never grew beyond a trial in 1803. Some years later (but too late for King) it was demonstrated that good-quality indigo dye *could* be obtained from the Australian species.

Other Australian native plants do contain a range of dyes, mostly yellows, browns, greens and reds, but seldom blue or purple. One of the few reported sources of blue dye is the flower of the native-garden favourite 'Happy Wanderer', a cultivar of False Sarsaparilla (*Hardenbergia violacea*). The resulting colour has been described as 'grey-blue'. There are other blue-flowered Australian plants, and the blue-purple berries of species such as Ooray or Davidson's Plum (*Davidsonia pruriens*), the Ash Quandong (*Elaeocarpus reticulatus*) and Blue Lilly Pilly (*Syzygium oleosum*) could be the source of some indigo-like colours. However, if there are any such colours trapped within the green stems of Australian plants, they are not well known.

Back to the burgeoning world market in indigo. In the 20th century, the demand for blue jeans and grey-blue worker's clothes could never have been met by natural indigo cultivation alone. An even greater impetus to find a synthetic analogue was the frustration of other European countries with the English domination of the world indigo market. A suitable alternative (which, as with most things in modern life, was a coal-tar or petroleum derivative) was discovered in 1880 by the German chemist Adolf von Baeyer. It took a further 20 years and millions of dollars of research for a cost-effective process to be developed.

BRETT GREGORY/AUSCAPE

Australian Indigo (*Indigofera australis*). Despite initial findings, good-quality indigo dye can be obtained from the Australian species.

Today, natural indigo is still produced and used in small quantities. Because *Indigofera* extracts contain several other pigments, such as Indigo Red, the resulting colours are more complex and variable, and to some more interesting and beautiful. The colour of the dye also depends upon the local variant of *Indigofera* used and where it grows. The most sought-after hue in the Middle Ages, for example, came from a Baghdad plantation of *Indigofera tinctoria*. And for some, the coppery sheen produced after ironing or pounding cloth dyed from 'natural' indigo is particularly alluring. Undoubtedly most devotees are drawn to a combination of the alchemy, the delight at watching the colours transform, and an appreciation that just as every individual plant is different, so every batch of indigo dye produces a different colour. □

FURTHER READING

Balfour-Paul, J., 1998. Indigo. *British Museum Press: London.*

Delamare, F. & Guineau, B., 2000. Colour: making and using dyes and pigments. *Thames & Hudson: London.*

The Handweavers and Spinners Guild of Victoria, 1974. Dyemaking with Australian flora. *Rigby: Adelaide.*

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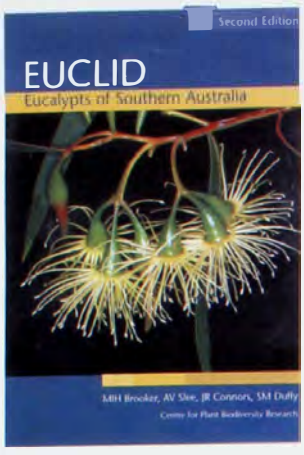
reviews



EUCLID: Eucalypts of Southern Australia

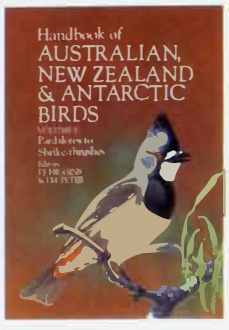
CD ROM. Second edition by M.I.H. Brooker, A.V. Slee, J.R. Connors and S.M. Duffy. CSIRO Publishing, Vic., 2002, $110.00 rrp.

THIS CD IS AN UPDATE OF TWO WELL-KNOWN BOOKS, *Field guide to eucalypts, Volumes 1 and 2*, and supplants an earlier CD on eucalypts of the south-east. Eucalypts are often tricky to identify because there are so many species, and the EUCLID interactive key, plus clear photographs of leaves, flowers, fruits, seeds, trunks and whole trees in this CD, are a great help. It is clearly organised and easy to use.

The technical language will deter non-botanists. In describing, for example, the leaves of Mottlecah (*Eucalyptus macrocarpa*), these words are used: amplexicaul, cordate, concolorous, emarginate, intersectional, and subcrenulate. Although all but one of these words are defined in the glossary, this kind of language will dismay many amateurs for whom simpler words are often available, for example 'stem-clasping' for 'amplexicaul'.

The authors of this CD do not accept as valid all recently named eucalypt species, interpreting some as varieties of existing species. Nor do they accept the split from *Eucalyptus* of the genus *Corymbia*. Most naturalists won't complain about that, but botanists will. Even so, this is an immensely valuable reference for anyone serious about identifying eucalypts (and related *Angophora* species) in the southern half of Australia, covering 690 species in all.

—TIM LOW



Handbook of Australian, New Zealand & Antarctic Birds. Vol. 6. Pardalotes to Shrike-thrushes

Ed. by P.J. Higgins and J.M. Peter. Oxford University Press, Melbourne, 2002, 1,225 pp. $395.00 rrp.

THE IMPORTANT HANDBOOK OF AUSTRALIAN, NEW ZEALAND & ANTARCTIC BIRDS (HANZAB) series continues with more passerines (songbirds) in this, the sixth, volume. It treats 107 species, which include such well-known birds as pardalotes, scrubwrens, thornbills, robins, whipbirds, babblers, whistlers and shrike-thrushes, as well as many less familiar ones. All species are illustrated in 37 colour plates painted by several artists.

The layout of the species accounts remains the same as that in previous volumes, with sections on field identification, habitat, distribution and population, threats and human interactions, movements, food, social organisation and behaviour, voice, breeding, plumages and moult, measurements and weights, ageing and sexing, and geographical variation. These accounts serve to present not only what is known about these birds, but also what areas of information are lacking. Thus, some familiar species receive 20 or more pages of text, whereas poorly known ones get as few as four pages. Hopefully, by identifying areas in which we are knowledge deficient, HANZAB will stimulate workers to investigate our less-known birds.

Although the price of these volumes is high, the series remains a critical reference for anyone who wants to know about Australian and New Zealand birds. It will fall outside the price range of many people, but no-one with a serious interest should lack access to it. With the next volume, this impressive work will be completed.

—WALTER E. BOLES
AUSTRALIAN MUSEUM

How to Dunk a Doughnut: The Science of Everyday Life

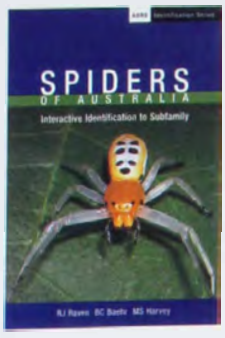
By Len Fisher. Weidenfeld & Nicolson, London, 2002, 240 pp. $35.00 rrp.

MOST PEOPLE, ESPECIALLY THE YOUNG, WONDER ABOUT HOW AND WHY THINGS WORK, and sometimes an answer from your parents of "just because" really isn't good enough. Len Fisher takes over from lazy or uninformed parents with *How to dunk a doughnut*.

Fisher first hooks the reader by asking a seemingly basic question about something many of us might take for granted. He then explains in layman's terms the reasons behind the occurrence and, for the scientifically minded, supplies a concise, quantitative explanation at the end of each chapter.

The book covers topics ranging from how to boil the perfect egg, to why some boomerangs won't come back, giving it content to spark the curiosity of everyone.

—JASON MORVAN
AUSTRALIAN MUSEUM



Spiders of Australia: Interactive Identification to Subfamily

By R.J. Raven, B.C. Baehr and M.S. Harvey. CSIRO Publishing/Australian Biological Resources Study, 2002, $89.95 rrp.

THIS IS THE FIRST CD INTERACTIVE IDENTIFICATION KEY that deals with a major regional spider fauna. Its coverage extends from Australia to Papua New Guinea and New Zealand. The key obviously represents a prodigious effort of research and compilation by the three authors. It is based upon web-integrated Lucid Player Plus software and comes with numerous excellent diagrams and photographs, as well as distribution maps and explanatory or descriptive (DELTA-generated) notes. As a guide to regional spider families and subfamilies, it is an important resource as the only up-to-date key now available.

The CD is presented in two parts. The first part is an enthusiastically idiosyncratic but informative introduction to spiders, the Australian fauna and taxonomy. It includes a checklist of Australian spiders (also available on the net via the Queensland Museum as a periodically updated resource) and an anatomical glossary.

The second part contains the keys themselves. One can elect to directly enter the key to the Mygalomorphae or the Araneomorphae. However, if unsure about which of these to choose, a third option (rather confusingly titled "Australian Spider Subfamilies") provides a short key to five 'groupings' including, oddly, the Hypochiloidea, which is not represented in the Australasian region. Using the keys is quite simple, especially after doing the tutorial provided.

The CD would have benefited from further editing and testing to fix some typographical, factual and presentation glitches noted. Overall, though, this is a very useful resource for anyone working with or interested in Australian spiders.

—MIKE GRAY
AUSTRALIAN MUSEUM

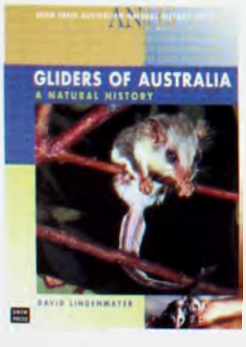
Magpie Alert: Learning to Live with a Wild Neighbour

By Darryl Jones. University of New South Wales Press, Sydney, 2002, 157 pp. $29.95 rrp.

WHAT A GREAT BOOK! Because Australia has few places where Magpies are not found, most Australians have some sort of opinion about them. The book provides current information on mainly suburban Magpies, how and why they attack people, and how this can be managed. Although based around Brisbane, most of the findings should be relevant elsewhere as well. It is also about people and how their behaviour affects the Magpies.

There are seven chapters, ranging from background information to discussions of behaviours, and their causes and situations, of both Magpies and their victims. Often a question or hypothesis is posed and the reasons or evidence, for or against, follows. In fact, the book is a good practical example of the scientific method as well as a study on Magpies. The style is light and conversational and the details fascinating and varied. I confess to reading it from cover to cover like a novel. It is a great book for families, councils, wildlife authorities, naturalists, and anyone who has ever been swooped by a Magpie.

—MARTYN ROBINSON
AUSTRALIAN MUSEUM



Gliders of Australia: A Natural History

By David Lindenmayer. University of New South Wales Press, Sydney, 2002, 160 pp. $34.95 rrp.

THIS LATEST ADDITION TO THE University of New South Wales Natural History series is a detailed, authoritative and highly readable work focusing on some of Australia's most attractive yet elusive mammals, the gliders. Gliding has evolved in three different groups (families) of possums, which range in size from the diminutive Feathertail Glider (small enough to fit into the palm of your hand) to the Greater Glider (over a kilogram in weight). This book provides a fascinating account of some of the important aspects of the biology and conservation of the six Australian species.

Beginning with a discussion of the origins and evolution of gliding, Lindenmayer highlights some of the special adaptations, including a gliding membrane, gripping pads on the feet, widely spaced eyes (which assist in judging distance) and the female's compartmented pouch that cushions young against the impact of the mother's landings. Subsequent chapters detail diets, habitat use, behaviour, life history and reproduction. The final chapter addresses conservation and management of gliders and the factors that have led to three species—the Mahogany Glider, Yellow-bellied Glider and Squirrel Glider—being listed as endangered or vulnerable.

Gliders of Australia draws heavily on the author's own extensive experience in the forests of eastern Australia, and is an extremely valuable addition to the library of natural-history enthusiasts, students and professionals alike.

—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.

ANIMAL WELFARE

WIRES

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

Membership: $40.00

Wildlife Carers Network—Central West Inc.

PO Box 787
MUDGEE NSW 2850
Ph: 0408 966 228
Contact: Joan Hills

Membership: $20.00

BIRDS

Birding NSW

PO Box Q277
QVB Post Shop
SYDNEY NSW 1230
Ph: 02 9712 1180
Web: *www.ozemail.com.au/~nswbirds*
Contact: Barrie

Membership: $35.00 per Family

CONSERVATION

Tablelands Frog Club Inc.

Mail Bag 71
YUNGABURRA QLD 4872
Ph: 07 4096 6556
Contact: Beryl Davidson

Membership: $15.00 Single $5.00 Concession

Tasmanian Conservation Trust

102 Bathurst Street
HOBART TAS. 7000
Ph: 03 6234 3552
Web: *www.tct.org.au*

Membership: $30.00 Single $18.00 Concession $40.00 Organisation $60.00 Corporate

EDUCATION

CSIRO's Double Helix Science Club

PO Box 225
DICKSON ACT 2602
Ph: 02 6276 6643
Web: *www.csiro.au/helix*
Contact: Jo-Anne McRae

Membership: $27.00 or $24.00

The Royal Society of Victoria

8 La Trobe Street
MELBOURNE VIC. 3000
Ph: 03 9663 5259
Web: *www.sciencevictoria.org.au*

Membership: $145

ENVIRONMENTAL

Gecko-Gold Coast & Hinterland Environment Council

Gecko House
139 Duringan Street
CURRUMBIN QLD 4223
Ph: 07 5534 1412
Web: *www.gecko.org.au*
Contact: Ben Perkins

Membership: from $16.50

Greening Australia National Organisation

Ph: 1900 950 854
Web: *www.greeningaustralia.org.au*
Membership: Membership is State/Territory coordinated. please contact your State/Territory office for more details.

National Parks Association of NSW

Level 9, 91 York Street
SYDNEY NSW 2000
Ph: 02 9299 0000
Web: *www.npansw.org.au*
Contact: Tara Cameron

Membership: $55.00 Adult $65.00 Household $30.00 Concession

National Parks Association of QLD

PO Box 1040
MILTON CENTRE QLD 4064
Ph: 07 3367 0878
Web: *www.npaq.org.au*
Contact: Leon Misfeld

Membership: $45.00 Single $67.00 Family $25.00 Student

MUSEUMS

TAMS—The Australian Museum Society

6 College Street
SYDNEY NSW 2010
Ph: 02 9320 6225
Web: *www.amonline.net.au/tams/*
Contact: Alison Byrne

Membership: $88.00 Family $70.00 Single $52.00 Concession

The Waterhouse Club

SA Museum
North Terrace
ADELAIDE SA 5000
Ph: 08 8203 9802
Web: *www.waterhouseclub.org.au/whc*
Contact: Mary Lou Simpson

Membership: $90.00 Family $70.00 Single

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Dinosaur Club

Australian Museum Education
6 College Street
SYDNEY NSW 2010
Ph: 02 9320 6223
Contact: Kate Cox

Membership: $15.00

REPTILES & AMPHIBIANS

SA Herpetology Group

C/- SA Museum, North Terrace
ADELAIDE SA 5000
Ph: 0419 806 896
Contact: Gavin Kluske

Membership: $28.00 Adult $24.00 Concession $32.00 Family

Newsletter/Journal; Monthly meeting; Bi-monthly meeting; Annual meeting/Conference; Weekly meeting; Quarterly meeting; Field outings/Tours; Conservation/Working programs; Discounted Goods; Magazine; Social/Education activities; *Nature Australia* magazine; Seminars

q&a

COURTESY CHARMAINE WENCK

White-crowned Snake (*Cacophis harriettae*).

Snake Charmer

Q: *We found this dead snake in our Ipswich front yard one morning (photo enclosed). It had bite marks on it that I assume were inflicted by a Cat. The snake had white scales on its head, but the rest of the body was a beautiful shiny black. It was 46 centimetres long. What sort of snake is this, and is it poisonous?*

—Charmaine Wenck
Ipswich, Qld

A: The photo shows a White-crowned Snake (*Cacophis harriettae*). It is an egg-laying member of the venomous family of snakes called the Elapidae. But unlike death adders, tiger snakes, taipans, black snakes and brown snakes, this species is not considered dangerous due to its small size and inoffensive behaviour. It grows to a total length of about 50 centimetres.

White-crowned Snakes occur in woodlands and forests along the east coast of Australia from the vicinity of Townsville to north-eastern New South Wales. They are nocturnal and hence susceptible to nocturnal predators such as Cats. They feed primarily on day-active skinks, which they probably find sheltering beneath leaf litter.

Like the other three members of its genus, this species has an interesting threat display. When confronted by an intruder, the snake raises the front of its body vertically off the ground with the head at a right angle to the body and slowly sways. In dim light, the pale crown with its dark central area gives the appearance of a snake threatening with an open mouth. Unfortunately, this behaviour didn't work for your snake.

—Allen E. Greer
Australian Museum

The Trouble with Puggle

Q: *What do you call a baby echidna, a baby Platypus, or a baby monotreme?*

—Margot Craddock
Montrose, Vic.

A: 'Puggle' is a term that was first used to refer to echidna young by Peggy Rismiller, who studies the Short-beaked Echidna on Kangaroo Island. In fact, it's a term she used nearly 11 years ago in this magazine (*Nature Aust.* Spring 1993), two years after its debut in *Australasian Science Magazine*. In her 1999 book *The echidna: Australia's enigma*, she proposes that the term be used for baby monotremes in general (in other words, for the Platypus as well).

However, 'Puggle' is also the trademark name for a soft toy and series of children's books, registered by the Barber family, from Victoria, in 1979. The toy bears an uncanny resemblance to a baby echidna. There has been some confusion about whether the proposed name for baby echidnas came from the toy, or whether it was independently derived. Either way, the facts are this: the Barber family was the first to use the name and, since then, it has been used to refer to baby echidnas.

And the Platypus? In 1998 Brisbane's

A baby Short-beaked Echidna (*Tachyglossus aculeatus*).

D. PARER & E. PARER-COOK/AUSTRALIAN

Gap Community Kindergarten wrote to the Australian Museum, proposing the name 'plateena' (based on a combination of 'platypus', and 'pateenah', which is a Tasmanian Aboriginal name for egg). A note about it was written the following year in *Australian Geographic* (July–September 1999). In March 2003 the *Sydney Morning Herald* ran a story on the birth of Platypus twins at Taronga Zoo and referred to them generically as 'puggles'. As far as I know, though, 'plateena' is the only name that has been proposed specifically for a baby Platypus.

If you speak to monotreme workers, most prefer not to give special names to the young of echidnas or the Platypus. Call them 'nestlings' when they are in the nest, or 'pouch young' when they are in the pouch, they say. One of the organisers of the Monotreme Symposium, held in Sydney in July 2003, went so far as to declare the meeting a 'puggle-free zone'!

But language, like the Platypus and echidnas, is an evolving thing. And if the words 'puggle' and 'plateena' are used often enough, they will eventually become absorbed into the lexicon. Indeed, the editors of the next (fourth) edition of *The Macquarie Dictionary* already have plans to include the word 'puggle'. Apparently they will cite the registered trademark of the soft toy as the derivation. As for its definition—well, they haven't decided whether it will be the name for a baby echidna, or the name for baby monotremes in general. At this stage echidnas look set to win the label, but this may well change further down the track.

—G.H.

Answers to Quiz in Nature Strips (page 20)

1. *Cutworms* **2.** *Germany* **3.** *Spear-throwing device* **4.** *Groote Eylandt* **5.** *National Aeronautics and Space Administration* **6.** *Two* **7.** *Frilled Lizard* **8.** *Burrowing Bettong* **9.** *Bonobo* **10.** *1080 ('ten-eighty')*

JOHN FIELDS/NATURE FOCUS

Pic Teaser

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, *Nature Australia* Magazine. Please don't forget to include your name and address. The first correct entry will win a copy of *Famous Australian birds*. Spring's Pic Teaser was a toad bug (*Nerthra* sp.).

Bring back the devil?

We predict that introduction of the Devil will suppress Fox numbers through competition and direct predation.

ABOUT 430 YEARS AGO, THE Tasmanian Devil became extinct on mainland Australia and can now only be found in the southernmost State. Conventional wisdom has it that the Dingo drove the Devil from the mainland, as well as its now fully deceased cousin the Thylacine. Equally plausible, though, is the idea that improved Aboriginal technologies and population expansion at around the same time that Dingoes were introduced (4,000 years ago) led to increased predation on Thylacines and Devils. But whether Dingoes, or Aborigines leading traditional lifestyles, were responsible, neither are now present in most of south-eastern Australia. European Australians got rid of them both. Consequently, there is a *prima facie* case for the reintroduction of Thylacines and Devils. Of course, this is impossible for the extinct Thylacine, but not so for the Devil.

Reintroduction, like extinction, can have unforeseen consequences and before proceeding we would need vigorous debate backed up by sound empirical analysis. The problem is that European Australians have forced a new equilibrium on the Australian fauna and for many species the balance is precarious. Adding a new player will affect this balance, conceivably sending other species into the abyss. However, in this case, we predict that the addition of another carnivore to the Australian mainland will reduce overall predation on endangered species, counterintuitive though this may seem.

Our argument is founded on the concept of 'meso-predator' release. Removing the top predator from a system relaxes pressure on the next largest (the 'meso' or middle predator), allowing it to increase in abundance. Because the preferred prey of this predator never exactly fits the profile of the one that was removed, the affects on prey species will be asymmetrical. A classic example of meso-predator release is that of the Dingo and the Fox.

Removing the Dingo from much of Australia has benefited the Fox, and the overall environmental impact may have been detrimental. The reasons are twofold. Although the Dingo's diet is flexible, it typically takes larger prey than the Fox. Thus, the two can coexist, but in addition to suppressing Fox numbers through competition, Dingoes are likely to kill Foxes where they encounter them. A balance is struck, with Dingoes favouring larger prey, Foxes taking smaller fare. When Dingoes are taken out of the equation, pressure on larger prey, such as big kangaroos, is relaxed. However, predation on smaller species will soon increase as Fox numbers rise. In addition to increased top-down pressure through Fox predation, smaller species are squeezed bottom-up, as growing numbers of large kangaroos eat into their resource base. Semantic debate over whether the Dingo is 'native' aside, its persecution may have done more harm than good, and further moves against it should be considered in this broader context. Certainly, many ecologists see the Fox as feral enemy number one for Australia's native mammals.

But what happens if, instead of removing the top predator, we add one? Enter the Devil. While the Devil is more dependent on carrion than the Fox, their niches overlap. We predict that introduction of the Devil will suppress Fox numbers through competition and also direct predation of Fox cubs in the den, thereby reducing the overall impact on Australia's most vulnerable species. The most important factor in determining the outcome of encounters between predatory mammals is size. Devils are twice the body mass of Foxes and vastly more powerful where it counts—the jaws. Our hypothesis is that the Devil will reduce Fox populations, but because Devils are less efficient predators, the total impact on small species will decline.

Are we sure that bringing back the Devil will help shift the balance in favour of our most vulnerable species? No. Reintroduction cannot proceed without robust experimental support. Devil–Fox interactions must first be examined within enclosed areas. Even then it might be argued that, because each community is unique, demonstrating that Devil reintroduction may be beneficial in one part of Australia is no guarantee it will not impact adversely in other regions. Whatever the outcome of such experiments, they will lead to deeper insight into the ecology of both Devils and Foxes. In light of the recent, potentially catastrophic introduction of the Fox to Tasmania, as well as the ongoing trauma inflicted by this depressingly adaptable pest to mainland endemics, this is insight well worth having. □

FURTHER READING

Johnson, C. & Wroe, S. (in press). Causes of extinction of vertebrates during the Holocene of mainland Australia: arrival of the dingo, or human impact? The Holocene.

DR STEPHEN WROE IS A PALAEONTOLOGIST AT THE UNIVERSITY OF SYDNEY. DR CHRISTOPHER JOHNSON LECTURES IN TERRESTRIAL ECOLOGY AT JAMES COOK UNIVERSITY.

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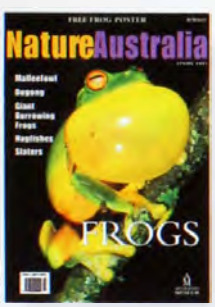

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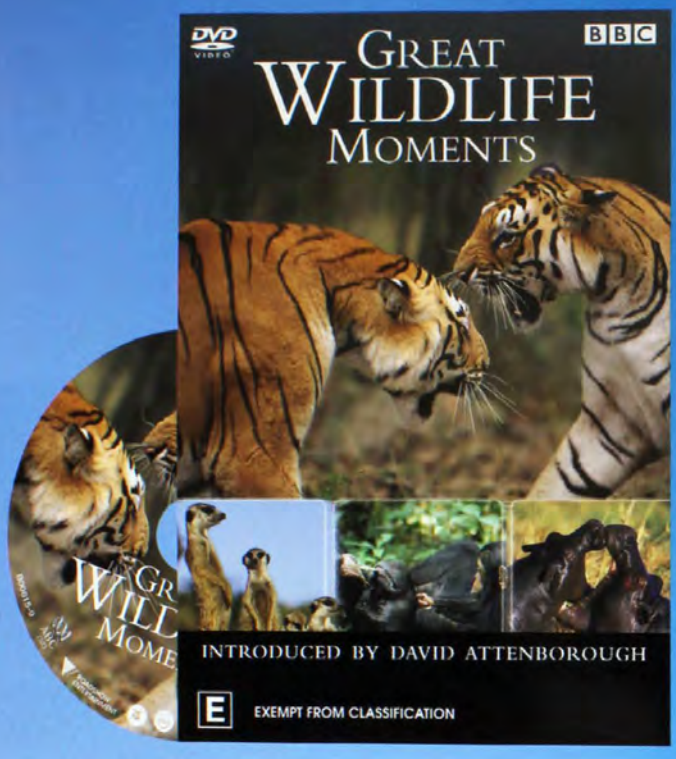

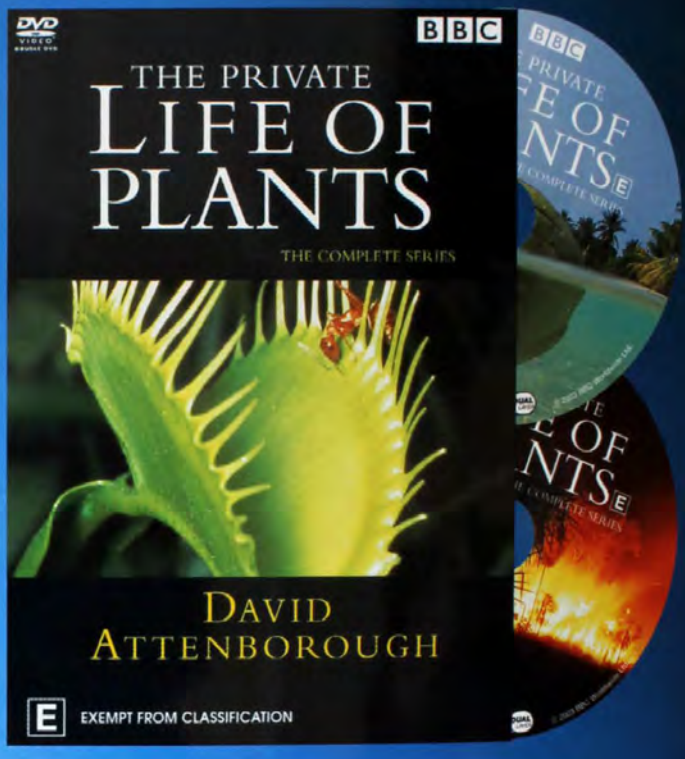

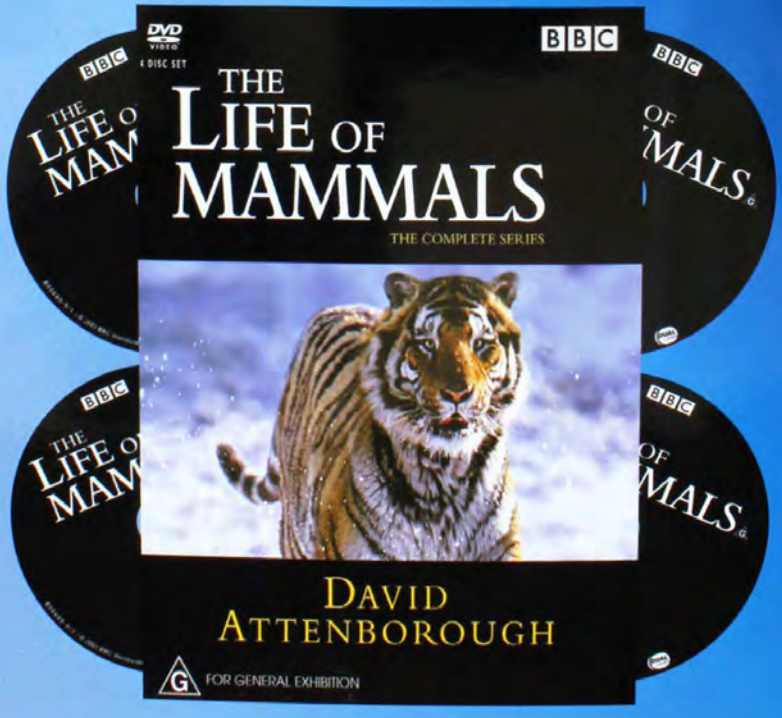

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