FREE POSSUM POSTER

Nature Australia

WHITLEY AWARD WINNER 2002

SPRING 2002
$9.50 INC GST

Mountain Brushtails
Beaked Whales
Fire Ants
Goannas

FAIRY-WRENS

ISSN 1324-2598

AUSTRALIAN MUSEUM 175 YEARS

NatureAustralia

SPRING 2002 Volume 27 Number 6

Published by the Australian Museum Trust
6 College Street,
Sydney, NSW 2010
Phone: (02) 9320 6000
Fax: (02) 9320 6073
Web: www.natureaustraliamagazine.com.au
Trust President: Brian Sherman
Museum Director: Michael Archer

Publishing Manager
JENNIFER SAUNDERS, B.SC.
email: jennys@austmus.gov.au

Editor
GEORGINA HICKEY, B.SC.
email: georgieh@bigpond.com

Photo Editor
KATE LOWE
email: klowe@austmus.gov.au

Design & Production
WATCH THIS! DESIGN

Advertising
KEH HILL/BUSINESS MAGAZINES
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 Mockridge Bulmer

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.

Published 2002 ISSN–1324–2598

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

FRONT COVER
Female Superb Fairy-wrens go to great lengths when it comes to choosing a father for their young. Just before they lay eggs they take off under the cover of darkness to visit their chosen male, returning home well before sunrise. Photo by Daniel Ebert.

up front

Celebrations are in order as *Nature Australia* has just received the Whitley Award for Best Zoological Periodical (2002) from the Royal Zoological Society of New South Wales.

First presented in 1979, these awards recognise outstanding publications that contain significant amounts of information relating to the fauna of the Australasian Region. Each year a committee consisting of both academics and non-academics is formed to review all the entries and recommend the assignment of awards in the various categories. For a publication to be successful in the Whitley Awards, it must either make a significant contribution of new information, or present a new synthesis of existing information. Evidence of excellence is sought mainly in the text but illustrations are taken into consideration, as well as standard of design, presentation and production.

It's especially satisfying for the Australian Museum to win this award as the Whitleys are a tribute to Gilbert Whitley, an eminent Australian ichthyologist who joined the Museum in 1922 as an illustrator and assistant. In 1925 he was appointed as the Museum's Ichthyologist, a position he held until his retirement in 1964. Whitley was instrumental in building the Australian Museum's Ichthyology collection and a produced an exceptional body of publishing, illustrative and scientific work.


GUNTHER SCHMIDA, NATURE FOCUS

Northern Banjo Frogs spawning.

In keeping with our ongoing efforts to provide you with the best nature magazine in Australia, we have introduced a new regular feature that highlights what's going on around you in the natural world each season. In this issue, Spring, we focus on the Common Koel, frog spawning and the conundrum of matching caterpillars with butterflies and moths. Also in this issue we meet the marine master of mimicry, the 'other' brushtail possum and an ant that is set to become an eco-terrorist.

— JENNIFER SAUNDERS
Publishing Manager

contents

ARTICLES

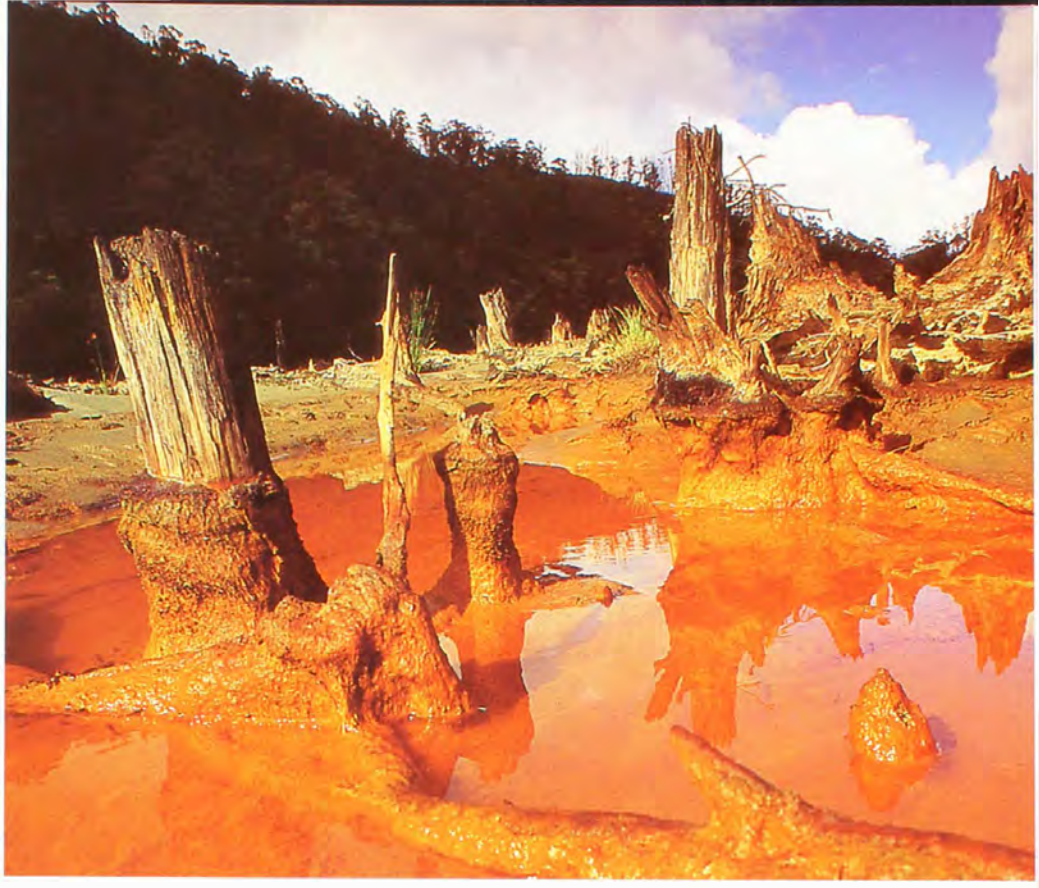
The Burden of Beauty
Bright and blue, and oh so sexy, male Superb Fairy-wrens pay a price for their good looks.
BY ANNE PETERS
30

The Other Brushtail Possum
Few people will have heard of, let alone seen, a Mountain Brushtail Possum. Here's your chance to get to know this feisty, charismatic creature.
BY KAREN VIGGERS & DAVID LINDENMAYER
46

Ant Wars
They destroy the family picnic, kill livestock and native fauna, start fires and send house prices plummeting—they are Red Imported Fire Ants—eco-villains extraordinaire.
BY TIM LOW
54

Bare Bones & Beaked Whales
Longman's Beaked Whale may be the least known whale species in the world. But a recent DNA analysis suggests the reason could simply be one of misidentification mistaken identity.
BY MEREL DALEBOUT
62

Masters of Mimicry
Forget chameleons, stick insects and anglerfishes because, when it comes to mimicry, the Mimic Octopus beats them all.
BY MARK NORMAN
38



REGULAR FEATURES

THE BACKYARD NATURALIST

Goannas, First-class Monitors

Goannas, once famous for their fake dinosaur movie roles, are world-class wrestlers with an indiscriminate appetite for flesh.

BY STEVE VAN DYCK

24

RARE & ENDANGERED

Green Sawfish

Its tropical muddy habitat, natural rarity and declining numbers mean that few people will ever get to see a Green Sawfish in the wild.

BY JOHN POGONOSKI

26

WILD THINGS

Wattle Become of Acacia?

Australia looks set to lose most of its wattles, thanks to a carve-up of the genus *Acacia*.

BY TIM LOW

28

PHOTOART

Pictures that Bite

These images are sure to make us stop and think.

BY REG MORRISON

72

SECRET LIFE OF PLANTS

After Dark

What do plants get up to after dark? For some, night-time means party-time!

BY TIM ENTWISLE

76

THE LAST WORD

The End of Natural Evolution

Human influences can alter the way a species evolves. But does it really matter?

BY ALLEN E. GREER

84

COLUMNS

1 Up front

4 Letters

6 Spring

8 Nature strips
News of the latest discoveries of our natural world.

78 Reviews

81 Society page
Clubs and societies around Australia.

82 Q & A
Your questions answered.

letters

Barred Frog Record

I have just read Frank Lemckert's article on the Giant Barred Frog (*Nature Aust.* Autumn 2002) and learnt with some dismay that this frog is believed to be extinct in the Blue Mountains. However, I have a photograph (submitted) of a frog that looks remarkably like the Giant Barred Frogs pictured in the article, which I took in January this year on a walking track near Victoria Falls. Perhaps the frog has not entirely disappeared from the area?

—Michael Dear
Blackheath, NSW

*The frog in the photo was not actually a Giant Barred Frog (*Mixophyes iteratus*), but the closely related Southern Barred Frog (*M. balbus*). This species has also suffered major declines and has disappeared from just about all of the Blue Mountains. As far as I know, this record is probably the first confirmed sighting of a Southern Barred Frog in the Victoria Falls area and the Gross River Catchment for at least 20 years. It is great to know that they are still there. This is a very important record and I am pleased my article helped to unearth it.*

—Frank Lemckert
State Forests of NSW

Sacred Owl

In the interesting article by Steve Van Dyck (*Nature Aust.* Autumn 2002) it is asserted that the Barn Owl (*Tyto alba*) was significant to the Greeks and Romans and to the goddess Minerva. The owl in question is in fact the Little Owl (*Athene noctua*), which was sacred to Athene, not Minerva.

—Des Griffin
Sydney, NSW

Premature Deliveries

Eric Dorfman's explanation for the origin of the story of storks' bringing Dutch babies (*Nature Aust.* Autumn 2002) raised my eyebrows. He writes that people 'cuddle' in winter and suffer parturition in spring. That much difference in gestation ought to define a different species!

—Des Petersen
Dalby, Qld

It is true. I did say the birds arrived in the Netherlands in early spring, and herein lies the problem. The storks are actually summer visitors. According to D. Hartley in Lost country life *(Pantheon Books, 1979), farmers would start to spend more time indoors from about November, when the days were getting shorter. "[The] mediaeval labourer, up at daylight and working on the land for as long as he could see, needed no candle—he went to bed." Based on this calendar, babies would have been on the rise somewhere between July and August, at a time when the storks were building nests and raising their young.*

—Eric Dorfman
Wellington Conservancy, NZ

Field Moles

Letter-writer Pat Lowe (*Nature Aust.* Spring 2001) may be pleased to know that there is in fact a study under way on marsupial moles in the field. In this collaborative research project involving the South Australian Department of Environment and Heritage and Anangu-Pitjantjatjara Land Management, we are combining the expertise of traditional owners with scientific techniques in an effort to learn about the ecology of the Itjaritjari or Southern Marsupial Mole (*Notoryctes typhlops*). Anangu elders have generously shared their knowledge of these animals, taken us to areas where Itjaritjari are still relatively common, and taught us to recognise the often-subtle signs of the

DAVE WATTS/NATURE FOCUS

The Barn owl (*Tyto alba*).

Nature Australia **requests letters be limited to 250 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** *Open air essays*. **The winner this issue is Michael Dear.**

The Southern Barred Frog—alive and well in the Blue Mountains.

animals' presence.

We use a range of techniques to examine their distribution and abundance, habitat preferences, vulnerability to predators, and behaviour. While some of this work involves searching for signs of the animals on the surface, we are also investigating the underground world of Itjaritjari. We do this by digging trenches and searching for signs of an animal's tunnels which, although sand-filled, are recognisable and persist within the sand structure for months or even years.

Thompson *et al.* (*Nature Aust.* Summer 2000–2001) were correct in predicting that geophones (seismic sensors) will be useful in the studies of marsupial moles, and we have been utilising this technology for the past two years. So far, we have obtained signature sounds of the animals digging and have monitored their activity cycles underground. We hope to use geophone technology to automatically track the animals and in this way learn about their behaviour in detail, and without interfering with them in any way.

This project is labour-intensive and we are fortunate to have the support and involvement of Earthwatch volunteers.

—Joe Benshemesh
Alphington, Vic.

Social Climbing Wagtail

Last summer, we were honoured to have a pair of Willie Wagtails raise a brood in the backyard. The nest was about six metres up a gum tree, so we hoisted an extension ladder up to a nearby, large branch to enable us to observe the nest. Over the next week or so, various members of our household made the trip up the ladder. And then, somewhat surprisingly, one of the parent birds 'climbed' the ladder in much the same way as we humans did. He (or she; I couldn't tell them apart) hopped from the ground to the first rung of the ladder, then proceeded to hop from rung to rung towards the top, before flying the rest of the way to the nest! I hope some of your readers find this of interest.

—Brian Ward
Douglas Park, NSW

Spring

Compiled by Geordie Torr and Martyn Robinson

Male (above) and female (right) Common Koel.

The sound of spring

From a distance, the 'coo-ee' or 'ko-el' call of the Common Koel (*Eudynamys scolopacea*) has a lovely haunting quality. Just pray you don't hear it coming from your own backyard. One of spring's more vocal harbingers, this migratory bird regularly drives humans to distraction with its loud and persistent call.

Each year, around September, the Common Koel returns to northern and eastern Australia from New Guinea and beyond. More often heard than seen, it's the male that does all the 'coo-ee'ing. He calls to let other males know that the area is occupied and to attract females.

One way to get a look at this secretive bird is to let loose with your own impression of the call. If your impersonation skills are good enough, the resident male will come looking for the rival. For those of you who live outside the Common Koel's range and are curious to hear its call, visit the ABC's Backyard Birdwatch website (www2.abc.net.au/science/birds/default.htm).

The Common Koel's lack of popularity extends to other birds, but in this case it's because of its parental strategy, rather than its call. It's a type of cuckoo, with the female laying her eggs in the nests of medium-sized birds such as the Magpie-lark and Red Wattlebird. The male's calls may also help the female get away with this, by distracting the hosts. While they're off chasing the male, the female can sneak into the nest and lay her eggs unhindered. Exploiting this behaviour is another way to see a Common Koel—when you hear a male call, look out for a mob of birds in pursuit and chances are they'll be heading straight for the Koel.

The caterpillar conundrum

Don't look now, but a ravenous horde is about to descend upon your garden. All around the country, caterpillars are hatching out of eggs laid last autumn or at the start of the warmer weather.

Many caterpillars are difficult to identify beyond the family level because often we simply do not know which squishy, leaf-munching grub will transform into which graceful butterfly or moth. Generally speaking, however, if the caterpillar has a spike on its tail then it's probably going to become a hawk moth (family Sphingidae); if it's very hairy, it's probably one of the 'woolly bears' (Anthelidae); and if it's a 'looper' or 'inchworm'

From the collection

This is the earliest collected specimen of a Bogong Moth (Agrotis infusa) in the Australian Museum's collection. It comes from Manly, New South Wales, and is thought to have been collected in 1903. Unfortunately the original label is a bit indistinct—it could read 1903 or 1905—and there is no collector's name. Bogong Moths are famous for their southerly spring migration, which takes them from their breeding grounds on the western plains (as far as the Darling Downs, Queensland) to the cool alpine regions of the Great Dividing Range. Sometimes westerly winds blow them farther east, where they are attracted to the lights of the big cities. Those that manage to complete the journey head for caves and crevices in the Alps, where they rest in their hundreds of thousands from November to March. There they escape the summer heat, but not the numerous predators that rely on this annual bounty of fat and protein. In autumn, the surviving moths migrate back to the plains, a staggering round trip of up to 3,000 kilometres.

Caterpiller and adult of the Dingy Swallowtail Butterfly (*Papilio anactus*).

then it will probably turn into a flattened, camouflaged moth from the family Geometridae.

A good resource for identifying caterpillars is located at **www-staff.mcs.uts.edu.au/~don/larvae/larvae.html**. There you'll find photos of a variety of caterpillars and the butterflies or moths (lepidopterans) they will become, together with lists of the caterpillars' known food plants.

The caterpillar–moth/butterfly conundrum offers amateur naturalists a great opportunity to contribute to science. By taking 'before-and-after' shots of any unidentified caterpillar you find, and noting what it's eating, you can add to the body of lepidopteran lore.

Calling all froggers

Warm nights + spring rains = amorous amphibians. Most of Australia's frogs breed in spring and summer, so chances are, if you live near a creek or pond, your nights will soon be filled with the frantic croaking of male frogs calling their lungs out for a mate.

Among the few frogs to leave behind conspicuous egg masses are the 12 species of *Limnodynastes*. Typically breeding in still water, they lay their eggs, which can number in the thousands, in floating foam nests. By paddling with her front legs, the female pushes bubbles underneath her body and past her cloaca, where they become trapped in the egg-and-jelly mixture she produces. The resultant 'life-raft' helps protect the eggs from aquatic predators. It may also provide them with a ready supply of oxygen, while at the same time keeping them in the warm surface water, where they develop more quickly.

A great time to learn more about your local frogs is Frog Week, held each year in the first week of November. Most States have resident frog study groups that are open to anyone with an interest in amphibians, and many hold special Frog Week events each year. Visit the WWF Frogs! Program website **(www.frogs.wwf.org.au)** for contact details for most of the frog societies around Australia, a calendar of frog-related events, a list of frog field guides and loads more fascinating stuff.

Conspicuous spawners: Northern Banjo Frogs (*Limnodynastes terraereginae*).

***Frog Week*, held each year in the first week of November, is a great time to learn more about your local frogs.**

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

nature strips

COMPILED BY GEORGINA HICKEY

RICHARD FULLAGAR, KARINA HOLDEN, MICHAEL LEE, KAREN MCGHEE, MICHAEL MCLEAN, STEVEN SALISBURY, RACHEL SULLIVAN, ABBIE THOMAS AND GEORDIE TORR ARE REGULAR CONTRIBUTORS TO **NATURE STRIPS**.

Bluffing Deer

Did male competition among our prehistoric ancestors help lead to the development of modern human speech? That's the intriguing question now posed by the discovery that the human voice box, or larynx, isn't as anatomically unusual as scientists once believed.

Adult humans have what's known as a 'descended' larynx. Rather than sitting up high in the oral cavity, it 'drops' when we're babies and in boys descends even farther during puberty. This creates a relatively long vocal tract. Its development is thought to have been critical in the evolution of complex speech and has been traditionally considered uniquely human.

But Tecumseh Fitch (Harvard University) and David Reby (Large Mammals Research Institute in Castanet, France) recently reported that the males of at least two species of deer—Red Deer (*Cervus elaphus*) and Fallow Deer (*Dama dama*)—also have descended larynxes. Although it now seems this feature evolved independently more than once, the researchers believe the driving force behind it may have been similar for both deer and humans.

Each autumn during the mating season, Red and Fallow Deer stags advertise their status with low-pitched, low-frequency bellows during which they drop their larynxes below their already-descended resting positions, temporarily extending their vocal tracts even farther. In vertebrates, longer vocal tracts are usually associated with bigger body size. Fitch and Reby believe male Red and Fallow Deer drop their larynxes to create sounds that indicate their vocal tracts are longer than they

Humans aren't the only animals with descended larynxes. Red Deer stags have them too.

really are, thereby bluffing would-be competitors into believing their bodies are also larger.

Similar tactics, the researchers suggest, may have been important among early human males.

—K.McG.

Crossing the Line

In the natural world, when it comes to mating, animals tend to stick to their own kind. Crossbreeding with the wrong species can be a dead-end business, either because the mating will be unproductive or the offspring sterile. Yet for the female Collared Flycatcher (*Ficedula albicollis*), a male of the *wrong* species might actually be the right choice.

Collared Flycatchers overlap with Pied Flycatchers (*Ficedula hypoleuca*) in the forests of central Europe and Sweden. Thor Veen (Uppsala University, Sweden), Ben Sheldon (Oxford University) and colleagues have been investigating the peculiar pairings and have found there's a pay-off for females that look beyond their own species for a mate.

Although Collared Flycatchers make up to 95 per cent of the population in the hybrid zones, females may still choose a Pied Flycatcher despite the availability of their own kind. What's more, an increasing number of females will cross the line towards the end of the breeding season to pair with the other species. The researchers suggest this is because Pied Flycatchers inhabit the more desirable territories during this time of year. Consequently hybrid pairs have more surviving offspring than same-species pairs.

GREG HAROLD/ALSC.APP

Eastern Blue-tongued Lizards lap up life in the suburbs.

Lounge Lizards

Urbanisation is a dramatic imposition on any natural environment. Destruction of habitat, the construction of roads and buildings, and the fragmentation of the remaining bushland have caused the disappearance of most native vertebrates in and around Australian cities. But Eastern Blue-tongued Lizards (*Tiliqua scincoides*) offer a striking exception to this rule. Not only have they survived the relentless march of suburbia, they actually seem to prefer it.

Jennifer Koenig and colleagues from the University of Sydney tracked 17 blue-tongues with radio transmitters around the suburban 'wilderness' of north-western Sydney. They also monitored body temperature, and recorded feeding habits and behaviour.

They found the lizards actively utilised the human-modified habitats in preference to the remnant patches of less disturbed areas. They especially liked the gardens. One reason for this preference may be the abundance of food (fruit, fungi, snails and insects) commonly found in many backyards.

Another reason for their ability to persist in suburbia may be their stubborn tendency to stick with certain 'safe' locations. The lizards were found to repeatedly visit a small number of shelters within their home range, spending over 70 per cent of their time in shelters such as drainage pipes or old wood piles. Pregnant females were particularly sedentary and, while males had much larger home ranges, they tended to stick to vegetation corridors (such as along fence lines) and consistently avoided roads when moving between sites.

Conveniently, the blue-tongues' daily pattern of activity showed very little overlap with that of humans. Lizards were most active in the late morning and early afternoon, when most of the residents were at work having their morning or afternoon tea break.

—M.McL.

COURTESY ANDREW PARKER

Desert-dwelling farmers may take a tip from this African beetle (*Stenocara* sp.).

But it's not all happy families. In fact, the daughters of hybrid pairs are born sterile. The male offspring, however, are fertile and make up the majority (65 per cent) of all hybrid chicks. Veen and colleagues suggest the female may manipulate the sex ratio by producing more males to increase the survival of her genes into the next generation. It seems she is also manipulating the male she nests with, as genetic studies reveal more than half the offspring raised by mixed pairs are actually pure-bred Collared Flycatchers. While some flycatchers appear to be carrying on with liberal interspecies relationships, most of the females are merely social parasites, forcing the chicks of not only another male but also a male of another species onto their witless mate.

—K.H.

Water-harvesting Beetle

How can farmers living in the Namib and other deserts obtain water for drinking and irrigation? Simple, just follow the example of their beetles. The answer, quite literally, is blowing in the wind.

The Namib Desert along the south-western coast of Africa supports a unique sand-dune fauna. High winds blow across the hot surface, and there are occasional dense, early-morning fogs. One species of beetle (*Stenocara* sp.) has evolved a remarkable strategy to extract water from these fog-laden winds.

The beetles are black, have almost spherical bodies around two centimetres across, and support themselves on thin, stilt-like legs. Most noticeably, their bodies are covered in small bumps, about half a millimetre in diameter. When Chris Lawrence (QinetiQ, UK) and I looked at the beetles' cuticles through an electron microscope, we found tiny, rounded nodules, just ten microns in size, arranged in a close-packed hexagonal pattern. These covered the sides and valleys (but not the tops) of the larger bumps, or 'mountains' as they appeared under the microscope. The nodules were also coated in water-repellent wax, while the 'mountain peaks' were wax-free. It was the combination of both surface types that gave the beetles their ability to drink in the Namib.

We made a simple model of the surface of *Stenocara* by coating a glass microscope slide in wax. Then we partially embedded tiny glass beads, about the size of the beetle bumps, into the wax. We lined up alternative models next to the *Stenocara* slide before tilting them all and spraying them with a fine mist. When the mist hit a plain glass slide, the minute droplets formed a single, flat covering of water, which evaporated under heat or streamed off the slide in an unpredictable direction. Landing on a slide with a wax surface, the droplets remained minute and were simply blown away in all directions. But large drops formed immediately on the *Stenocara* model, and rolled directly into the collector at the base of the slide.

The *Stenocara* beetle has evolved a droplet-growing system. It tilts its body (bum up, if you like) into the fog-laden wind and minute

2001 FLAT POSTER COLLECTION

The 2001 collection of *Nature Australia* posters is now available for the discounted price of $12.00 (including postage, handling and GST). These posters do not have any folds and are mailed to you in a rigid cardboard mailing tube ready for framing.

If you would like to purchase this Limited Edition set or any of the posters individually, just fill out the form in the back of this issue.

The Limited Edition 2001 Poster Collection includes: the Red-eyed Tree Frog, Eclectus Parrot, Yellow-footed Antechinus and the Giant Bear Cuscus.

water droplets are repelled from the mountain sides and troughs towards the peaks, where they soon become large drops. At around five millimetres in diameter they roll down the beetle's back towards its mouth. At this size the drops remain stable in a strong wind, and are not blown off the beetle.

Our project, while revealing some interesting biology, led us to create a simple model of the beetle's surface that can efficiently collect water from rapid mists. The current method of collecting water from deserts with wind-blown fogs relies on vertically suspended nets. A square metre of netting can collect 5–13 litres of water for drinking and irrigation each day. However, a similar-sized sheet with the *Stenocara* surface moulded into it collects several times more water and is also more resilient. Our long-term goal is to employ the fog-collecting device on tents and on the roofs of buildings. Hopefully these will greatly aid farming in inhospitable regions of the world. The range of other possible applications is limitless.

—Andrew Parker
Oxford University, UK

False Dental Records

Enamel is the hardest known biological material and, accordingly, teeth are one of the most common body parts fossilised and studied by palaeontologists. Indeed, mammalian evolutionary trees were once described as "teeth giving rise to other teeth". Recent research, however, casts doubt on the reliability of teeth for inferring biological history.

Gavin Naylor and Dean Adams (Iowa State University) examined the evidence for the origin of whales. This is a classic case of what biologists call 'data incongruence', with genetic evidence strongly suggesting that whales are related to hippos, but anatomical evidence instead allying whales with mesonychians, a group of bizarre, extinct mammals that resembled carnivorous moose (see "The Way to a Whale", *Nature Aust.* Summer 1999–2000). After examining the anatomical evidence closely, however, these workers discovered that not all the anatomy conflicts with the genetics. The teeth strongly place whales with mesonychians but the rest of the anatomical evidence supports (albeit weakly) the genetic conclusion of a whale–hippo grouping. Naylor and Adams concluded that whales are indeed related to hippos and that teeth alone are painting a misleading picture due to evolutionary lability and convergence.

This view has been reinforced most recently by discoveries of primitive

ILLUSTRATION BY JOHN KLAUSMEYER

Reconstruction of the primitive semi-aquatic whale *Rodhocetus*, based on 47-million-year-old fossils from Pakistan.

Eocene fossil whales from Pakistan. Hans Thewissen (Northeastern Ohio Universities College of Medicine) and colleagues have uncovered disarticulated bones of *Pakicetus* and *Ichthyolestes*, and reconstructed them as terrestrial mammals with long legs adapted for running. Based on even better, articulated skeletons, Philip Gingerich (University of Michigan) and colleagues described *Artiocetus* and *Rodhocetus*, semi-aquatic whales that looked and behaved something like living sea lions. These archaic whales possess limbs very different from those of mesonychians (which dentition suggested might be whale ancestors), but very similar to those of artiodactyls, the group of hoofed animals that includes hippos.

The apparent unreliability of dental evidence for inferring relationships is sobering, considering much palaeontological dogma comes from research performed decades ago and often based largely on teeth. It will certainly give skeptics something to chew on.

—M.L.

Baby Behemoths

In 1997, a team of palaeontologists discovered a dinosaurian maternity ward in the badlands of Patagonia. Tens of thousands of eggs, each about the size of a grapefruit, were scattered over an area of about 1.5 square kilometres. The 80-million-year-old site, described by Luis Chiappe (Natural History Museum of Los Angeles County) and colleagues, remains the largest dinosaur nesting ground ever found.

COURTESY LUIS CHIAPPE

An exquisitely preserved skull (facing left) found inside the egg of a sauropod dinosaur.

At first it was unclear what type of dinosaur laid the eggs. The skeletons of unhatched dinosaurs are poorly calcified and decompose rapidly soon after the embryos die. Although some of the eggs had traces of embryonic skin adhering to the inside of the shell, no bones could be found. Finally, after hundreds of hours of painstaking preparatory work, miniature teeth were found inside one of the eggs.

Fire First

It is hard to imagine people living without fire. The use of fire seems as human as language and its origins have been almost as difficult to trace archaeologically. There has been heated debate on just when human ancestors first made or utilised fire.

Ralph Rowlett (University of Missouri) has recently documented the earliest known evidence for fire, in the 1.6-million-year-old Koobi Fora deposits in Kenya. These are associated with the archaeological remains of early humans (*Homo erectus/ergaster*). But were these fires lit by natural causes or by the human occupants of the site?

The evidence comes in the form of about 20 reddish patches, each about 50 centimetres in diameter with a smooth, basin-shaped cross-section. After eliminating fungi or iron particles as the cause for the discolouration, Rowlett measured the heat energy (thermoluminescence) of the sediments and showed that the patches had indeed been heated more than the surrounding ground, and up to 400° C, confirming burning as the cause but ruling out sweeping bushfires. Lightning strikes also could not have been to blame, as they tend to burn much hotter and form only very small patches. Burnt tree stumps were eliminated as well because they leave irregular-shaped pits where the fire burns into lower roots. Furthermore, Rowlett found a variety of distinctive plant microfossils called phytoliths in most of the patches, implying that several species of wood were burnt, as is usual for a campfire, not just a single stump.

And what were the first fires used for? Most likely they were used for warmth, protection from animals, and/or cooking (see "What's Cooking?", *Nature Aust.* Autumn 2000). But whether humans 1.6 million years ago had the technology or know-how to actually make fire themselves, or whether they simply 'harvested' fire from natural sources, remains a hot topic of current research.

—R.F.

Archaeological evidence shows that early humans have been controlling fire for over 1.6 million years.

The chisel-like nature of the teeth suggested they belonged to titanosaurs, a group of Cretaceous sauropods that included behemoths such as the 35-metre *Argentinosaurus*.

Most recently, Chiappe *et al.* have reported finding exquisitely preserved skulls in six of the eggs, confirming the identity of the embryos. This latest discovery has catapulted titanosaurs to the centre-stage of dinosaur palaeobiology, since much about their growth and social and reproductive behaviour can now be studied.

Some of Queensland's sauropods were similar to many of the South American titanosaurs, and lived in comparable environments. Although no eggs have yet been found, it's tempting to think that the floodplains of ancient Queensland also played host to enormous colonies of nesting giants.

—S.S.

GREG HARRIOTT, MUSEUM

The live-bearing water skink *Eulamprus tympanum* uses temperature to determine the sex of its babies.

Mother's Choice

Should parents be allowed to choose the sex of their children? As bioethicists tussle with this vexed question, it seems that some lizards may already be doing so.

In many vertebrates, sex is determined genetically at the time of fertilisation. In some reptiles, on the other hand, sex is determined by the temperature at which the eggs are incubated. For many years, this so-called temperature-dependent sex determination or TSD was thought to be the domain of egg-layers (turtles, crocodiles and some lizards). So it came as a surprise to Kylie Robert and Michael Thompson (University of Sydney) when they discovered TSD in a live-bearing reptile—the water skink *Eulamprus tympanum*.

When the researchers brought pregnant females into the laboratory and maintained them at different temperatures, they discovered that as the temperature got warmer, the number of males increased, until by 32° C all of the babies were male.

Female live-bearing lizards are able to control the temperatures experienced by their developing young by moving between sun and shade. When combined with TSD, this would enable them to determine the sex ratio of their litter.

TSD could explain why *Eulamprus tympanum* is restricted to alpine areas—the warmer temperatures lower down could cause all-male clutches. It could also spell doom for the species if the predictions of temperature change due to the greenhouse effect are accurate. Without anywhere cooler to retreat to, they could find themselves rapidly running out of females...and a future.

—G.T.

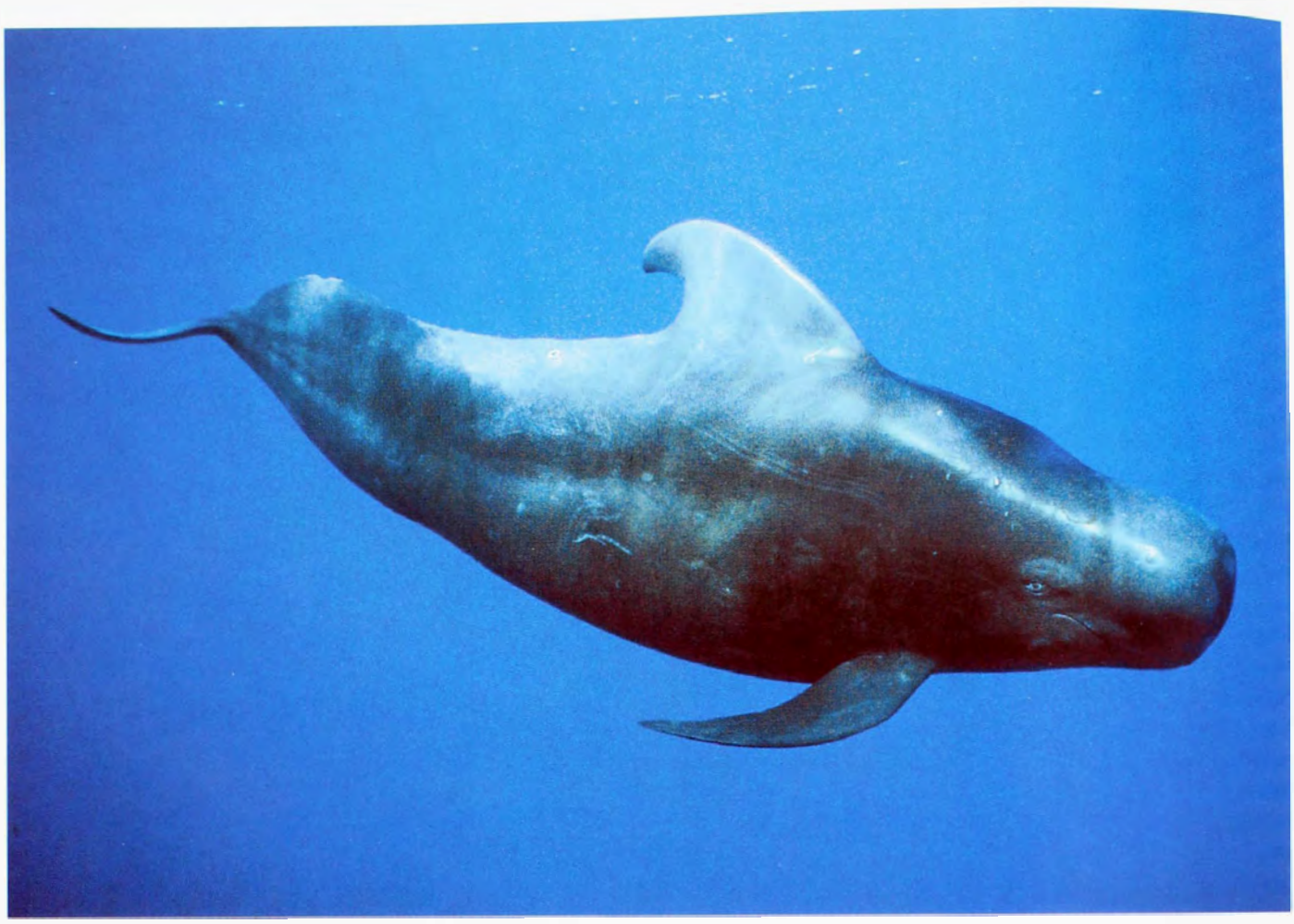
African elephants have been lumped together as one species even though differences are glaringly obvious.

Jumbo Jumble

Science has made a jumbo mistake. It now appears there are two (not one) species of African elephants—the Savanna Elephant and the Forest Elephant.

African elephants have always been lumped together as one species, *Loxodonta africana*, even though differences between them are glaringly obvious. Forest Elephants, which make up about a third of Africa's elephants, are much smaller in stature and have rounder ears and straighter, thinner tusks. Scientists have been arguing for generations as to whether they are distinct species, but only now with DNA testing can they prove how great the divide is.

Nicholas Georgiadis (Mpala Research Centre in Kenya) used a dart gun to extract a plug of skin from the hides of 195 elephants in 21 different populations. Study of the DNA, by Alfred Roca and colleagues



Odd as it may seem, whales such as the Short-finned Pilot Whale (*Globicephala macrorhynchus*) can't see blue.

at the National Cancer Institute in Maryland, revealed that Savanna and Forest Elephants are indeed genetically distinct. The differences between them are half as large as the differences between African Savanna Elephants and Asian Elephants (*Elephas maximus*). In fact, the two African elephants are as different as Lions and Tigers! In light of these discoveries, the Forest Elephant has been recognised as a separate species, *Loxodonta cyclotis*.

Yet with this news comes a warning. If Africa's elephants are made up of two different species, the plight of these majestic creatures is far more serious than previously thought. And until legislation is changed to include the new species under laws of protection, this inadvertent loophole leaves Forest Elephants particularly at risk.

—K.H.

Blue-blind Whales

Ocean water, although it appears clear, cuts out the longer (red) wavelengths of light the deeper you descend. This means that, below a certain point, everything you see looks pretty much all blue…unless you are a whale or seal. In a surprising twist of logic, whales and seals have been found to lack the ability to see blue—the colour most often associated with the sea.

Most land-dwelling mammals can see both long and short wavelengths of light (red through to blue), with the help of structures in the eye called L-cones and S-cones. But when Leo Peichl (Max Planck Institute for Brain Research) and colleagues examined seven whale and five seal species, they found only L-cones (green-to-red-sensitive) and no S-cones (blue-sensitive). Whales and seals, unlike their respective closest land relatives, are essentially colour-blind. And it appears that these two unrelated marine groups, in their return to the sea, independently lost their ability to see blue.

So why can't whales and seals see short-wave (blue) light, when they spend so much time foraging in an almost totally blue environment? The researchers suggest that, when early whales and seals moved from the land to the sea, they initially inhabited coastal, shallow waters, which would have been more turbid. In contrast to clear water, turbid water cuts out short-wave light with depth. In these conditions, the ability to see long-wave light (at the red end of the spectrum) would have been a real advantage and they may have gradually lost the ability to see blue. This may also have given them their intelligent edge, by freeing up parts of the brain for other complex sensory abilities. Whales and seals that have since exploited deeper waters may well like their 'blue' cones back. But it's pretty impossible, in evolutionary terms, to get back what you've given away.

—A.T.

Original Hippies

Many human cultures adorn themselves with

jewellery. But how, when and why this practice came about has been a mystery. Finds from the Middle East (western Asia) provide some insight.

Until recently, the oldest clearly recognisable ornaments that occurred in any abundance were 40,000-year-old beads from Africa and eastern Europe. However, Steven Kuhn (University of Arizona) and colleagues from Turkey and the USA have now analysed the excavated remains of seashell beads found in a coastal cave in Turkey and another site in Lebanon. The beads are distinguishable from the remains of meals by the presence of irregular punctures (not the perfect, bevelled holes that are often bored by predatory molluscs). They are also relatively small (7–18 millimetres), whole and wave-worn (indicating they were collected from a beach as empty shells, not live). These beads have been dated to at least 41,000 years, showing that they are as old as ornaments from Europe and Africa.

COURTESY STEVEN L. KUHN

Turkish beads: 1.5 centimetres long, perforated, and over 40,000 years old, these beads were made for talking!

The essentially simultaneous appearance of beads across three continents, the authors argue, might have something to say about human demographics at the time.

Beads, like other personal ornaments, convey social identity such as gender, age, and the type of people you hang out with (think of hippies). This highly visual sort of information would be useful in situations where one is more likely to meet strangers and may be why

© ANDREW HENLEY/CAMS

St Andrew's Cross Spider (*Argiope keyserlingii*). Does the 'cross' attract both prey and predators to the web?

people in higher-density areas tend to wear more jewellery. Kuhn and colleagues argue that the first widespread occurrence of beads around 40,000 years ago may indicate that previously isolated populations were expanding. The resulting increase in interaction of foreign cultures, the authors believe, would have required some sort of standardised form of long-distance visual communication. And beads, it seems, were it.

—R.E.

It Doesn't Always Pay to Advertise

Spiders are a bit like shopkeepers, waiting on their webs for the next 'customer' to arrive. Some spiders use advertising to draw in more customers, adding an extra silk structure known as a stabilimentum to their webs. Probably the best-known example in Australia is the 'cross' of the St Andrew's Cross Spider. The stabilimentum reflects UV light and apparently attracts more flying insects (see "Silky Lures", *Nature Aust.* Spring 1997). It may also advertise the web's presence to birds, preventing them from flying into it.

But if a stabilimentum attracts prey, couldn't it also attract predators that aren't afraid of webs? Wee Khee Seah and Daiqin Li (National University of Singapore) set out to test this possibility using the orb-weaver *Argiope versicolor*. This spider decorates its webs with one of at least five different types of stabilimenta, including discs and crosses. For their predator, the researchers chose *Portia labiata*, a jumping spider with acute vision that isn't afraid to climb onto webs and feed on other spiders.

The researchers found that when the jumping spiders were given a choice between webs with and without stabilimenta, they always went for the former, regardless of whether or not there was a spider on the web. And when given a choice between decorated webs with and without spiders, the predators showed no particular preference.

Each morning, when *Argiope versicolor* spins its new web, it incorporates a different stabilimentum to the one it used the day before. The researchers suggest this reduces the chance of predators learning to associate a particular pattern with a tasty orb-weaver.

—G.T.

Cackling Chooks

Anyone who has ever kept chooks will know that a loud, repetitive cackle signifies a freshly laid egg. But what possible purpose might this distinctive call serve? Perhaps the hen is advertising to males her willingness to mate again. If so, this could promote competition between the males and increase the likelihood that the female ends up with a superior-quality male.

To test this idea, Tommaso Pizzari and Tim Birkhead (University of Sheffield, UK) watched a group of free-range fowl (*Gallus gallus domesticus*). They found that cackling was not associated with an increased rate in copulation, nor with increased aggression between

QUICK QUIZ

1. *What is the tallest flowering plant in the world?*
2. *Name the internationally renowned evolutionary biologist who died in May 2002.*
3. *Into which two Australian States were Laughing Kookaburras introduced?*
4. *How many body segments does an ant have?*
5. *What is a medusa?*
6. *Name one of the two rivers that the Queensland Lungfish was confined to at the time of European settlement.*
7. *What is the English translation of* terra nullius*?*
8. *Can bulls see red?*
9. *Name the only species of mammal that is restricted to the State of Victoria.*
10. *What do lithologists study?*

(Answers on page 83)

males. Only 15 per cent of hens actually cackled after egg-laying and those that did were no more likely to mate than those that didn't cackle. Indeed, most copulations occurred late in the afternoon, while egg-laying (and cackling when it happened) occurred during the middle of the day. Furthermore, when the researchers played back recordings of post-laying cackles and contentment calls to roosters, they found that the roosters didn't take any particular notice of either of the two call types. Clearly, in this population of free-range chooks, post-laying cackling has nothing to do with soliciting mates.

A loud cackle signifies a freshly laid egg. But what possible purpose might this distinctive call serve?

Given that loud calling after egg-laying would increase the vulnerability of the hen and egg to predators, it seems likely that the post-laying cackle would have some adaptive value that outweighs the risks. But what, if not to attract mates? Perhaps the opposite—to keep males away, thus reducing the costs of sexual harassment. Roosters are known to be pretty tough on their partners, typically forcing copulations on females. Certainly in Pizzari and Birkhead's study, some of the hens suffered from lethal internal injuries from overly enthusiastic advances from roosters.

—G.H.

Well-slung Duck

Scientists have come across the longest bird penis ever to be measured. It belongs to the Argentine Lake Duck (*Oxyura vittata*) and, at full stretch, the corkscrew-shaped organ is almost half a metre long.

The Argentine Lake Duck is one of the stiff-tailed ducks, which are noted for their sexual promiscuity. And to match their libido, they have relatively long penises, according to Kevin McCracken (University of Alaska Fairbanks) and

MICHAEL FREEMAN/AUSCAPE

Why is the region surrounding the iris of human eyes white, whereas it is brown in other primates?

Bright Eyes

One line you're unlikely to hear a human use in the movie "Planet of the Apes" is: "Don't shoot until you see the whites of their eyes." Why not? Because apes don't have whites; they have browns. In fact, we're the only primates in which the sclera, the region surrounding the iris, is devoid of pigmentation.

And according to Hiromi Kobayashi and Shiro Kohshima of the Tokyo Institute of Technology, the white sclera isn't the only unusual feature of the human eye. After examining the eyes of a wide variety of primates they found that, compared with other primates, ours show an extraordinary degree of horizontal elongation. We also have the largest ratio of exposed sclera in the eye outline.

In order to investigate why our eyes are so unusual, the researchers videotaped primates while they were eating (the humans were videoed alone in a hamburger shop as they chomped on a burger) and then compared head and eye movements of the subjects. They found that humans have the highest ratio of eye-to-head movements (that is, we tend to move our eyes rather than our whole head) and that we look horizontally more often than vertically.

The researchers concluded that, as our size increased, our eyes became elongated in order to extend our visual field, particularly in the horizontal plane, without the need for whole-body or head movements. Horizontal scanning would presumably be more important for terrestrial species than those that spend time in the treetops. Indeed semi-arboreal, and especially arboreal, species tend to have much rounder eyes.

The researchers also suggested that the white sclera evolved in humans because it enhanced the communication signals required for cooperative behaviours such as group hunting, by allowing people to tell which way others are looking. In non-human primates, however, the brown sclera works like a pair of dark sunglasses, camouflaging the direction of the gaze, which may help them to escape from predators. The need for gaze camouflage in humans, the authors say, would have decreased with enlarged body size and the use of tools and fire.

—G.T.

Of the bird species with a penis, the Argentine Lake Duck holds the record for length.

COURTESY KEVIN C. MCCRACKEN

colleagues.

Previous measurements taken from dissected specimens estimated the duck to have a 20-centimetre-long penis—about half the length of the drake's body. But a live bird caught in Argentina's Córdoba region revealed this to be a gross underestimate. The everted penis of the aroused drake was 32.5 centimetres long, but it could stretch when fully unwound to 42.5 centimetres. By comparison, the penis of an Ostrich is only about 20 centimetres long.

In such promiscuous birds there is probably stiff competition between drakes to father the ducklings. McCracken *et al.* speculate that the giant penis might be an example of runaway sexual selection, where female preference drives male anatomy to ever-greater extremes. However, sperm competition might also be a factor. Supporting this is the discovery that the base of the penis is covered in spines, while the end is soft and brush-like. The researchers suspect that the drake uses the bottlebrush tip to remove sperm stored in the female's oviduct from her previous suitor, to increase the mating drake's chances of paternity.

It remains to be seen how much of the penis is actually inserted during copulation, and whether the female has an anatomy to match it.

—R.S.

Neanderthal Nurses

We know that Neanderthals and modern humans overlapped for at least 100,000 years, and that they had distinctive facial and dental features. But how different were they socially?

Serge Lebel (University of Quebec), Erik Trinkaus (Washington University) and others argue that a scarred and nearly toothless jawbone from Bau de l'Aubesier, France, implies that even the earliest Neanderthals exhibited surprisingly modern behaviour. Dated at between 169,000 and 191,000 years old, the jawbone shows evidence of such severe disease that chewing would have been practically impossible, yet bone growth over the tooth sockets indicates that the Neanderthal continued to live for several months at least. This individual could only have survived with a little help from his friends (in the form of food preparation etc.) and shows that the act of caring for the infirm has been going on for nearly 200,000 years.

The act of caring for the infirm has been going on for nearly 200,000 years.

Other interesting finds at the site include an upper incisor with distinct bevelling that cannot be attributed to chewing food. Instead, the researchers suspect, the wear pattern was produced from using the teeth as tools to process animal or plant material. Also found was an upper molar with a distinctive groove caused by repeated toothpicking—further evidence of this widespread human practice, which dates back nearly two million years (see "Ancient Toothpicks", *Nature Aust.* Winter 1993).

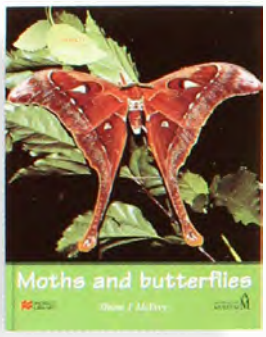
Neanderthals were certainly different from modern humans, and they did not survive as a group. But, increasingly, the differences seem less remarkable than the similarities.

—R.F.

Gorillas Splash Out

When it comes to intimidating rival males, Western Lowland Gorillas really splash out. In swampy clearings or bais in northern Congo, male silverbacks engage in spectacular water displays, either dive-bombing into deep pools or striking the water surface hard with one or both palms. This is one of the few known cases of a land mammal using water to communicate.

Richard Parnell and Hannah Buchanan-Smith (University of Stirling, UK) observed 124 Western Lowland Gorillas (*Gorilla gorilla gorilla*) that came to feed at the 13-hectare Mbeli Bai over a period of three years. Because females were out of sight for more than half of the displays, the researchers believe the primary purpose of the displays is to intimidate rival



The Australian Museum and MacMillan Education Australia are proud to announce their latest series of children's books: Insects and Spiders.

Written for 9 to 12 year olds by the Australian Museum's own scientist, Dr Shane McEvey, they're easy to read, and packed full of fantastic pictures and amazing facts.

You'll never look at an insect or spider in quite the same way again!

Find out how scientists collect and identify insects and spiders, all about the life cycle of these animals, where they live, what they eat and much, much more.

You'll never look at an insect or spider in quite the way same again!

PURCHASE THESE INDIVIDUALLY OR AS A SET FROM THE AUSTRALIAN MUSEUM SHOP AND GET A 10% DISCOUNT IF YOU MENTION THIS AD.

Schools can order the series direct from Educational Book Sellers.

MACMILLAN LIBRARY

AUSTRALIAN MUSEUM

Chimp's Living Doll

Chimpanzees in captivity will play with dolls and other toys, perhaps partially out of boredom. But now wild Chimps have been observed making their own toys—out of live animals.

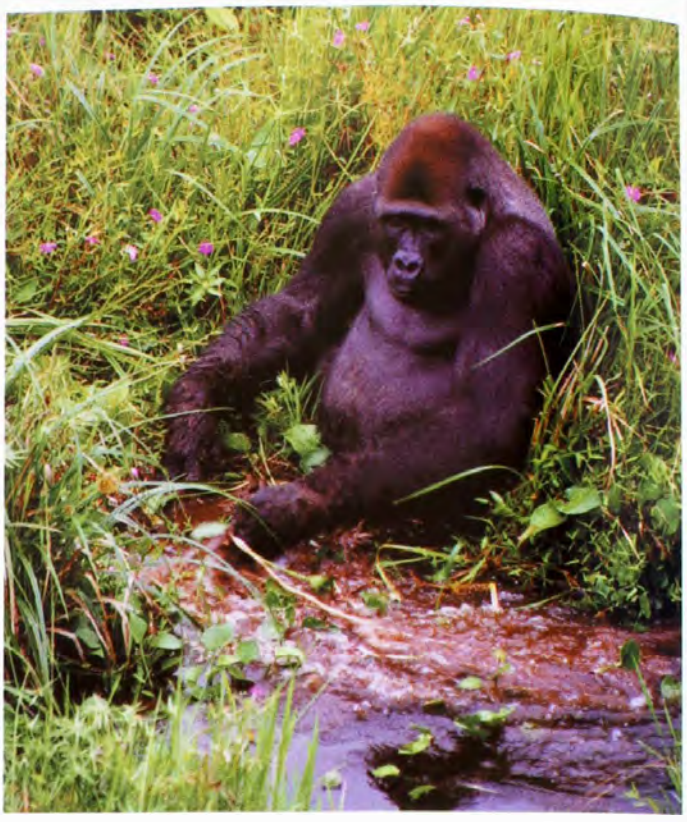
Satoshi Hirata and colleagues from Kyoto University have been watching a colony of Chimpanzees (*Pan troglodytes*) in Guinea for some years, and have twice observed Chimps playing with a Western Tree Hyrax (*Dendrohyrax dorsalis*), a small tree-dwelling mammal. In the first instance, the Chimps became intrigued by an adult hyrax that had fallen out of a tree. Screaming with excitement, they rushed at it, slapping the ground nearby, then touching it with a sapling. Later, they took turns hitting it before finally abandoning it alive. Five years later, an eight-year-old male from the same colony began carrying a live hyrax about with him, sometimes slapping it against branches. He dropped it, but it was later picked up by an eight-year-old female. She carried it about on her shoulder, then made a nest and settled in with the now-dead hyrax, grooming it and poking it with her fingers. The next morning she still had the hyrax and continued to groom it and carry it about for another hour or so. The researchers later found it abandoned.

While the Chimps pretty much loved the hyrax to death, they made no attempt to eat it, even though other Chimps are known to eat meat. This colony lives in an area where there are few potential mammalian prey species, so perhaps the Chimps just never had the chance to develop the carnivorous habit. Or perhaps they were just playing. Chimps have been observed playing with baboons, and Bonobos (Pygmy Chimpanzees) will toy with certain monkey species. Either way, the study shows that Chimps have a remarkable memory: the female who carried the hyrax around with her was present five years earlier when the other Chimps were playing with their 'living doll'.

—A.T.

COURTESY GAKU OHASHI

A Chimpanzee from Guinea playing with a live Western Tree Hyrax.



Western Lowland Gorillas express themselves with water. Unfortunately the illegal trade in 'bushmeat' means that Gorillas may become extinct before their behaviour is fully understood.

males, not to attract females.

While little is known about the social behaviour of Western Lowland Gorillas (mainly because observation is difficult in their dense jungle home), it is common for male Gorillas to charge towards their rivals, veering away at the last minute and smacking their palms down on the ground. The discovery that Western Lowland Gorillas use similar actions in water shows that they are able to adapt to and manipulate the local environment to achieve their goals.

The researchers also say that this unusual behaviour may have developed only in Gorillas that visit open swampy clearings like Mbeli Bai, where visibility is far greater than in the forest, and where long-distance, highly visual displays are more effective.

—R.S.

Humpback's Bumpy Flight

Forget about jumbos. When it comes to flying, Humpbacks are probably the only massive mammals we should be thinking about. Recent research suggests that bumpy protuberances on aeroplane wings, like those found on the flippers of Humpback Whales (*Megaptera novaeangliae*), might have aerodynamic advantages over the smooth sleek lines we're traditionally accustomed to.

The knobbly lumps that occur on the leading edges of Humpback flippers are known as tubercles. They're unique to the species and their purpose has long puzzled scientists. But Philip Watts (Applied Fluids Engineering, California) and Frank Fish (West Chester University, Pennsylvania) believe these structures may be one important reason why Humpbacks are such

agile movers for their size. Tubercles, the researchers have shown, might actually improve the ability of Humpbacks to make tight and fast turns through the water as they round up and pursue their small prey.

In computer simulations using fixed wing-shaped panels, Watts and Fish found that, at the correct angle, leading-edge tubercles could increase lift by almost five per cent at the same time as reducing drag by more than ten per cent. It's a double effect that's rarely produced using a single structure. Usually if a structure increases lift, it also increases drag. The special effect appears to result because the tubercles induce a series of low-pressure pockets across the upper surface of the flipper, as opposed to a continuum of low pressure that would come from a smooth leading edge.

Apart from aircraft wings, the findings may prove useful in the design of rudders for marine vehicles.

—K.McG.

FURTHER READING

References for the stories that have appeared in this edition of Nature Strips are available online:

www.natureaustraliamagazine.com.au

FRANÇOIS GOHIER, ARDEA

Speed bumps? This Humpback Whale shows off the prominent tubercles on the leading edge of the flipper.

Goannas, first-class monitors

What made goannas so suitable for the fake dinosaur roles was their innate talent for wrestling and general reptilian belligerence.

FOR ME, GOANNAS FALL INTO that bag of temperamentally dodgy animals alongside feral Cats, wild Galahs and elephant seals. The thought of having to check any of them for gingivitis or ticks attached to the inside walls of their anal sphincters is enough to bring on a coronary.

Unlike the rest of them though, a goanna's proclivity for biting and scratching was seized on long ago for what it was worth. This might be inconceivable to today's "Walking-with-Dinosaurs" generation, but long before black-and-white TV, goannas were up there on the big silver screen mesmerising the movie-going world. They were the unacknowledged stars in cutting-edge time warps, centre-of-the-Earth journeys and prehistoric nightmares, cunningly blown up and grappling in slo-mo with one another on the edges of Cretaceous Hollywood crags. What made goannas so suitable for the fake dinosaur roles was their innate talent for wrestling and general reptilian belligerence. And a few close-ups of their long, lashing, forked, slurping tongues could just about paralyse the kids in the front two rows.

But where did all the movie goannas, in their fake velcroed horns and spines, come from? Don't tell me movie producers used to send special-effects personnel all the way to Australia to bag up potential stars. The truth is that goannas (genus *Varanus*) are not the sole property of Australia. They are found all through Africa, Asia, as far north as Turkmenistan and as far east as the Solomons. We might think some of our goannas are huge, but the celebrated three-metre Komodo Dragon (a goanna—*Varanus komodoensis*) from eastern Indonesia dwarfs the biggest Australia can boast. What we can be justifiably proud of though is the diversity of goannas we have compared with the rest of the world (about 30 of the world's 50-odd species). But that doesn't mean they started in Australia. Biochemical research suggests varanids originated in South-East Asia and radiated out from there.

The irony in dressing up goannas to play dinosaur roles is that goannas really are made of that same heavy reptilian metal as the dinosaurs of old. Modern-day *Varanus* species go back to an ancestor that appeared around 15–20 million years ago, but *Telmasaurus*, one of the earliest varanids, was dodging between dinosaur legs in the Upper Cretaceous. A more recent close relative, a horrifying heavyweight called *Megalania*, could have trundled around eastern Australia as recently as 30,000 years ago. Estimated to have been up to 5.5 metres long, this goanna was definitely one for Aborigines to keep half an eye open for during a midday snooze.

Without being too unkind, goannas can be something of a wheelie-bin, with an undiscriminating appetite for flesh, be it hot, fresh and running, or very dead and crawling. The long, flicking, forked tongue (which does not actually have any taste buds on it) picks up scent particles on the wind and transfers these to the roof of the mouth where they are 'read' by structures called Jacobson's organs. Using this method, goannas can locate food that is hidden, or bleeding and stumbling off through the bush. (Among lizards, that long and deeply forked tongue is unique to goannas. How else could we have known those dinosaurs on the movies weren't real?)

Chook pens and garbage tips hold a particular fascination for goannas, and the subject of eggs has brought many a goanna unstuck. Yet I know of one that met with terminal stomach surgery, not for entering my mother-in-law's chook house and stealing the day's clutch of precious hen eggs, but for also gulloping down all the expensive china look-alikes that the long-suffering Leghorns relied on for inspiration. Goannas have been shown to have long memories, and presumably the look of these eggs had it swallowing on nostalgia, or the smell of the sitting hens was still smeared over the crockery clutch.

On the matter of garbage, a bush-

Lace Monitor

Varanus varius

Classification
Family Varanidae.

Identification
Up to 14 kg, 1.5–2 m long. Dark blue-black, patterned with creamy blotches in variable bands around body. Tail laterally compressed.

Distribution and Habitat
Coast and ranges of eastern Aust., most wooded habitats (mangrove to semi-arid).

Biology
Diurnal, shelters in hollow trees, logs or in burrows. Active in warm weather. Eats mostly baby birds, mammals, reptiles, insects. Mates Nov.–Dec., 4–6 weeks later 6–12 leathery eggs laid inside hole excavated in a termite mound (termites reseal breach). Young hatch and dig out the following Oct.–Nov. (females reported to assist young out).

BY STEVE VAN DYCK

walking friend of mine once arrived exhausted at camp one afternoon to prise off his boots and strip his reeking socks from feet that hadn't been washed in 65 kilometres. While his stinking feet luxuriated in the dry air, he lay back on his elbows and watched with interest as a goanna descended a nearby tree, tested the spicy air with its tongue, swaggered over to his boots, grabbed one of his mountaineering socks, and ate it. Did the goanna gag on the Holeproof, or at least regurgitate it in disgust? No. Having slept with that warm fuzzy feeling in its stomach all night, it slipped down from the tree again the next morning and swallowed the other!

The ease with which goannas can be fed has long made them impressive (if not exciting) displays in captivity. Many years ago a member of a Queensland Museum fossil expedition was asked to bring back from the field a large goanna for a live public display. Before leaving, he was briefed on how to perform the capture. Wait for the goanna to scale a tree, shoot the supporting branch out from under it, then, before it has a chance to pick its wits up out of the dust, grab it by one hand on the seat of its pants and the other on the scruff of its neck, and throw it in a bag.

All went perfectly up to a point. The heavy monitor struggled up a tree, the branch was blown out from under it, and down it came like a stricken Lancaster. With a resounding wallop the flabby undercarriage hit the tarmac and the intrepid palaeo dived into the unwinding wreckage. From then on, theory and practice went their separate ways.

With the neck-grip fumbled completely, and the pants-grip sliding down towards the tip of the tail, the goanna, in full control of all faculties other than anger and revenge, turned for the kill. This was the time to surrender zoology to physics, and in near Olympian hammer-throw style the desperate hunter, with goanna in tow, went into a slowly accelerating spiral that eventually lifted the poor lizard back into orbit. This at least gave the scientist time to consider his next move while centrifugal force kept the teeth and claws at arms length.

The rising mushroom of dust and expletives had, by now, drawn the rest of the party to the dress circle where they watched the final throes of the touching pirouette. Round and round whirled gladiator and mace, with shrieks of "Get a bag, get a bag!" coming from the swirling blur in the middle.

Now even naive children know not to stick fingers into food blenders or mowers, and all present that day knew that to "get the bag" was one thing...delivering it to the man in the middle was quite another. So they let vertigo wrap up the performance and, in deference to the old goanna, not one of the teary-eyed audience stopped clapping as it slowly staggered off into the scrub. □

KATHIE ATKINSON

A Lace Monitor displays its talent for climbing vertical objects.

FURTHER READING

Cogger, H.G., 2000. Reptiles and amphibians of Australia. *Reed New Holland: Sydney.*

King, D. & Green, B., 1999. Goannas. *UNSW Press: Sydney.*

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

Green Sawfish

With around half the world's known sawfish diversity, Australia is in a strong position to conserve these extraordinary fishes.

BY JOHN POGONOSKI

FEW PEOPLE CAN CLAIM TO HAVE seen a Green Sawfish (*Pristis zijsron*) in the wild. Unfortunately, a combination of their tropical muddy habitat, natural rarity and declining numbers suggests that even fewer people will see one in the future. Diving in such habitats is unappealing due to poor visibility and the often-valid assumption that sharks and crocodiles abound. Consequently, photographs of live specimens are generally limited to aquarium individuals, or those struggling on the decks of trawlers after becoming entangled in fishing nets.

Sawfishes (family Pristidae) are actually rays with a flattened, blade-like snout or saw armed with lateral teeth. As in other rays, their gill slits are on the underside of their heads. They feed on fishes that they stun with sideswipes of their saws. Some are known to use their saws to probe the muddy seafloor for invertebrates. There are about seven known species of sawfishes, four of which occur in Australian waters.

Very little is known about the specific habitat requirements and life history of the Green Sawfish. Historically, it was known from shallow, muddy, inshore estuaries and offshore coastal environments of tropical and subtropical Australia and other parts of the Indo-Pacific. Today it appears to be confined to very small ranges within this large area. Although once found southwards to at least Sydney, the last confirmed museum record from New South Wales was in the 1970s. There have been anecdotal reports of juveniles in estuaries of northern New South Wales in recent years, but these cannot be confirmed. The species is currently listed as Endangered by the World Conservation Union and Endangered in New South Wales under the *Fisheries Management Act* 1994.

The Green Sawfish attains a massive seven metres in length, a quarter of which comprises the saw. It gives birth to live young and, although the exact number of young is unknown, it is likely to be between five and 20. To avoid damage during birth, sawfishes are born with flexible saws and soft teeth, which soon harden.

In October 1926 a five-metre-long Green Sawfish was found wallowing around in the shallows at Sydney's Manly Beach before lifeguards harpooned it on the assumption it was a dangerous shark. Although anecdotal evidence suggests that sawfishes may be harmful (especially when thrashing around in a net), there are no reliable accounts of people being wounded from sawfishes while swimming in Australian waters.

The Green Sawfish appears to be declining in most parts of its range due to a combination of their incidental capture ('bycatch') in net fisheries and possibly inshore habitat degradation. Sawfish fins have fetched high prices in the Asian shark-fin soup trade, but the extent to which individual sawfish species are traded is unknown. In the past, sawfish flesh was consumed, saws were sold as curios, and in some cultures saws even used as weapons or as decorative ornaments.

Our knowledge of sawfishes has been gleaned largely from pickled museum specimens and accounts of people who have caught them. Due to the high cost of intensive sawfish surveys in the remote locations where they occur, commercial fishers and Aborigines in the northern States of Australia are particularly important sources of sawfish information. Researchers at the Queensland Fisheries Service (QFS) are currently working closely with the commercial set-mesh net fishers to learn about the life cycles of sawfishes in the Gulf of Carpentaria. The aim of this project is to map the distributions and track the movements of sawfishes by tag-

KYLE ARNSON

A Green Sawfish from Barrow Island, Western Australia, uncommonly found stranded on mud.

ging specimens captured by commercial fishers.

With around half the world's known sawfish diversity, Australia is in a strong position to conserve these extraordinary fishes—assuming we act before abundances drop too low to sustain successful recovery plans for each species. The fate of sawfishes in Australia and overseas relies on continued research of their populations and some form of initial protection in areas where they still occur. In the meantime, if anyone has any information on sightings and/or captures of sawfishes, especially if accompanied with photographs, please contact the Australian Museum. □

FURTHER READING

Last, P.R. & Stevens, J.D., 1994. Sharks and rays of Australia. *CSIRO: Melbourne.*

Pogonoski, J.J., Pollard, D.A. & Paxton, J.R., 2002. Conservation overview and action plan for Australian threatened and potentially threatened marine and estuarine fishes. *Report to Environment Australia, Canberra*, http://www.ea.gov.au/biodiversity/threatened/action/index.html

JOHN POGONOSKI IS A TECHNICAL OFFICER IN THE ICHTHYOLOGY SECTION OF THE AUSTRALIAN MUSEUM, SYDNEY. HIS PRIMARY INTEREST IS IN THE CONSERVATION OF AUSTRALIAN FISHES AND THEIR HABITATS.

Wattle become of Acacia?

Three botanists are fighting to keep Acacia *for Australia.*

AUSTRALIA IS THE LAND OF eucalypts (*Eucalyptus*) and wattles (*Acacia*), plants that inspire great affection and national pride. But what most Australians don't know is that *Eucalyptus* and *Acacia*, as names, are falling under the knife. *Acacia* may not have much of a future here.

Eucalypts are rather a mixed bag, and back in 1971 Lawrence Johnson (New South Wales National Herbarium) and Lindsay Pryor (ANU) suggested that the genus *Eucalyptus* might need chopping up into several smaller genera, an idea first proposed in 1913. A genus is merely a category for grouping together closely allied species—those descended from one ancestor. If plants in a genus are not really closely related, the genus should be carved up. Recent DNA work shows two primary groups within *Eucalyptus*, and in 1995 Ken Hill (Royal Botanic Gardens Sydney) and Johnson took the daring step of shifting the bloodwoods and ghost gums—113 species in all—into a new genus *Corymbia*. *Corymbia* species tend to have woody urn-shaped gum nuts. Hill and Johnson stressed that such trees should still be called 'eucalypts' in common parlance. They had acted bravely. Eucalypts are as dinky-di as meat pies, and to say that some eucalypts are not *Eucalyptus* is rather like arguing that Australian Rules is not real football. Many botanists, foresters and nurserymen were riled.

Five years later Ian Brooker (CSIRO) challenged their move, arguing that *Corymbia* species should go back to *Eucalyptus*. But the journal in which he made the plea published a response in the same issue that repudiated his change. It was never adopted. The idea of keeping all the eucalypts together has great emotional appeal but the DNA work could not be ignored. Most botanists are now reconciled to *Corymbia*, sentimentality and convenience yielding to scientific reality. And botanists may take the knife to *Eucalyptus* again one day and slice it up more finely.

Of more immediate concern is the plan by Les Pedley (Queensland Herbarium) to shift nearly all of Australia's 950-odd wattles into the genus *Racosperma*. If ever a genus needed splitting it is *Acacia*. Africa's flat-topped thorn trees sit in this genus alongside Australia's wattles despite obvious differences. Pedley argued for change back in 1986 and later transferred Queensland wattles to *Racosperma*, an old and not very euphonious name coined in 1829. But he stirred up so much ire that his proposal was ignored. Botanists were so keen on *Acacia* that they kept insisting wattles *were* closely related to those funny trees overseas.

New DNA evidence, however, has debunked that claim and a carve-up of *Acacia* now looms. But three botanists, led by Bruce Maslin (Western Australian Herbarium), are fighting to keep *Acacia* for Australia. Under international rules of nomenclature a genus name should be applied according to its original use. Because *Acacia* was first coined for trees in Africa, our wattles would lose out. But the researchers are appeal-

Eucalyptus **takes its name from the cap covering the bud (from the Greek *kalupto* meaning cover). Mottlecah (*E. macrocarpa*)—still in *Eucalyptus*—has the largest flowers and caps of any eucalypt.**

BY TIM LOW

ing to the International Association for Plant Taxonomy to exercise discretion and allocate *Acacia* to our beloved wattles. "I think that in the interests of our country we should try to save the name *Acacia* for Australia", Maslin told me. If he succeeds, many acacias in Africa, Asia and the Americas will be lumbered with a new name, possibly *Sassa*.

The fight by Maslin and his team could be construed as Australian chauvinism, but their arguments are appealing. Australia has the lion's share of Acacia species, more than three times as many as the rest of the world combined. Australian wattles are widely grown overseas (for land reclamation, firewood, tannins and ornamentals), and many countries would be inconvenienced by a change to *Racosperma*. DNA work shows that the genus *Acacia* should really be split at least three ways, which means that half the African *Acacia* species will end up with a name change anyway (becoming *Senegalia* species).

Maslin notes that, whereas *Acacia* is a feminine name, *Racosperma* is neuter. The endings of many specific names will have to go from *-a* to *-um* to match the new gender. *Acacia elata*, the Mountain Cedar Wattle, for example, will become the unrecognisable *Racosperma elatum*. Herbaria all over Australia will have to devote precious time to updating thousands upon thousands of labels and database entries, with nurseries following suit. The Western Australian Herbarium alone has 40,000 wattle specimens. "The change would cost millions", Maslin complained.

Pedley, like other experts I spoke to, expects Maslin's appeal to fail. Like everyone else, he would like to keep *Acacia* for Australia, but rules of nomenclature are rarely relaxed. "On the evidence, we have to just forget about *Acacia* for Australia", he told me (although a handful of our species will stay in *Acacia*).

Australia, once the land of *Eucalyptus* and *Acacia*, may soon be the land of *Eucalyptus*, *Corymbia* and *Racosperma*. That's not a pretty thought, but in the world of botany, the rules rule. □

PHOTOS: TIM LOW

Golden Wreath Wattle (*Acacia saligna*) grows so widely overseas that a name change to *Racosperma salignum* will inconvenience experts in many countries.

FURTHER READING

Brooker, M.I.H., 2000. A new classification of the genus Eucalyptus *L'Her. (Myrtaceae).* Aust. Syst. Bot. *13: 79–148.*

Hill, K.D. & Johnson, L.A.S., 1995. Systematic studies in the eucalypts. 7. A revision of the bloodwoods, genus Corymbia *(Myrtaceae).* Telopea *6(2–3): 185–504.*

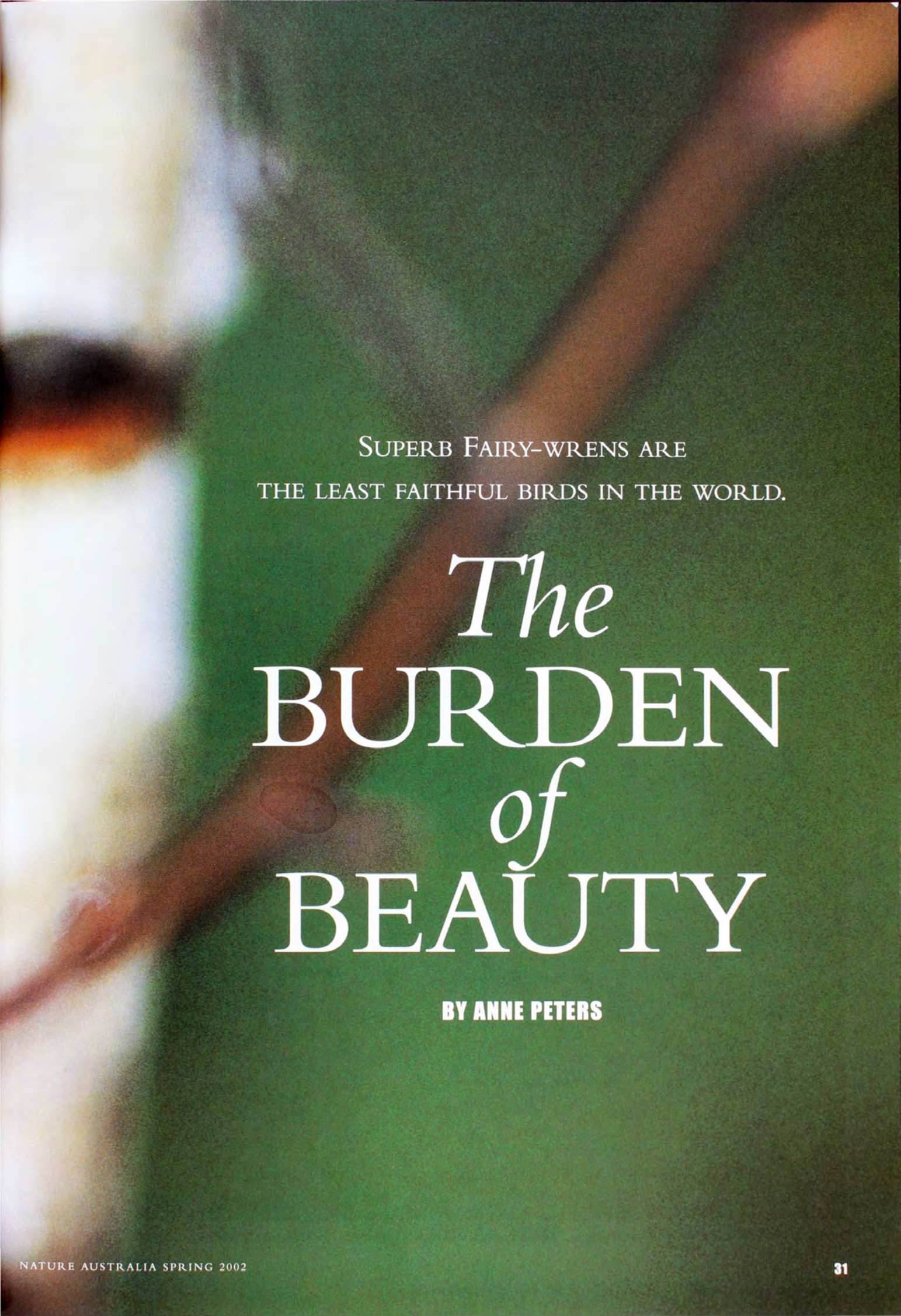
Miller, J.T. & Bayer, R.J., 2001. Molecular phylogenetics of Acacia *(Fabaceae: Mimosoideae) based on the chloroplast MATK coding sequence and flanking TRNK intron spacer regions.* Amer. J. Bot. *88(4): 697–705.*

Pedley, L., 1986. Derivation and dispersal of Acacia *(Leguminosae), with particular reference to Australia, and the recognition of* Senegalia *and* Racosperma. Bot. J. Linn. Soc. *92: 219–254.*

TIM LOW IS A BIOLOGIST AND WRITER BASED IN BRISBANE. THE TITLE OF THIS ESSAY IS FROM A 1989 PAPER BY BRUCE MASLIN (AUST. SYST. BOT. SOC. NEWSL. 58: 1–13).

DANIEL EBERT

The shiny azure patch of the male Superb Fairy-wren's plumage creates a striking contrast with the deep blue and velvety black feathers of the breast and back.



SUPERB FAIRY-WRENS ARE
THE LEAST FAITHFUL BIRDS IN THE WORLD.

The BURDEN *of* BEAUTY

BY ANNE PETERS

A small group of Superb Fairy-wrens, one brown female and two beautiful blue males, call my backyard home. As I watch them foraging together in the early morning sun, it is hard to believe that their seemingly harmonious family life is founded on universal adultery, while the males are locked in a tough beauty contest to impress the fussy females. In fact, my own study has shown that the bright blue males even risk sacrificing their health for the sake of beauty.

The unmistakable Superb Fairy-wren (*Malurus cyaneus*) was one of the first birds noted and described by early European visitors to Australia, their attention drawn by the iridescent blue-and-black plumage of the breeding male, combined with a quirky cocked tail and an inquisitive nature. Decades of study by a succession of researchers have shown that fairy-wrens are not only attractive and delightful but they also lead incredibly complex social lives.

One of the founders of Australian ornithology, the eminent Ian Rowley, was the first to study a population of individually marked Superb Fairy-wrens, at "Gungahlin", in the grounds of the CSIRO Division of Wildlife Research in Canberra. He attached small plastic rings of different colours around the birds' legs which made it possible to identify individuals with binoculars. In his 1965 paper he confirmed that Superb Fairy-wrens—like other fairy-wrens and many Australian birds—are cooperative breeders. Often one or more male helpers share the territory with the breeding pair and assist with territorial and parental duties. The helpers are behaviourally subordinate to the dominant male, but otherwise they are sexually mature and develop a complete colourful plumage during the breeding season.

At first sight it is a happy little scene—a devoted mother and her committed partners, all pitching in to raise their babies. However, not all is what it seems, as became clear in the course of a detailed study of a population in the Australian National Botanic Gardens in Canberra. This research was initiated 15 years ago by Raoul Mulder for his Ph.D. studies at the Australian National University (ANU), and his supervisor, Andrew Cockburn, has continued the project, leading a large and diverse team of researchers and students (including me).

The first hint that not all is harmonious came with the observation that females are frequently visited by males other than their own partners. These suitors are neighbouring males that have temporarily left their own territory for the sole purpose of courting. During the peak breeding season, during spring and the first half of summer, these males spend up to three hours per day in pursuit of females. David Green and Helen Osmond, indefatigable members of the ANU fairy-wren field team, spent

© ANDREW HENLEY/ARDEA

A male Superb Fairy-wren in brown winter plumage can be distinguished from the female by his black bill and blue tail.

KATHIE ATKINSON

The social harmony of the Superb Fairy-wren family is not affected by the fact that most of the young are illegitimate.

many days closely following individual males through bushes and bogs. They noted that philandering males crossed up to eight territories (500 metres at least), which is a sizeable distance for such mediocre fliers that otherwise never venture far. Upon arrival on the target territory, the suitor flies in a straight line to the resident female and performs a highly conspicuous courtship display. He erects his azure ear tufts, lowers his wings, spreads out the velvety black feathers on his back and twists his body from side to side to show off his contrasting azure, dark blue and black plumage. Sometimes he presents the female with a parting gift of a yellow petal, after which he returns home to his own family group.

During the display, the female continues to go about her business, largely ignoring the ardent suitor. And there is much ignoring to do: when a female is nest building she may be visited by as many as 13 males in half an hour. Interestingly, none of their displays leads to copulation. This might explain why most resident males, when they happen to witness their female being courted by a stranger, take little action to intervene. Nevertheless, such frequent, manifest courtships of seemingly firmly pair-bonded females do cast doubt on the image of the faithful family.

These doubts were confirmed through sophisticated laboratory tests. Analysis of the genetic relatedness of adults and their young by DNA fingerprinting clearly showed that Superb Fairy-wrens are the least faithful birds in the world. When it comes to mating, a female Superb Fairy-wren routinely ignores the brilliant-blue males that share her home territory and help raise her young. Indeed, 76 per cent of all offspring are sired by males other than the female's social mates. A low level of adultery is common in many pair-living animals (including humans). However, for illegitimacy to be the norm, with only one in four young being descen-

dent from the males that rear it, is unique among animals.

This genetic exposé raised a number of issues, particularly how, when and where these illegitimate matings take place. As I mentioned earlier, courtship displays by philandering males never lead to copulations, and females had never been seen leaving their own territory. In all the years that fairy-wrens have been studied in Canberra, we have only once witnessed a female mating with a male other than her social mates.

Given that extra-pair copulations are so rarely observed, while from the fingerprinting it is evident they occur very frequently, we suspected that they happen in the dark. This suspicion was recently put to the test by Mike Double and colleagues from the ANU. Again, state-of-the-art technology assisted in providing the answer: this time it was ultra-light radio-transmitters, so small that the researchers could attach them to female fairy-wrens. The transmitters were attached to one female at a time, when she was building a new nest. During the following week, the crew started radio-tracking this female more than an hour before sunrise, stumbling around in the darkness, listening to the 'beep-beep-beep' of the signal coming from the small shrub that had served as her night roost.

WHY DO FEMALES

go through all this trouble when they have perfectly fine males at home?

On most days, nothing happened. However, on some days, half an hour before daybreak, the source of the beeps started rapidly moving away. Neck-breaking chases after the invisible brown birds ensued in the dim light. Typically, a female would continue on her purposeful journey for a while, then stop, pause for a few minutes in a shrub one to five territories from her own, and then return home just before sunrise. Females never left their territory during daylight hours and they only made these pre-dawn expeditions when they were at the peak of fertility, two or three days before egg laying. DNA analysis of the young that hatched from these eggs provided the final proof of the purpose of these forays: all females had mated with the male they had visited.

So much for how and when, but the most intriguing question remains: why? Why do female fairy-wrens go through all this early-morning trouble to mate with some distant male when they have several perfectly fine males at home? Why do they forsake the males that share every other aspect of their life? DNA analysis by Peter Dunn at the ANU of large numbers of fairy-wrens, and a careful search for the fathers of the illegitimate young, revealed that the females in the Botanic Gardens are consistent in their preference. Some males are vastly more successful at attracting females for a pre-dawn sperm donation, and a mere four per cent of all males sire 50 per cent of young. What is it about these males that is special? Why are they chosen?

ANNE PETERS

A male Superb Fairy-wren mid-moult. Moulting lasts only a few days and, if he manages to produce his bright plumage before mid-winter, he may be rewarded with many extra-group matings during the subsequent breeding season.

More likely than not, one or two of these fledglings were not sired by their mother's social mate but by a neighbouring male that moulted into his blue plumage well before mid-winter.

FEMALE MATE CHOICE IS OFTEN based on beauty. Many female birds prefer to mate with the most brightly coloured males. In fairy-wrens, all sexually mature males seem equally blue and beautiful. However, on closer inspection the successful males have one thing in common: they moulted from their dull brown winter plumage into their bright blue plumage months before the start of the breeding season when other males usually turn blue. Throughout winter, while the average male is still dull brown, a few males can be seen strutting their bright blue outfits. These early-moulters are the lucky few that will attract large numbers of furtive female visits many months later, during the subsequent breeding season. For a female fairy-wren, a male that was blue before mid-winter is somehow irresistible, and procuring his genetic contribution for her future offspring is well worth getting up early for.

Exactly how females know or remember which males were the early-moulters, and how they manage to find them, is at present unknown. The few males that are blue in mid-winter certainly advertise this fact widely. Males start courting females on the day they complete their blue plumage, and continue to do so until breeding is over. The daily displays over the long months leading up to the breeding season are a constant reminder to females of their superior moulting ability and they may

KATHIE ATKINSON

Male Superb Fairy-wrens can often be seen inspecting the nests of neighbouring females, presumably to monitor their progress and estimate when they will be fertile. During this time the males increase their courtship efforts, yet to little avail, it seems, as courtship displays are never followed by matings.

even be providing females with information on their whereabouts. My colleagues are currently looking at the males' displays in more detail in the hope of shedding light on this puzzle.

A more fundamental question is, why do the females bother? In other words, what are they getting out of it? Also, given the great rewards of being blue before mid-winter, why do only a few of the males do it? What stops the others moulting earlier in the year? These questions might have one and the same answer: male quality. I suspected that being blue in winter is a health hazard that only truly superior males can endure, and it is these exceptionally healthy males that females seek out before dawn.

In general, females always aim to find the best genetic sire for their offspring. In order for the gene-champions to stand out from the crowd, they somehow have to be tried and tested. Since females cannot directly test a male's genetic quality, they often use some indicator of male vigour as a proxy; these indicators must be easy to assess for the female, but hard to produce for the male. If being blue is a risky business, then showing off your bright blue plumes during the cold winter months is certainly hazardous, as winter is a very hard time for a small bird. But how might sporting a shiny blue plumage constitute a health hazard? Besides possibly increasing their visibility to predators, I thought it could have something to do with the side effects of testosterone.

Testosterone is the principal male hormone in birds and mammals. It stimulates development of typical male physical characters (such as human muscles, or the rooster's comb and wattles), and male sexual and courtship behaviours. For mostly mysterious reasons, the same testosterone that produces impressive displays of masculinity and makes males dominant and attractive to females also makes males more susceptible to diseases. There is a substantial body of scientific evidence that testosterone-loaded male mammals have greater trouble fighting off diseases, and as a consequence they suffer more from parasites and infections and live shorter lives. If this were also true

in fairy-wrens, then testosterone-induced suppression of the immune system could be a risk for male fairy-wrens wanting to secure future mating success by being blue in winter. To test this hypothesis I investigated two things. Is testosterone necessary for blue plumage? And is testosterone immunosuppressive in fairy-wrens as it is in mammals?

The answer is a resounding yes to both questions. First, high testosterone and blue plumage are a package deal. A male cannot have one without the other. Blue males always have high testosterone levels, even in the middle of winter. In addition, I could induce any brown male at any time to produce his bright blue feathers by giving him a dose of testosterone—much like using steroids to turn a skinny lad into a muscle man. Second, testosterone not only produces the bright blue feathers (and cocky behaviours) of the male fairy-wren, it also suppresses his immune functions. When I treated males in the lab with testosterone, they were much less likely to fight off a simulated challenge to their immune system. (I tested these testosterone-burdened males with a harmless imitation of an infection, so they suffered no consequences.) Testosterone is clearly a health burden for fairy-wren males, and one that they cannot escape if they are in blue plumage.

So what about those blue males in winter? Are they suffering any ill consequences of their testosterone load? Out in the real world, a less active immune system is not a good idea. We all know that small children, or the elderly, or people whose immune systems are suppressed are much more susceptible to all kinds of diseases that barely bother the rest of us. The same must be true for those blue fairy-wrens in winter. They have to be pretty tough to undertake the risk of weakening their immune system through the hardest time of the year. Not just any male can take this gamble. Indeed, I found that the early-moulters play it very safe. When I analysed the immunological health status of blue males in winter, none of them showed any signs of ill health. In fact, the blue males showed a stronger, more active immune system than the brown males! So the males that are blue in mid-winter manage the peril of high testosterone levels during the hardest months extremely well, most likely because they are healthier than those that delay development of their blue plumes until milder weather. And females, by choosing to mate with the pedigree males that survive the trial of the early moult, make sure that their offspring have the finest fathers and the best genes.

It is no easy feat for a male fairy-wren to acquire extra-pair matings. The males that moult before mid-winter—the males that females fancy so much that they leave their roost before the crack of dawn to mate with them—show off their class by bearing the burden of beauty. Only the best of the best can pay the price of their beautiful blue plumage and endure high testosterone levels all through the cold winter months. So females may be fussy but they are not frivolous in their choice of genetic mates. They look for the healthiest pick of the bunch, and being brilliant-blue in the heart of winter is a colourful—and reliable—signal of endurance and prowess.

Superb Fairy-wren

Malurus cyaneus

Classification
Family Maluridae

Identification
Males bright blue-and-black (nuptial plumage) during breeding and brown in autumn and winter. Juveniles and females dull brown with light rufous lores. Males in brown plumage distinguished from females by their blue tail and black bill and lores.

Habitat and Distribution
Resident in south-eastern Aust. and Tas. In open forest, but well-adjusted to altered landscapes as long as shrubs suitable for nesting are available.

Biology
Breeds early spring to late summer. Domed grass nest with side entrance, well hidden in vegetation, within 1.5 m above ground. May fledge max. 3 broods of 2–4 young; av. 4 fledglings per group per year (in Canberra). Groups consist of a dominant pair with 0–4 sexually mature helpers, which cooperate to care for nestlings and fledglings, and to defend territories (0.5–2.0 ha) year round.

FURTHER READING

Double, M. & Cockburn, A., 2000. Pre-dawn infidelity: females control extra-pair mating in superb fairy-wrens. Proc. R. Soc. Lond. B *267: 465–470.*

*Mulder, R.A. & Magrath, M.J.L., 1994. Timing of prenuptial molt as a sexually selected indicator of male quality in superb fairy-wrens (*Malurus cyaneus*).* Behav. Ecol. *5: 393–400.*

Peters, A., 2000. Testosterone treatment is immunosuppressive in superb fairy-wrens, yet free-living males with high testosterone are more immunocompetent. Proc. R. Soc. Lond. B *267: 883–889.*

Rowley, I. & Russel, E., 1997. Fairy-wrens and grasswrens: Maluridae. Bird families of the world. Vol. 4. *Oxford University Press: Oxford.*

DR ANNE PETERS HAS RECENTLY COMPLETED HER PH.D. STUDIES ON TESTOSTERONE AND LIFE-HISTORY TRADE-OFFS IN SUPERB FAIRY-WRENS AT THE DEPARTMENT OF BOTANY AND ZOOLOGY, AUSTRALIAN NATIONAL UNIVERSITY. SHE IS CURRENTLY WITH THE MAX-PLANCK-INSTITUTE FOR ORNITHOLOGY STUDYING SOME OF EUROPE'S BLUE BIRDS, BUT HOPES TO RETURN TO AUSTRALIA AND ITS FAIRY-WRENS BEFORE TOO LONG.

THERE ARE NO BETTER MASTERS OF MIMICRY THAN THE OCTOPUSES AND THEIR RELATIVES. BUT THE KING OF ALL MIMICRY IS THE RECENTLY DISCOVERED MIMIC OCTOPUS.

MASTERS *of* MIMICRY

BY MARK NORMAN

I'VE BEEN LUCKY ENOUGH TO SEE THE WORLD'S BEST mimicry show. One little octopus in the tropical waters of Indonesia makes other mimics look a tad on the dull side. Sure, insects that look like sticks, or spiders that look like bird poo, are amazing creatures, but they're all one-trick ponies. The Mimic Octopus beats them all because it can mimic more than one subject.

Many creatures are good at looking like something else. This can take the form of camouflage, where an animal matches its background. Moths that blend in with the colour of bark or dead leaves are a good example. Some camouflage experts, like chameleons, can even change their colour or patterns to match different backgrounds. True 'mimicry' takes disguise one step further. Rather than just matching the colour, texture and patterns of the background, the animal impersonates the shapes, postures and movements of an object or creature in its own right. Some mimics even supplement their guises with appropriate motions, such as stick insects that sway in an imaginary wind.

Mimic Octopuses use jets of water through their funnel to power-glide over the sand when foraging.

Most discussions of mimicry seem to concentrate on land examples. However, the most spectacular examples occur in the sea. Stonefishes, goblinfishes, anglerfishes and pipefishes, for example, perfectly match their surroundings. And, like the chameleons, flatheads and flounders can change colour and pattern to match different backgrounds.

Many harmless creatures impersonate poisonous ones to avoid being eaten. Some leatherjackets, for example, mimic pufferfishes, and the transparent juveniles of some pearlfishes impersonate jellyfishes with long trailing fin rays that look like stinging tentacles. On the other hand, many predators mimic harmless creatures. False Cleanerfish (*Aspidontus taeniatus*) pretend to clean then bite chunks out of their customers, while many anglerfishes look like sponges, complete with fake siphons and shaggy growths. They can also slowly change colour to match other sponges in the area. Small fishes regularly meet their end when they back into what they think is the safety of a harmless sponge. Like the stick insects, some juvenile batfishes avoid the attention of predators by adding special motions to their impersonations. By dragging one fin along the sea floor, these fishes look just like dead leaves drifting in the current.

However, there are no better masters of mimicry than the octopuses and their relatives (the cephalopods). Their high-speed colour, texture and shape changes make the tricks of chameleons, flounders and anglerfishes look like paint drying. Most octopuses and cuttlefishes are excellent at camouflage, being able to move undetected through a diversity of habitats.

TRUE MIMICRY HAS ONLY BEEN observed in a few cephalopods. The Broadclub Cuttlefish (*Sepia latimanus*) does a great impersonation of a drifting mangrove leaf, complete with spots and stem. The Caribbean Reef Squid (*Sepioteuthis sepioidea*) has been observed

Juvenile batfishes (*Platax* spp.) impersonate floating dead leaves by drifting along in the current and trailing the lower fin along the sand like the heavier stem of a leaf.

MARK NORMAN

The Papuan Cuttlefish (*Sepia papuensis*) hides amongst dead seagrass fronds by raising two arms and showing a hatched dark pattern on the body.

swimming with schools of foraging parrotfishes, showing an eyespot on the body and swaying the arms side to side to look like a fish's tail. Small males of the Giant Cuttlefish (*Sepia apama*) can even mimic the opposite sex (see "Cuttlefish Do it in Drag", *Nature Aust.* Spring 2000). They 'dress up' as females and sneak past the larger, territorial males. Then, when the big boys are off beating each other up, the little guys quickly mate with the unguarded females.

But the king of all mimicry is the recently discovered (and soon to be described) Mimic Octopus. I first heard of this amazing octopus from underwater photographers Roger Steene and Rudie Kuiter. These widely travelled photographers came back from Indonesia raving about the weirdest octopus they'd ever seen. They encountered it when they went to photograph a supposed flounder. As they got closer, the 'flounder' dissolved into an octopus, which promptly proceeded to put on other guises. They returned with spectacular still photographs of an octopus with all sorts of strange postures.

At first, I was skeptical about some of the claims. The photographs certainly looked like impersonations of sea snakes, flounders and lionfishes, but it was a bit like interpreting ink spots on a psychologist's couch. They could have been isolated parts of other behaviours (such as courtship or territorial displays) that had been misinterpreted as mimicry. I had to see for myself. So, with a film crew from the BBC Natural History Unit, we embarked on an expedition to Indonesia in search of the Mimic Octopus.

According to Roger and Rudie, the best location was the sand and mud habitats of Lembeh Strait in northern Sulawesi. My research colleague Julian Finn set off ahead to find the octopuses before the full crew arrived. Working with local divers, he spent three weeks

MARK NORMAN

Mimic Octopuses use the burrows and holes of other animals as temporary lairs. They often sit in the mouth of the lair during the day watching for passing prey or predators.

and more than 50 dives hunting the area to no avail. When we joined him, we spent another two weeks looking. In five weeks of searching and more than 200 dives between us, we still had nothing. It wasn't going to add up to much of a movie: "The (Unsuccessful) Hunt for the Mimic Octopus".

In the end, we chartered a boat down the east coast, where Rudie had seen a Mimic Octopus on a previous expedition. For another week we dived three to four times per day, but still no luck. On the evening of our third last night, we were starting to despair. Lots of interesting creatures but no Mimic Octopuses. We spent that night in frank discussions with the depressed producer on how to make a documentary without the star. But the next morning saw a complete change in mood. When I jumped off the back of the boat for our first dive of the day, I ended up right on top of a Mimic Octopus. With much arm waving and screaming through my snorkel, I alerted the team to prepare the cameras.

INDIVIDUAL

octopuses put on multiple disguises.

THE OCTOPUS WAS SITTING sentinel in the mouth of a burrow on the top of an acorn-worm mound. It had all its arms down the hole and was watching us with its stalked eyes, each topped with an elongate horn of skin (and muscle). It keenly watched our comic arrival and preparations for a while, then seemed to write us off as little threat. Suddenly the show began.

Thin, banded arms began sliding out and down the sides of the worm mound. The octopus fully emerged and spread out its elegant long arms. It was

around 60 centimetres from arm tip to arm tip. With the full film crew in tow, it started foraging out over the sand. It fed by covering an area of sand under a disc of webs while using the fine arm tips to flush small animals into the waiting suckers. It also probed single arms deep into burrows and holes. Its capture rate was good, regularly passing prey items to its mouth, located beneath its body.

As it started heading farther afield, we witnessed our first act of mimicry. Instead of crawling along the bottom or jetting body-first like other octopuses, the Mimic Octopus took on the form of a swimming flatfish. It drew its arms around itself in a leaf shape, raised its eyes and poked its funnel out to provide propulsion. Jets of water drove it along, allowing the animals to undulate or glide over the sea floor like a swimming flounder. The shape and patterns matched a poisonous flatfish found in the area known as the Banded Sole (*Zebrias* sp.). This fish has poison glands along its sides that cause lockjaw in animals that attack it.

Foraging seemed to consist of alternate bursts of crawling and flounder-swimming. On return to its original hole, the octopus stopped and raised all arms over its head, each bent in a curved zig-zag shape. Rudie explained later that this seemed to be mimicry of large solitary anemones (such as *Megalactis* spp.) that live in the region. The anemones have similar-looking wavy black tentacles and are armed with powerful stinging cells, strong enough to kill and seize fish.

In our last two days we came across a total of four Mimic Octopuses (one male, three females), all out and about during daylight hours. Each was on its own and each put on a good show for us. The best cases of mimicry (or at least the most obvious to us) were of lionfishes and sea snakes. For lionfish mimicry, the octopus swam above the seafloor with all arms spread around its body like the trailing poisonous spines and banners of these fishes. Sea-snake impersonations involved poking six arms down a hole while stretching the other two arms in opposite directions.

Individual octopuses put on multiple disguises, however many of the observed postures and behaviours were open to interpretation. One animal swam up to the water surface where it jetted along with all its long arms drawn together in a single shaft (like a swimming snake?). This sort of exposure is very unusual behaviour for a

(Left) The Banded Sole (*Zebrias* sp.) has poison glands at the base of its fins that cause lockjaw in its attackers. (Below) A Mimic Octopus impersonates a poisonous flatfish by drawing its arms around its body into the shape of the fish and gliding through the water.

PHOTOS: ROGER STEENE

(Above) A Mimic Octopus impersonates a venomous sea snake by placing its six arms down a hole and waving two banded arms to look like an undulating snake. (Right) Banded sea kraits (*Laticauda* spp.) advertise their strong venom with a banded black-and-white colour pattern.

vulnerable octopus, particularly during the day. Octopuses and their relatives make excellent meals for fishes as they are all muscle, have no spines, no armour and very few are poisonous. The octopuses that I'm used to studying seem to spend all their time and energy remaining hidden, or camouflaged and hence invisible. Yet this octopus parades around doing weird shows in broad daylight where there is no protection from the numerous potential predators.

It seems that the Mimic Octopus's performances give it protection. Most dangerous or poisonous sea creatures have dramatic banded colour patterns. Predators know to keep away from animals with these markings. The Mimic Octopus copies dangerous animals, tapping into the predators' fears and enabling it to forage in broad daylight. This octopus also seems capable of tailoring its response to different species, making seemingly conscious decisions about which model to mimic. For example, we only ever saw sea-snake impersonations when territorial damselfishes attacked foraging octopuses. Sea snakes are known to feed on damselfishes.

How does the Mimic Octopus incorporate so many disguises into its repertoire? Octopuses in general have large brains and large eyes, and are highly visual and intelligent animals for their size. Is the mimicry learnt, or is it hard-wired? I personally believe that the ability to mimic is genetic, the product of a long evolution. In other words, I really don't think an octopus watches passing creatures and practises impersonating them. However, at this stage there have been so few observations on the Mimic Octopus that no-one can say for sure.

If the ability to mimic is innate, how might such behaviour have evolved? The Mimic Octopus lives in sand and mud that's riddled with the burrows of shrimps, fishes, molluscs and worms. During the day the only animals that are

visible out on the sand are usually armed species like lionfishes and stingrays. At night, these 'sea plains' come alive with all sorts of animals that use the cover of darkness to hunt.

It is possible that the ancestor of the Mimic Octopus came from adjacent reefs and rubble banks. Out on the sand there is nothing to camouflage against; even a sand-coloured foraging octopus would still be obvious. With so much food out in the sand and mud, you can imagine animals making short feeding forays from the safety of reefs. The ones that patterned themselves and/or moved in a way that could be mistaken for a poisonous fish or sea snake may have been left alone; those that didn't were quickly eaten. Over hundreds of thousands of years, good impersonators would have been selected for, encouraging the evolution of this mimicry.

There is still so little known about this unusual octopus. I have been back to Indonesia twice since the first trip and have been lucky enough to observe a total of nine animals strutting their stuff. They have always been hard to find, often in inaccessible areas and in silty waters prone to bad visibility. Many mysteries remain. Juveniles, for example, have never been observed. Maybe one day we'll come across the little ones doing their own peculiar performances...midget mimics? Stay tuned. □

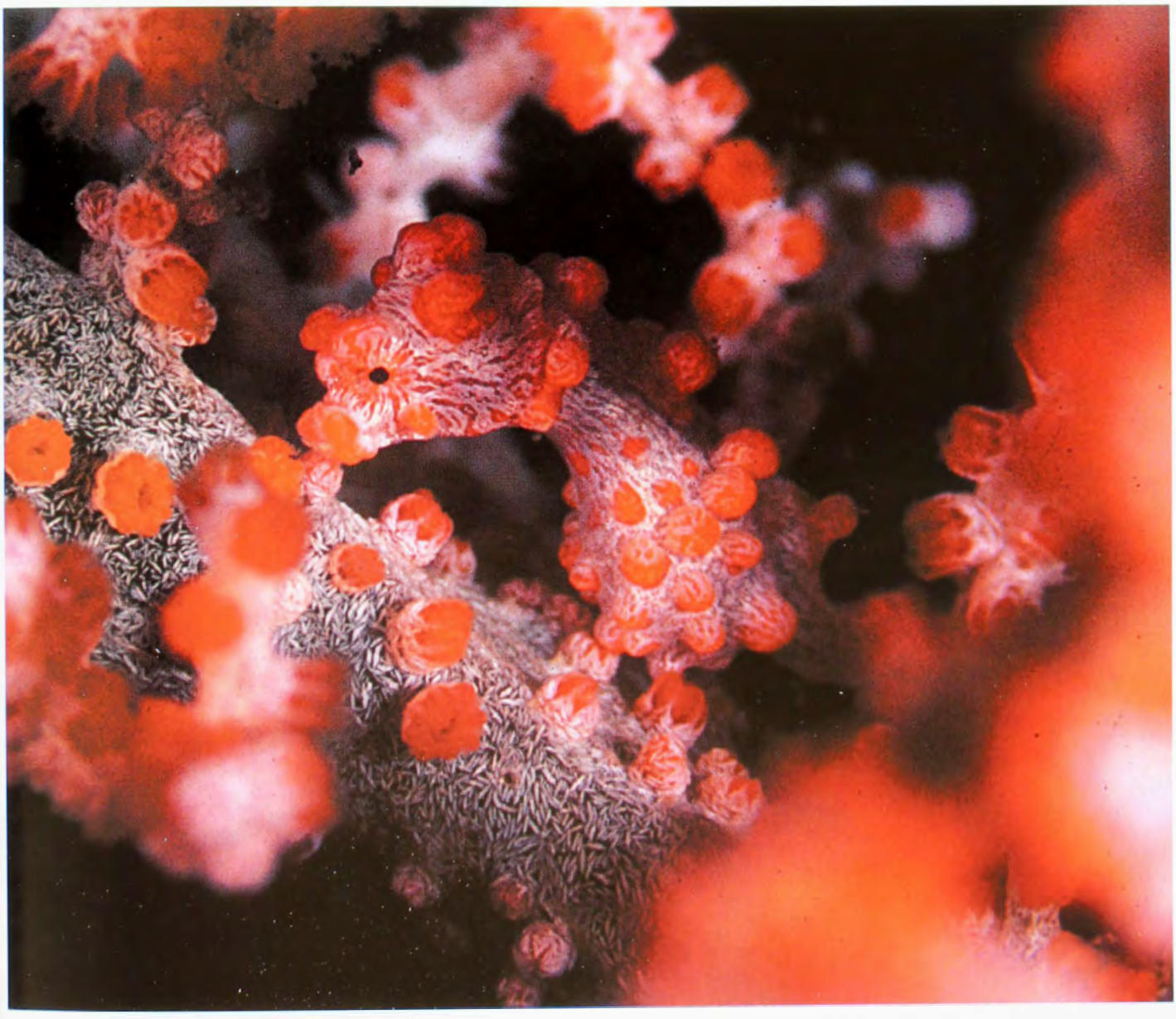
FURTHER READING

Norman, M.D., 2000. Cephalopods: a world guide. *ConchBooks: Hackenheim, Germany.*

Norman, M.D., Finn, J. & Tregenza, T., 2001. Dynamic mimicry in an Indo-Malayan octopus. Proc. R. Soc. Lond. B *268: 1755–1758.*

Hanlon, R.T. & Messenger, J.B., 1996. Cephalopod behaviour. *Cambridge University Press: Cambridge.*

DR MARK NORMAN IS A RESEARCH ASSOCIATE AT BOTH THE MELBOURNE MUSEUM AND THE DEPARTMENT OF ZOOLOGY, UNIVERSITY OF MELBOURNE. HE HAS BEEN WORKING ON OCTOPUSES AND THEIR RELATIVES FOR 14 YEARS, BOTH AROUND AUSTRALIA AND THROUGHOUT THE INDO-PACIFIC REGION.



MARK NORMAN

This Indonesian Pygmy Seahorse blends in perfectly with the fan coral on which it lives.

MOUNTAIN BRUSHTAIL POSSUMS ARE FEISTY CHARISMATIC CREATURES.

THE *other* BRUSHTAIL POSSUM

BY KAREN VIGGERS & DAVID LINDENMAYER

MANY AUSTRALIANS have met, lived or tangled with the Common Brushtail Possum (*Trichosurus vulpecula*)—a regular inhabitant of city parks and gardens, and an often-uninvited occupant of roofs and consumer of rose bushes and veggie patches. New Zealanders are particularly familiar with the Common Brushtail Possum. There are an estimated 70 million of these unwanted Australian exports in their country. However, many people probably do not know that there is another species of brushtail possum in Australia—the Mountain Brushtail Possum or Bobuck (*T. caninus*). It is much less famous (or infamous), with many fascinating aspects of its biology and ecology just coming to light.

To the uninitiated, the Common and Mountain Brushtail Possums appear quite similar. However, their scientific names reveal many of the key differences. The Mountain Brushtail Possum has short, rounded ears and a comparatively squat or Dog-like face; hence *caninus*, referring to canine or Dog. The Common Brushtail Possum has much longer ears and a more pointed face making it look more Fox-like. Its specific name, *vulpecula*, comes from the scientific name for the Fox (*Vulpes vulpes*). The Mountain Brushtail Possum is usually larger and thicker-set, and the sternal (chest) gland in males produces only a slight pink or light purple tinge. This is in contrast to the obvious, brown-yellow chest stain of male Common Brushtail Possums.

The two species of brushtail possums also have quite different distribution patterns and habitat requirements. The Common Brushtail occurs in many

As well as eating flowers and fruits, the Mountain Brushtail Possum consumes fungi, tree-fern fronds and the leaves of wattle trees.

JOHN MCANN-NATURE FOCUS

The long ears and Fox-like face of the Common Brushtail Possum distinguish it from the Mountain Brushtail Possum.

habitat types throughout much of eastern Australia (including Tasmania) and south-western Australia. The Mountain Brushtail is more restricted and occurs from near Melbourne in the south, to west of Gladstone in central Queensland. This species is largely confined to the forests of the Great Dividing Range, and it typically inhabits subtropical rainforests in the central and northern parts of its distribution and wet sclerophyll (eucalypt) forests in the south.

Mountain and Common Brushtail Possums rarely occur together. The Mountain Brushtail is almost never found in dry forests and woodlands—these are the domain of the Common Brushtail Possum—and it appears to

exclude the smaller Common Brushtail from wet forest habitats. Strong evidence for habitat exclusion on mainland Australia comes from Tasmania where the Mountain Brushtail is absent and the Common Brushtail occurs in large areas of wet forest, as well as other habitats. The absence of the Mountain Brushtail Possum from Tasmania seems to be associated with the vegetation that characterised the isthmus that linked the mainland to Tasmania some 15,000 years ago when sea levels were significantly lower than they are today. This wind-swept land bridge would have, at best, supported open woodland vegetation—an unsuitable environment for the Mountain Brushtail Possum.

The Common Brushtail Possum has been the subject of many studies, particularly in New Zealand where numerous

MOUNTAIN BRUSHTAIL

Possums develop a thick, luxuriant coat that was once highly sought after by English hat-makers.

investigations over many decades have sought ways to control them. In contrast, there have been only two major studies of the Mountain Brushtail Possum—one in northern New South Wales in the early 1970s by Ric How (now at the Western Australian Museum) at a site called Cloud's Creek, which has since been converted to a pine plantation, and the other, which we began in 1991, at a 35-hectare site at Cambarville in the Central Highlands of Victoria.

Studies of the Mountain Brushtail Possum in the Central Highlands region are particularly interesting because the species used to be the target of a very active fur trade and the strength of population recovery may give some clues to its ability to respond to present disturbance regimes like logging. The cool, wet climate of the Central Highlands region means that the resident Mountain Brushtail Possums develop a thick, luxuriant coat that was once highly sought after by English hat-makers. To capture animals,

Short ears and a flattened Dog-like face are key features of the Mountain Brushtail Possum.

JILL LOCHMAN-LOCHMAN TRANSPARENCIES

ESTHER BEATON

Almost 200 nest boxes have been established as part of a major research project in the Mountain Ash forests of the Central Highlands of Victoria. However, hardly any are used by the Mountain Brushtail Possum.

trappers used to lop the top off a tree fern and insert a wire noose into the exposed pithy core. When Mountain Brushtails came to feed on the core, they would be snared in the noose. Fortunately trapping ceased many decades ago and animals no longer have to deal with the prospect of keeping anyone's head warm other than their own!

Our study site at Cambarville is roughly 20 kilometres east of the town of Marysville, which is a two-hour drive north-east of the centre of Melbourne. It is one of Victoria's wettest places, with an average annual rainfall exceeding two metres. Cambarville is the site of a former logging village that once supported several dozen houses, a school and a sawmill. Now all that remains are one human resident, two cottages, the shell of the disused sawmill, a magnificent neighbouring stand of 80-metre-tall, old-growth Mountain Ash forest, and a thriving population of Mountain Brushtail Possums.

Much of our work on the Mountain Brushtail Possum has involved repeated trapping, marking and release of animals. Our greatest trapping success always occurs when we bait our wire cage traps with green ('Granny Smith') apples, perhaps because the smell of ripening fruit makes them irresistible to foraging possums. It is also possible that apples are less attractive to the numer-

ous other mammals like the Bush Rat (*Rattus fuscipes*) that occur in huge numbers in Mountain Ash forests.

Mountain Brushtail Possums are feisty charismatic creatures that are too large and aggressive to handle without causing significant stress to both possums and handlers. We therefore need to sedate them before we can mark them, check their age and reproductive status, take a small blood sample for genetic analysis, and carefully fit a radio-collar for telemetry studies. In all the years of our work, we have never hurt or lost an animal through our intervention, and all of our study animals have been caught and re-captured many times.

The first striking result from Cambarville was the sheer density of animals—more than one animal per hectare of forest, which is significantly higher than has been reported anywhere else in the species' distribution. The population density at Cambarville was also much greater than in surrounding regrowth forest, which raises the possibility that old-growth stands are important source areas of young dispersing animals and therefore critical in maintaining populations of the Mountain Brushtail Possum over large parts of its range. Fecundity rates at Cambarville were also extremely high, with most females giving birth to young year after year, even if they had the previous year's young still living in the natal territory. Survival of young was variable between years and sexes. Significantly more male young were born each year, however female young were far more likely to survive.

One amazing outcome of our trapping work at Cambarville was the rediscovery of a number of animals that had been marked in an earlier study in the late 1970s by Victorian Government ecologists John Seebeck and Bob Warneke. Their field-data books showed that these animals were adults when first marked, making them at least 17 years old when we recaptured them during the 1990s. Also, the animals were trapped in the same places they had been caught well over a

Mountain Brushtail Possum

Trichosurus caninus

Classification

Family Phalangeridae.

Identification

Adults up to 3.5 kg and occasionally 4.5 kg, head–body length 40–50 cm. Pelt olive-grey to grey-brown through much of its range, although black, chocolate and sandy-coloured animals may occur in north-eastern NSW. Similar to Common Brushtail Possum (*T. vulpecula*) but has short ears, a flatter (Dog-like) face, and males lack the brown-staining sternal gland.

Distribution and Habitat

From near Melbourne, Vic., to west of Gladstone, central Qld, throughout forests of Great Dividing Range. Wet sclerophyll (eucalypt) forests in southern part of distribution, and subtropical rainforest in central and northern parts of its range, supporting numerous hollow-bearing trees and high-density wattle understorey.

Biology

Breeds once a year in autumn. Females typically start to breed at 3–4 years old. Max. litter size 1. Eats foliage (particularly acacias and tree ferns), and also underground-fruiting fungi (truffles) and mushrooms.

Mountail Brushtail Possums from the northern part of their range feed on nuts from the Bunya Pine (*Araucaria bidwillii*).

decade earlier. These results make the Mountain Brushtail Possum one of the longest-lived and most sedentary species of marsupials. We can only imagine that the wet but highly productive old-growth forests at Cambarville are prime real estate in the possum world and there is little incentive for animals to move once they have settled there.

OLD-GROWTH FORESTS
are prime real estate and there is little incentive for animals to move once they have settled there.

Perhaps one of the most extraordinary findings of our work emerged when we radio-collared animals and began studying the way they used large trees with hollows as daytime denning or nesting sites. We followed animals to their nest sites each morning for nearly two years and found that, over a period of a few months, an individual may use more than 25 different hollow-bearing trees! In fact, the 16 radio-collared animals we tracked used more than 110 different hollow trees over the duration of the study. This result was totally unexpected and it may have occurred because animals were trying to confirm 'ownership' of as many nest sites within their home range as possible and thereby exclude potential rivals from using those trees. It was easy to pick the trees that brushtails used frequently—they had an extremely strong odour through being marked with urine as well as scent from the cloacal gland.

ESTHER BEATON

The majority of hollow-bearing trees used by a given animal were rarely shared with another possum, although there were a few trees occupied by up to six animals at one time. The simultaneous use of a single tree by many possums occurred only on rare occasions such as periods of heavy snow. Maybe the extra body heat generated by 18–24 kilograms of possum crammed into a single nest tree made it an attractive place to be when the mercury plummeted during bad winter weather!

Like almost all species of arboreal marsupials, the Mountain Brushtail Possum is an extensive user of tree hollows for denning and nesting sites.

An adult Mountain Brushtail Possum and young. The young stay in the natal territory for up to 18 months before dispersing.

The movement of animals between different nest trees is called 'den-swapping' and it is common among all species of possums and gliders. As discussed in a previous article on Leadbeater's Possum ("Stirring the Possum", *Nature Aust*, Autumn 2002), den-swapping may prevent owls from learning the location of active nest sites, or it may be that different trees have different thermal properties. In the case of the Mountain Brushtail Possum, statistical analysis revealed that den-swapping patterns were quite predictable and it proved possible to forecast when an animal was going to move to a new den site and which tree it was most likely to occupy next. The results of the radio-tracking work on den-swapping have enormous implications for forest management because they highlight the importance of retaining a large number of hollow trees on a logged site to ensure the provision of adequate numbers of nest sites for the Mountain Brushtail Possum, as well as numerous other hollow-using species.

SOME OF THE FUNDING FOR OUR work on the Mountain Brushtail Possum came from New Zealanders who were keen to find a way of controlling pest populations of the Common Brushtail Possum. Parasites and

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Like most species of arboreal marsupials, the Mountain Brushtail Possum has a prehensile tail that can be used like a fifth hand when climbing.

diseases offer potential solutions, but, extensive studies of the Common Brushtail had failed to identify an effective control agent. A parasite or disease that has co-evolved with a Common Brushtail Possum may have little impact, but one from the closely related Mountain Brushtail Possum could be highly effective. However, the only parasite we detected that appeared to have any pathogenic effects on the Mountain Brushtail was a large nematode worm that occurs in the liver. The Mountain Brushtail Possum is an intermediate host for this parasite. Presumably animals become so debilitated by increasing worm burdens over time that they eventually fall prey to the final (definitive) host for this parasite—the Carpet Python (*Morelia spilota*). Because this parasite does not kill its intermediate possum host before reproductive age, and because there are no definitive python hosts in New Zealand, it is unlikely to be a useful control method for Common Brushtails in the 'land of the long white cloud'. And besides, New Zealanders would hardly want to release yet another species (especially a snake!) to their country, given that it is already overrun with exotic pest vertebrates.

Since the Mountain Brushtail Possum lives to such a ripe old age and it takes a long time for turnover in the ownership of territories to occur, we plan to continue our work at Cambarville well into the future. Despite the long-term nature of the work, exciting new results are never far away. For example, we should soon have detailed paternity/maternity information for the 189 animals we have caught and blood-sampled in the past ten years. This will help us determine the mating system of the species and piece together breeding lineages among animals. These analyses will provide additional insights into the biology and ecology of what still remains one of Australia's poorer known marsupials. □

FURTHER READING

How, R., 1981. Population parameters of two congeneric possums, Trichosurus *spp. in north-eastern N.S.W.* Aust. J. Zool. *29: 205–215.*

Kerle, A., 2001. Possums. The brushtails, ringtails and greater glider. *UNSW Press: Sydney.*

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

The Mountain Brushtail Possum, has a deep, thick coat—the reason the species was once heavily hunted.

*Lindenmayer, D.B., Welsh, A., Donnelly, C. & Meggs, R., 1996. The use of nest trees by the Mountain Brushtail Possum (*Trichosurus caninus*) (Phalangeridae: Marsupialia). I. Number of occupied trees and frequency of tree use.* Wildl. Res. *23: 343–361.*

Viggers, K.L. & Lindenmayer, D.B., 2000. A population study of the Mountain Brushtail Possum, in the Central Highlands of Victoria. Aust. J. Zool. *48: 201–216.*

Dr Karen Viggers is a Post-doctoral Fellow at the Research School of Biological Sciences at the Australian National University in Canberra. She completed her Ph.D. on the ecology, population health and disease status of the Mountain Brushtail Possum and is now researching the veterinary ecology of Australian marsupials. Associate Professor David Lindenmayer is a Senior Fellow at the Centre for Resource and Environmental Studies at the Australian National University. He has worked on the ecology and management of the Mountain Ash forest and its fauna since 1983. Karen and David run field research camps at Cambarville to study the Mountain Brushtail Possum. Interested volunteers should call the Earthwatch Institute on (03) 9682 6828.

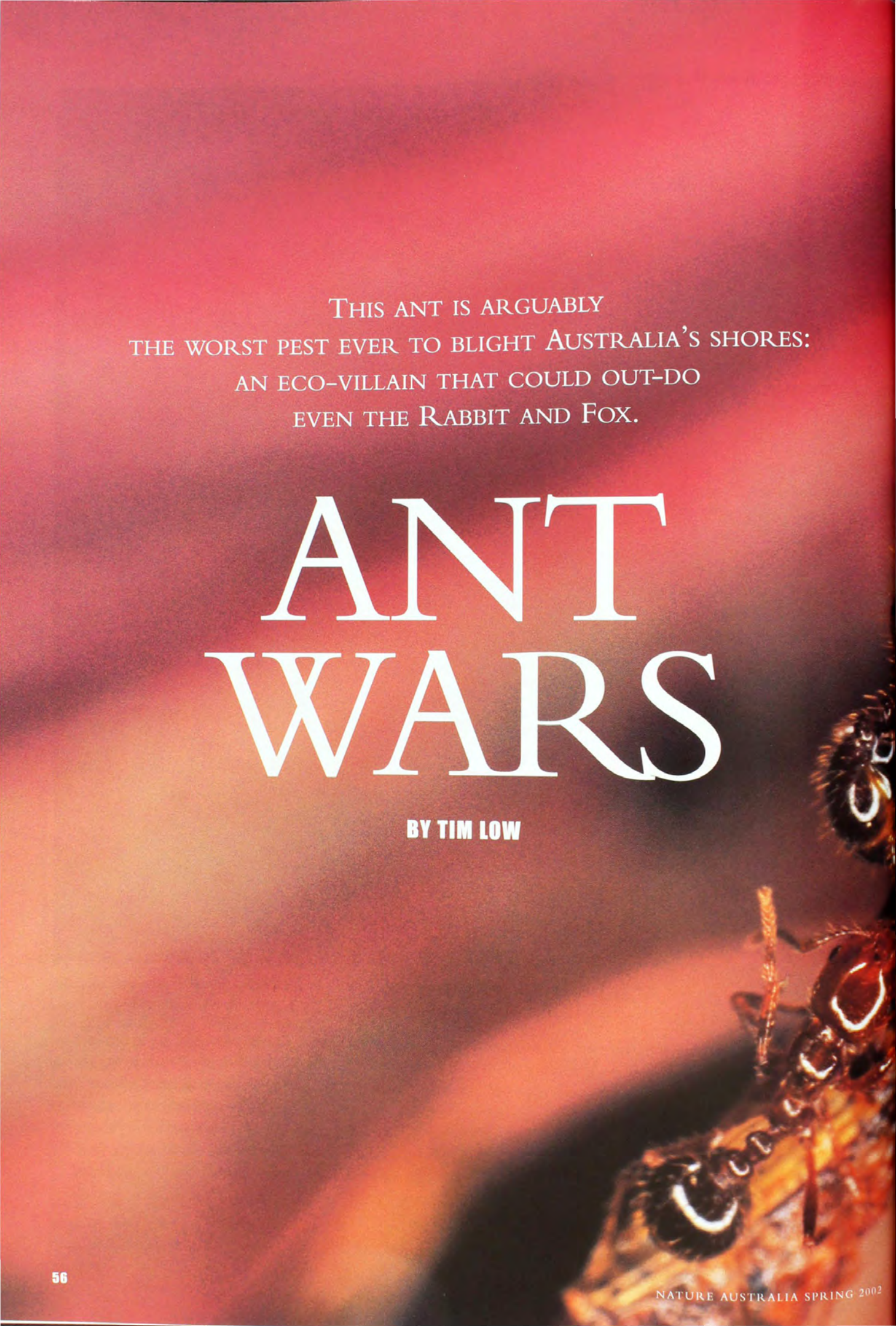
Stop Press

Latest studies have shown that the northern and southern populations of 'the Mountain Brushtail Possum' are in fact two distinct species. The southern population (the topic of this article) is still referred to as the Mountain Brushtail Possum but has a new scientific name. It occurs in Victoria, and possibly also southern New South Wales. The northern population remains *T. caninus*, and occurs in Queensland and at least as far south as Newcastle in central New South Wales. Its common name is now Short-eared Possum, to reflect the most obvious physical difference between the two species. (The Short-eared Possum also has a longer tail and longer feet, as well as other subtle morphological differences.) Genetically, the three species of brushtail possums (including the Common Brushtail Possum, *T. vulpecula*) are equally distinct from one another. The results are published in: Lindenmayer, D.B., Dubach, J. & Viggers, K.L. (2002). Geographic dimorphism in the Mountain Brushtail Possum (*Trichosurus caninus*)—the case for a new species. *Aust. J. Zool.* vol. 50 (in press).

THIS ANT IS ARGUABLY
THE WORST PEST EVER TO BLIGHT AUSTRALIA'S SHORES:
AN ECO-VILLAIN THAT COULD OUT-DO
EVEN THE RABBIT AND FOX.

ANT WARS

BY TIM LOW



Fire-ant colonies function much like a single integrated organism. This cluster of workers investigates a fallen flower.

STEVE WILSON

WHAT'S THE GREATEST threat to Australia's biodiversity? Most experts would nominate habitat loss, but the correct answer may well be exotic invasions. That's a point to ponder as we wait to see if Australia can rid itself of the dreaded Red Imported Fire Ant (*Solenopsis invicta*).

This ant is arguably the worst pest ever to blight Australia's shores: an eco-villain that could out-do even the Rabbit and Fox. In the United States it's the insect that sends children screaming indoors, starts fires, kills farm animals, destroys computers, renders parks uninhabitable, sends real-estate values plummeting and eliminates rare fauna. It sounds like something from an "X-files" episode but it's real. Not since World War 2 has Australia's way of life faced such a dire threat. At risk is the casual picnic, the backyard barbie, barefoot strolls, and outings in rubber thongs. The Federal Government says that fire ants, if not eliminated, will cost Australia $6.7 billion over the next 30 years.

The Red-Imported Fire Ant is native to South America where it causes few problems. In the 1930s it somehow reached Alabama, and since then has been spreading steadily across North America. It is now reviled as the worst pest in the southern United States, and each year 11 million Americans are stung and US$2.7 billion spent on control.

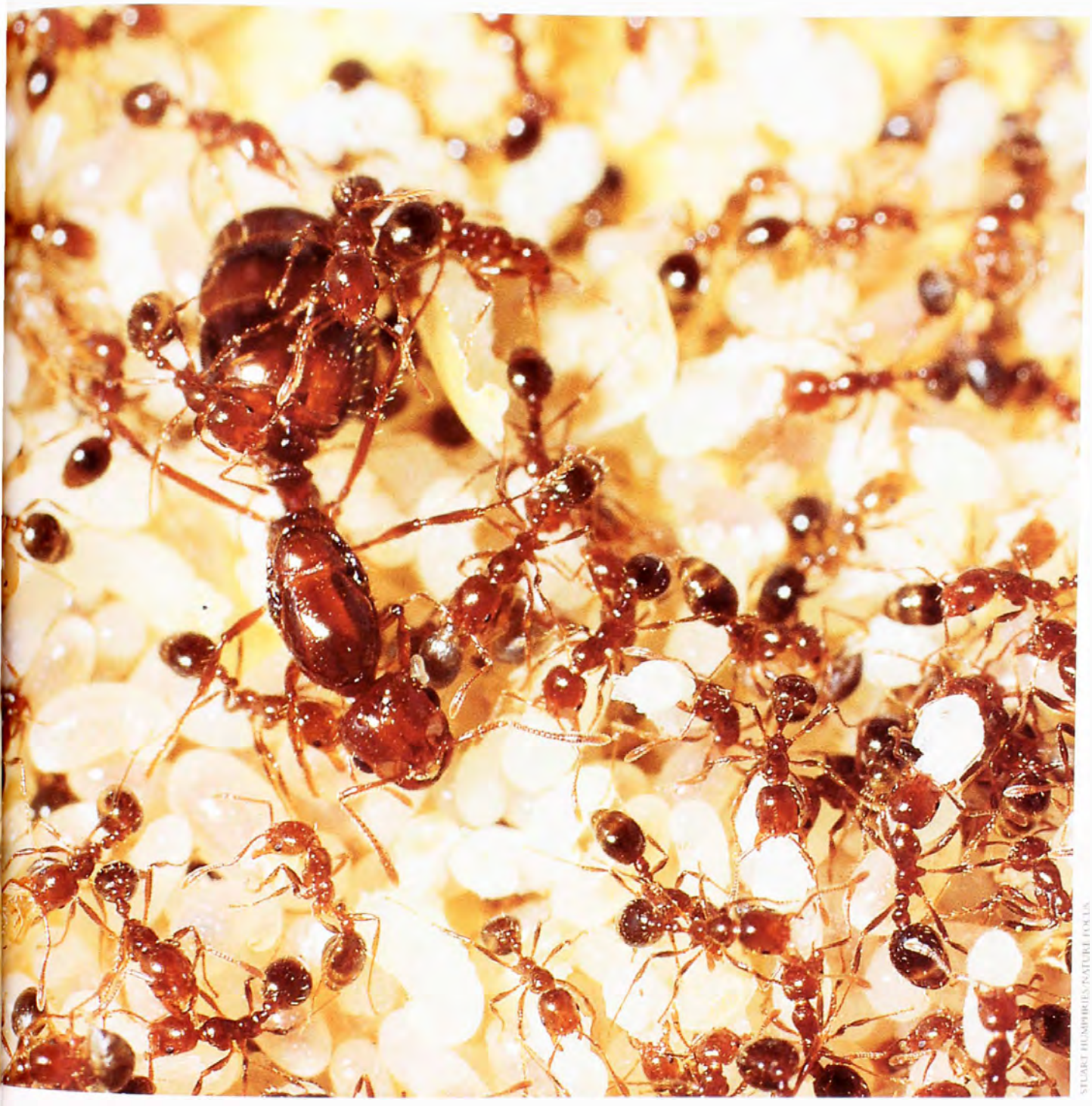
In February 2001 Red Imported Fire Ants were found in Brisbane. Surveys later showed that they had spread across more than 700 properties in 58 suburbs. In Wacol, the worst-affected suburb, nests extended over 45,000 hectares. Many homeowners had been enduring stings from the tiny ants without knowing what they were. One fire-ant sting isn't too bad—like a brush with nettles—but they crawl inside clothes and appear to sting in unison, bringing agony and raising blisters. Some Brisbane residents had been forced to abandon gardening and mowing, and children had to play on the streets because lawns were unsafe.

The Brisbane *Courier Mail* made much of the invasion, running dramatic 'Killer Ant' articles, but the media farther south made light of it all, despite climatic modelling to show that fire ants, if not checked, will invade most of the Australian continent, avoiding only the drier outback regions and loftier mountains. Fire ants have already reached Melbourne in a pot plant brought from Brisbane, although those few were soon quelled. Colonies travel about in pot plants, loads of soil and other garden supplies, and queens hitch rides on trucks.

Australian authorities are so alarmed that a massive $123 million, five-year eradication campaign is under way, run by the Queensland Department of Primary Industries. The Federal Govern-

In areas of Brisbane the density of fire-ant nests has reached one in every two square metres.

STUART HAMPTON/NATURE FOCUS



STUART HUMPHREYS/NATURE FOCUS

Fire-ant colonies contain hundreds of thousands of individuals. Here the queen is tended by worker ants.

ment and every Australian State has contributed. Growth-inhibiting baits are dropped regularly around tens of thousands of Brisbane homes in what constitutes one of the largest eradication efforts ever undertaken anywhere. The idea is that queen ants eating the baits will stop laying eggs, leading to the death of colonies.

FIRE ANTS ARE REMARKABLE. They are drawn to electric fields, and in North America are known to build nests inside air-conditioner units and computers, ruining them. They congregate around fuses and switches, triggering short circuits and fires. They often cause the failure of traffic lights, airport landing lights, telephone junction boxes, meters, pumps and other electrical units. Abandoned nests can cause subsidence under footpaths and roads.

On farms they do some good by harvesting pesty insects and aerating soil. But any benefits they bestow are outweighed by the costs. In North America they tunnel inside fruits and prey on seeds, sometimes destroying whole crops. They swarm over fruit-pickers. They ruin sprinkler systems and hoses. Worst of all, they attack newborn animals, sometimes killing foals, calves and chickens. Sluggish or immobile animals are stung around the eyes and blinded. Farmers have to poison ants in pens where stock give birth.

The harm done to farm animals has its parallels inside forests. In North America the ants are implicated in the declines of many species. They prey on hatchlings of alligators, terrapins, sea

PHOTOS STEVE WILSON

(Top and above) Captive colonies of fire ants are maintained within infected zones, in the Department of Primary Industries Laboratories at Wacol. Fecundity of these colonies can be compared with wild stock to gauge the effectiveness of growth inhibitors which will hopefully control the outbreak. (Right) Alone on the corrugated surface of a fingertip, a Red Imported Fire Ant worker shows its true dimensions. The Department of Primary Industries extensive public awareness program strives to overcome the perception that this potential disaster comes in large packages. Workers are only three to six millimetres long.

turtles and ground-nesting birds. Studies have shown that deer produce more young in places where fire ants are controlled, and the ants can remove 75 per cent of invertebrate sfrom invaded land, leaving behind far fewer insects for hungry birds and lizards. Red Imported Fire Ants wreak harm both as predators and competitors, displacing other ant species over wide areas.

In Australia introduced vertebrates, like the Fox, Cat and Brown Trout, are implicated in the extinctions or declines of many animals. But this new exotic predator—a tiny ant—is set to join their ranks. If the baiting in Brisbane fails, fire ants will advance across Australia and wildlife will suffer.

A study in Florida found a 15 per cent decline in numbers of Loggerhead Turtle (*Caretta caretta*) hatchlings emerging from fire-ant-infested nests. The Loggerhead is an endangered species in Australia, and fire ants, if they reach important rookeries such as Mon Repos near Bundaberg, will add to their woes. Another American study reported harm to the endangered Least Tern (*Sterna antillarum*) at the nest. Australia has two rare terns—the Little Tern (*S. albifrons sinensis*) and Fairy Tern (*S. nereis*)—that may be set to suffer in the same way. The Plains-wanderer (*Pedionomus torquatus*), an endangered bird confined mainly to grazed paddocks in south-eastern Australia, could find itself at grave risk. Other endangered species to worry about include the Grassland Earless Dragon (*Tympanocryptis lineata pinguicolla*), Adelaide Blue-tongue (*Tiliqua adelaidensis*) and Western Swamp Turtle (*Pseudemydura umbrina*), as well as the vulnerable Striped Legless Lizard (*Delma impar*). Rare invertebrates are also at risk, including snails, ants and also butterflies that rely on native ants to tend their larvae.

Other animals won't be at risk of extinction but their lifestyles will suffer. Fire ants in Brisbane have reached densities of up to one nest per two square metres. Painful fire-ant stings will become a fact of life for marsupials, ground-dwelling birds, reptiles and frogs, leading to changes in behaviour and habitat use. As well, vegetation structures will change. Australia is unusual in that vast numbers of plants—

" TRAMP ANTS DON'T TURN UP BY ACCIDENT ", HE SAID.

"They are an inevitable consequence of international trade. If you're moving millions of cargo containers around the world, it's going to happen."

more than 1,500 species—rely on native ants for seed dispersal. Ants carry seeds underground and eat the fleshy attachments (elaiosomes), thereby protecting the seeds from fire. Fire ants will displace native ants and skew forest regeneration.

How seriously wildlife suffers will depend upon how successfully the ants invade intact habitats. In North America fire ants are confined largely to gardens, parks, farms and other disturbed settings. The flying queens that found new colonies like to nest in the open near water, and when they do land inside forests they often choose clearings with dams. They infest camping grounds and walking trails but seldom penetrate natural habitats. That held true until the 1970s when a new form of fire ant appeared in America, one in which each nest holds many queens instead of just one. These polygyne (multi-queen) ants have smaller colonies than their single-queen counterparts, but their nests are interconnected, rather than territorially defended. Ant densities can reach 30 times that of the native ant fauna they displace and ten times that of the monogyne (one-queen) form. In heavily infested areas 99 per cent of ants are fire ants.

Polygyne fire ants often form new nests by budding, in which a group of ants excavates a new nest within striking distance of the old. In this way they can move from clearings into forest. Cas Vanderwoude, the entomologist in charge of Brisbane's fire-ant eradication program, told me of finding polygyne fire-ant nests extending right across a 200-metre strip of Brisbane forest. He expects that polygyne fire ants can penetrate intact eucalypt forest (but not rainforest) and, if left unchecked, will exact a dramatic toll on wildlife. Australia has the world's richest fauna of lizards, many of which eat ants. A preliminary study conducted in Brisbane found a complete absence of lizards from a fire-ant-infested site.

Red Imported Fire Ant

Solenopsis invicta

Classification
Family Formicidae

Identification
Very small reddish ant, 2–6 mm long. Difficult to distinguish from some native ants. Native *Solenopsis* species also occur in Aust., as does the Tropical Fire Ant (*S. geminata*) from North America.

Distribution and Habitat
Native to South America. In Aust. thought to be confined to Brisbane area.

Biology
Forages by day or night over ground and sometimes in shrubs or low in trees. Largely inactive during cooler months, and even during warm weather may confine foraging to brief periods. Defends nest with great vigour, stinging in large numbers. Attacks and overpowers animals up to size of foals. Also eats carrion, seeds, fruits, leaves, roots, bark, nectar, sap, fungi.

BRISBANE HAS TWO MAIN infestations of Red Imported Fire Ants, one centred on the Port of Brisbane and the other around the southern suburb of Wacol. The ants near the port are monogyne, the Wacol ants polygyne. DNA work shows that the latter could only have come from Argentina, whereas the port ants came from Brazil, either directly or indirectly via North America. Either way, we are left with the chilling thought that Brisbane was invaded twice by Red Imported Fire Ants in a few years.

How they arrived is anyone's guess. The Wacol ants presumably travelled among industrial goods, perhaps in stacked terracotta pots or inside a shipping container. The ants around the port may be descended from a queen that flew off a ship. It could have travelled from North America in earth attached to second-hand farm or industrial machinery. Huge loads of soil reach Australia on equipment. In 1996 an oil rig from Texas (a State with horrific fire-ant problems) arrived in Adelaide with 14 tonnes of earth attached. Alternatively, fire ants could have nested in or against the base of a shipping container that was left on the ground in America. The ants could have burrowed into dried mud or carried soil into a crevice to create a damp home.

The fire-ant invasion raises unsettling questions about the role played by trade in spawning new pest problems. The economic benefits of free trade are often lauded, but the hidden costs—potentially billions of dollars in this case—are seldom acknowledged. Invasion biologist

Red Imported Fire Ants forage mainly over the ground but also in schrubs or low trees.

STUART HUMPHREYS/NATURE PHOTOS

Dennis O'Dowd from Monash University discounts incremental improvements in quarantine as the antidote to travelling ants. "Tramp ants don't turn up by accident", he said. "They are an inevitable consequence of international trade. If you're moving millions of cargo containers around the world, it's going to happen." He has worked on Christmas Island, where the ecology has been ruined by Yellow Crazy Ants (*Anoplolepis gracilipes*) introduced there many decades ago. During 2001 these ants appeared in Cairns, and an eradication campaign is now under way.

The fire ants at the Port of Brisbane were first identified by Chris Burwell of the Queensland Museum. Both he and Vanderwoude expect Australia to be invaded next by the Little Fire Ant (*Wasmannia auropunctata*), or Electric Ant, a mean-stinging Latin American species that now thrives in plantations and forests on New Caledonia and other Pacific islands. Quarantine entomologist Bill Crowe told me these ants are regularly intercepted at airports. "I'm fairly confident there's been a huge increase in the amount of ants coming in on cargo", he said. Little Fire Ants, unlike their larger red relatives, will thrive in our rainforests.

The immediate concern is whether Brisbane's fire-ant eradication succeeds. Vanderwoude is supremely confident but other biologists harbour doubts. In North America fire ants prove very difficult to eradicate even from small areas. Every Brisbane property within the infested zones will be baited 12 times over three years with follow-up inspections for another two years. The big fear is that nests may occur well outside the mapped area, that fire ants are festering away on roadsides and in clearings somewhere far afield. I worry about the DNA evidence implying that fire ants invaded Brisbane twice within five years. Even if Australia's enormous and expensive eradication effort succeeds, we can expect fire ants to revisit our shores (along with other ants), again and again in coming years. Vanderwoude certainly expects them to return. "We know that they will", he said. Australia is locked into a war against foreign ants that will never end. □

FURTHER READING

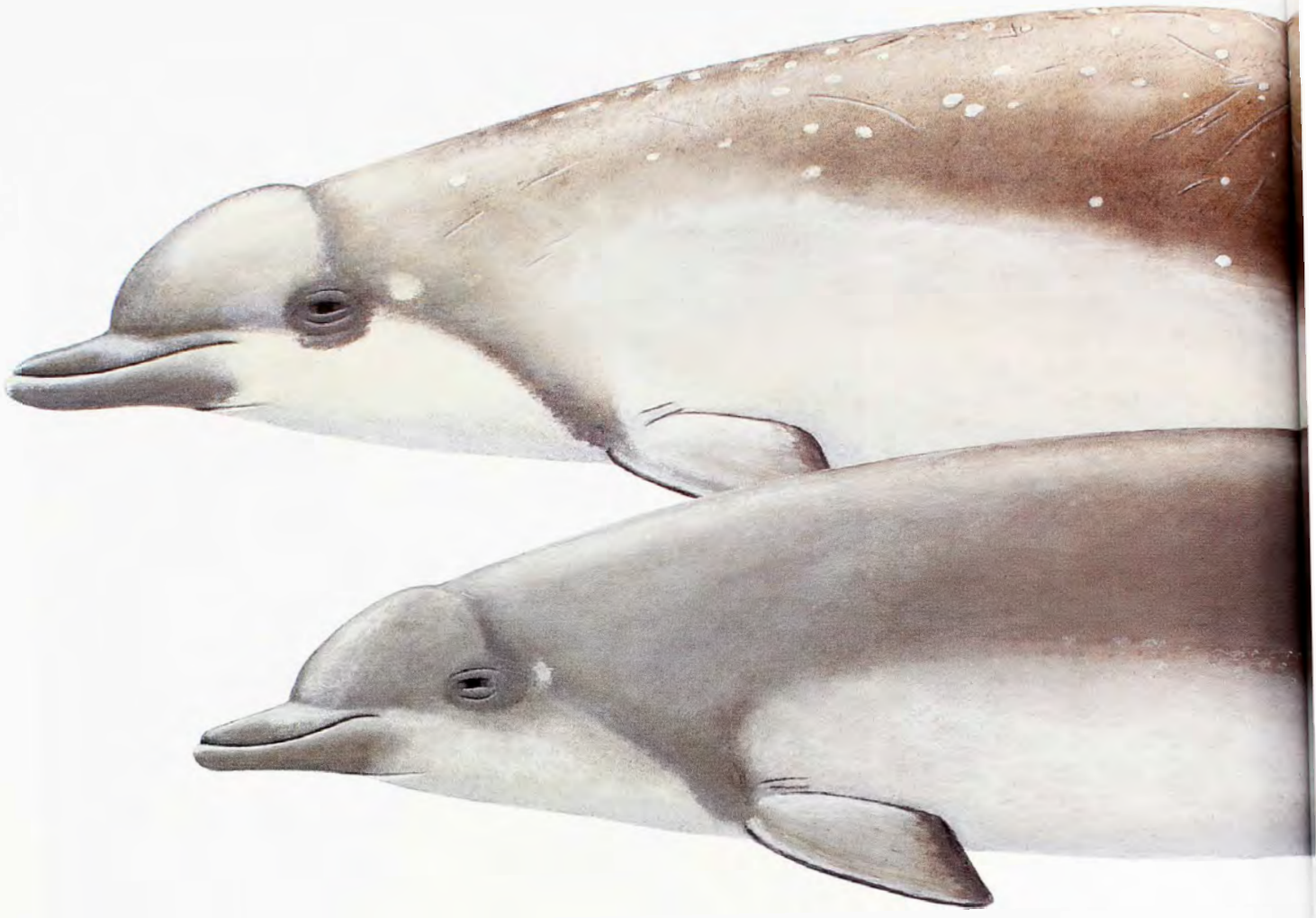
Fabres, G. & Brown, W.L., 1978. The recent introduction of the pest ant Wasmannia auropunctata *into New Caledonia.* J. Aust. Entomol. Soc. *17: 139–142.*

*Nattrass, N. & Vanderwoude, C., 2001. A preliminary investigation of the ecological effects of red imported fire ants (*Solenopsis invicta*) in Brisbane, Australia.* Ecol. Manage. & Restor. *2(3): 220–223.*

Vinson, S.B., 1997. Invasion of the red imported fire ant (Hymenoptera: Formicidae): spread, biology, and impact. Amer. Entomol. *43: 23–39.*

Wojcik, D.P., Allen, C.R., Brenner, R.J., Forys, E.A., Jouvenaz, D.P. & Lutz, R.S., 2001. Red imported fire ants: impact on biodiversity. Amer. Entomol. *47: 16–21.*

TIM LOW IS A BRISBANE-BASED BIOLOGIST AND WRITER, WHO WARNED IN 1999 (IN HIS BOOK *FERAL FUTURE*, PENGUIN) THAT AUSTRALIA FACED A GRAVE THREAT FROM NEW PESTS. HE CHAIRS THE FIRE ANT ENVIRONMENTAL ADVISORY GROUP.



BARE BONES & BEAKED WHALES

BY MEREL DALEBOUT

This finding confirmed that Longman's Beaked Whales really were out there, somewhere.

In 1882, the skull and lower jaw of a strange whale were found at Mackay, northern Queensland. No-one ever saw the animal these bones came from, but we can imagine it, sick and weak, drifting with the currents through the coral outcrops of the Great Barrier Reef, and finally coming to rest on the beach, where it died. In the months that followed, its flesh would have slowly decomposed or been eaten by birds and other animals until just the bones were left, to be scattered by the waves. Only through a stroke of luck did the skull remain, lying there on the sand, until it was collected by Mr E.W. Rawson, and donated to the Queensland Museum. When Heber A. Longman, the Museum's Curator, wrote about the whales of this area in 1926, he realised that this skull represented a new species of whale, previously unknown to science. He called it *Mesoplodon pacificus*, or the Pacific Beaked Whale, although it is now often referred to as Longman's

ILLUSTRATIONS BY PETER ARNOLD

Artist's impression of Longman's Beaked Whale; an adult female (top) and juvenile, based on information from recently discovered specimens.

Beaked Whale.

Beaked whales (family Ziphiidae) are the least known of all whales. Twenty one species are currently recognised, but most are known from only a handful of stranded animals and skeletal material in museum collections. Sightings at sea are generally rare, due to their deep-ocean distribution, elusive behaviour and possible low numbers. Examination of the stomach contents of a small number of animals suggests that they feed mainly on deep-water squids and fishes, and even crustaceans and starfishes from the seafloor. These whales, which range from 3.5 to 12 metres in length, may be some of the deepest divers known. Dives to over 1,000 metres in depth, lasting over an hour, have been recorded for some species.

Most species of beaked whales have only a single pair of teeth, set in the lower jaw. Generally these teeth develop and erupt through the gum only in adult males. In females and juveniles, the teeth remain buried in the gum, such that the animals are effectively toothless. (Only in a very few species do both males and females have erupted teeth.) Studies of scarring patterns suggest that males use their tusk-like teeth as weapons to fight other males, perhaps for dominance or for access to food or females.

The size, shape and position of the teeth, together with features of the skull, are important in distinguishing the many different types of beaked whales. However, as only adult males have erupted teeth, the heads of females and juveniles often require careful dissection to determine species identity. This is clearly not an option when dealing with live stranded animals. Even with dead animals, there is still a large potential for misidentification because most species are known from only a small number of specimens (think of the large differences in appearance between people from different parts of the world, yet we are all one species!). Also, diagnostic features may be apparent only in mature animals, and males and females can be quite different in appearance (sexual dimorphism). Even the experts can make mistakes.

After the discovery of the skull at Mackay (which is known as the 'holotype'—the specimen from which a species is first described), there were no further reports of Longman's Beaked Whale for many years. Some scientists felt that Longman may have been wrong in thinking this skull represented a new species. In 1937, Henry Raven (American Museum of Natural Histo-

In 1955,

a second skull and lower jaw of a Longman's Beaked Whale were discovered at a fertiliser factory in Somalia.

ry) proposed that it was just a Pacific Ocean form of the North Atlantic True's Beaked Whale (*Mesoplodon mirus*). In 1962, Charles McCann of the Dominion Museum (now the Museum of New Zealand Te Papa Tongarewa) suggested instead that it was the old, damaged skull of a female Southern Bottlenose Whale (*Hyperoodon planifrons*). This debate was finally resolved in 1968 by Joseph Curtis Moore (Chicago Field Museum). Using features of the skull, he showed that Longman's Beaked Whale was indeed a distinct species. He even felt it was sufficiently different from other beaked whales to be put into a new genus, *Indopacetus*.

In 1955, a second skull and lower jaw of a Longman's Beaked Whale were discovered at a fertiliser factory in Somalia, on the eastern coast of Africa. A description of this specimen was not published until 1968, so it was too late to be included in Moore's paper. However, it did confirm that Longman's Beaked Whales really were out there, somewhere.

In the laboratory at the Queensland Museum, the skull of Longman's Beaked Whale from Mackay awaits the author who will use a drill to obtain a sample of bone powder for DNA analysis. For a specimen approximately 120 years old, the skull is in good shape.

MERELL DALEBOUT

Since discovery of the Somalian specimen, there have been no further reports of Longman's Beaked Whale. As the species is known only from two skulls, we still have little idea about what these animals look like. Based on comparative skull size, they are probably about six to seven metres long and, from the empty tooth sockets in both specimens, we know they have a single pair of teeth set at the front of the lower jaw. The size of the Mackay skull suggests it may have been an adult male, while the smaller Somalian skull, likely from a younger animal, was possibly a female.

OVER THE LAST SIX YEARS, I HAVE compiled a DNA reference database for beaked whales as an aid to species identification, and to learn more about their evolutionary relationships. Although many living things are difficult to identify from external appearance, the identity of an organism always remains etched in the code of its DNA. Using a series of computer programs, the DNA sequence from an unknown 'test' specimen can be compared to sequences from known 'reference' specimens to determine its species identity.

All reference specimens used in the beaked whale database are validated by diagnostic skeletal material or photographs held in museum collections and archives. This has been possible only with the help of a large number of collaborators in many museums and universities around the world. As DNA can be obtained from almost any biological material, this database can be used to determine the species identity of a beaked whale, whether at sea, stranded alive, or long dead, no matter what age or sex, or how decomposed it may be, as long as a sample of some sort can be obtained. (Note, however, that in most States of Australia a permit is required to handle or collect any material from marine mammals.)

Although the database now includes

CARLOS OLAVARRIA

The author looking at the results of an automated DNA-sequencing run including the Longman's Beaked Whale holotype and new South African specimens.

R. L. BROWNELL JR

A pod of what scientists now recognise as Longman's Beaked Whales off the Maldives in the tropical Indian Ocean. These animals are very similar in appearance to Southern Bottlenose Whales, a species found only in cold temperate waters of the southern hemisphere. This photo suggests that Longman's Beaked Whales may not be as rare as first thought.

reference DNA sequences from all 21 known species of beaked whale, it took a long time to get to this point. Until recently, several hard-to-find species, including Longman's Beaked Whale, were missing. This meant that, for a while, some test specimens could not be identified with certainty. This was the case with two beaked whales that stranded on the Indian Ocean coast of South Africa—one in 1976 and one in 1992. Both of these animals were identified as Southern Bottlenose Whales from their external morphology. In August 1999, DNA was extracted from the skeletal remains of these specimens. Surprisingly, the results of my analyses showed that these animals were not Southern Bottlenose Whales, nor any of the other species represented in the database at that time.

In December 1999, I visited the Queensland Museum at the invitation of Steve Van Dyck, the Senior Curator of Vertebrates. My aim was to obtain a bone sample from the holotype of Longman's Beaked Whale for DNA analysis. Steve seemed very enthusiastic about the idea when I first approached him, but later confided that my request had come as a bit of a shock. Given the extreme value of this unique specimen, he felt it was akin to an art student asking permission to scrape paint from the lips of the Mona Lisa to check if her smile really was enigmatic! Clearly, it was important that the skull be damaged as little as possible.

I had been successful previously in extracting DNA from whale teeth and bone. A hand-held electric drill, with a fine drill bit, can generate enough material for genetic testing. Only 0.01 gram is needed, about the same as the head of a matchstick. The drilling must be done very slowly to avoid generating heat, which can destroy the surviving DNA. After an animal is long dead, DNA is usually better preserved in hard tissue (teeth and bone) than in soft tissue (skin and muscle), which decomposes rapidly. However, DNA is generally better preserved in teeth than in bone due to their dense mineral structure. In this case there was little choice as no teeth had been found with the Mackay skull. The age of the specimen (over 120 years) was also a problem, as was the fact that it had been found as bare bones on the beach, much weathered by the sun and sea. All these factors act to break down the DNA into smaller and smaller fragments, until almost nothing remains. My chances did not look very good, but experience had shown that every specimen is different, and you never know if you will be successful until you give it a try!

With Steve watching over my shoulder, I carefully drilled three small holes in an already broken section of the premaxilla, a bone that forms part of the rostrum or beak of the skull. Fortunately in beaked whales this bone can rival the teeth in density and hardness. I collected the small amount of bone powder in a foil tray, and took it back to the University of Auckland, New Zealand, for DNA extraction. To avoid any potential contamination from 'modern' whale DNA, such as that from living animals or recent strandings, all our 'ancient' DNA work is done in another laboratory, on a different floor from the main laboratory, using a completely separate set of chemicals and reagents. Stringent procedures are followed to ensure everything is kept as clean and sterile as possible.

THE NUMBER OF

Longman's Beaked Whales known to the world had doubled instantaneously!

In this ancient DNA laboratory, I attempted to extract DNA from the Longman's bone powder. Enzymes are used to digest the bone and cellular material, and any DNA remaining is then bound to small grains of silica (like powdered sand). The silica holds the DNA fragments immobile while they are washed clean of cell pieces and debris that have built up in the specimen over the years. The DNA is then released from the silica, and used as a template for Polymerase Chain Reaction (PCR) amplification. PCR can be envisioned as a sort of 'molecular photocopying' technique, where each copy of a DNA sequence serves as a template for making further copies. If any DNA is present in a specimen, the end result of PCR is millions of copies of the DNA fragment of interest, sufficient for sequencing and analysis. We were lucky! A small amount of DNA was successfully extracted from the Longman's holotype, and the sequence data added to the reference database.

TO OUR SURPRISE, WHEN A NEW series of DNA analyses was run, now including the sequence data from the Longman's holotype as well as the two mysterious South African animals, the results indicated that all three were the same species. The number of Longman's Beaked Whales known to the world had doubled instantaneously! Also, we could now see for the first time what this species looked like, as photos had been taken of the South African animals at the time of stranding. As expected from the initial misidentification, there was a strong resemblance to the Southern Bottlenose Whale, at least with young animals. This suggests that other Longman's Beaked Whales may also have been misidentified as this species. A similar suggestion was made

ILLUSTRATION BY FRANK KNIGHT

by Robert L. Pitman and co-authors in 1999, based on observations of unidentified 'bottlenose-like' whales in the tropical Indo-Pacific Ocean.

It remains unclear, however, whether Longman's Beaked Whale should be considered a member of the genus *Mesoplodon* or the sole member of its own genus, *Indopacetus*. Although similar in external appearance to bottlenose whales, some features of the skull nonetheless suggest a link with *Mesoplodon* beaked whales. Future analyses, using longer DNA sequences from fresh Longman's Beaked Whale material, may help to resolve this question.

So perhaps Longman's Beaked Whale is not as rare as we thought, but rather is often not recognised due to its morphological similarity with a more common, better-known species. Such a scenario can pose a serious danger to many poorly known species. If threatened directly by hunting or incidental takes, or indirectly by habitat destruction, such species may become extinct before their plight is realised. For this reason, in addition to the collection of traditional morphological information, DNA profiles should be compiled for endangered organisms wherever possible. Overall, 12 species of beaked whales are found in Australian waters, yet sightings are extremely rare. In this age of genetic engineering and Mars Landers, it is sobering to realise how little we still know about these enigmatic animals, living out there in the deep waters off the Australian coast. □

Longman's Beaked Whale

Indopacetus pacificus

Classification
Family Ziphiidae (beaked whales). Some consider this species to be a member of the genus *Mesoplodon* rather than *Indopacetus*.

Identification
Large whale with dolphin-like beak; approx. 6–7 m in length. Only two teeth, set at tip of lower jaw. As far as is known, teeth erupt from the gum only in adult males, and females and juveniles are effectively toothless. Large bulbous forehead (melon). Similar in appearance to Southern Bottlenose Whale (*Hyperoodon planifrons*).

Distribution
Deep offshore waters of the tropical Indo-Pacific Ocean. Known to date from only a few specimens.

Biology
Deep diver, feeding mainly on squid (based on what little is known about other species in family).

Status
Unknown. Possible threats from entanglement in shark nets, incidental takes by fisheries, and high-power military sonar.

Artist's impression of a Southern Bottlenose Whale. Longman's Beaked Whale may be difficult to distinguish from this better-known species.

FURTHER READING

Dalebout, M.L., van Helden, A., Van Waerebeek, K. & Baker, C.S., 1998. Molecular genetic identification of southern hemisphere beaked whales (Cetacea: Ziphiidae). Molec. Ecol. *7: 687–694.*

Moore, J.C., 1968. Relationships among the living genera of beaked whales . Fieldiana Zool. *53: 209–298.*

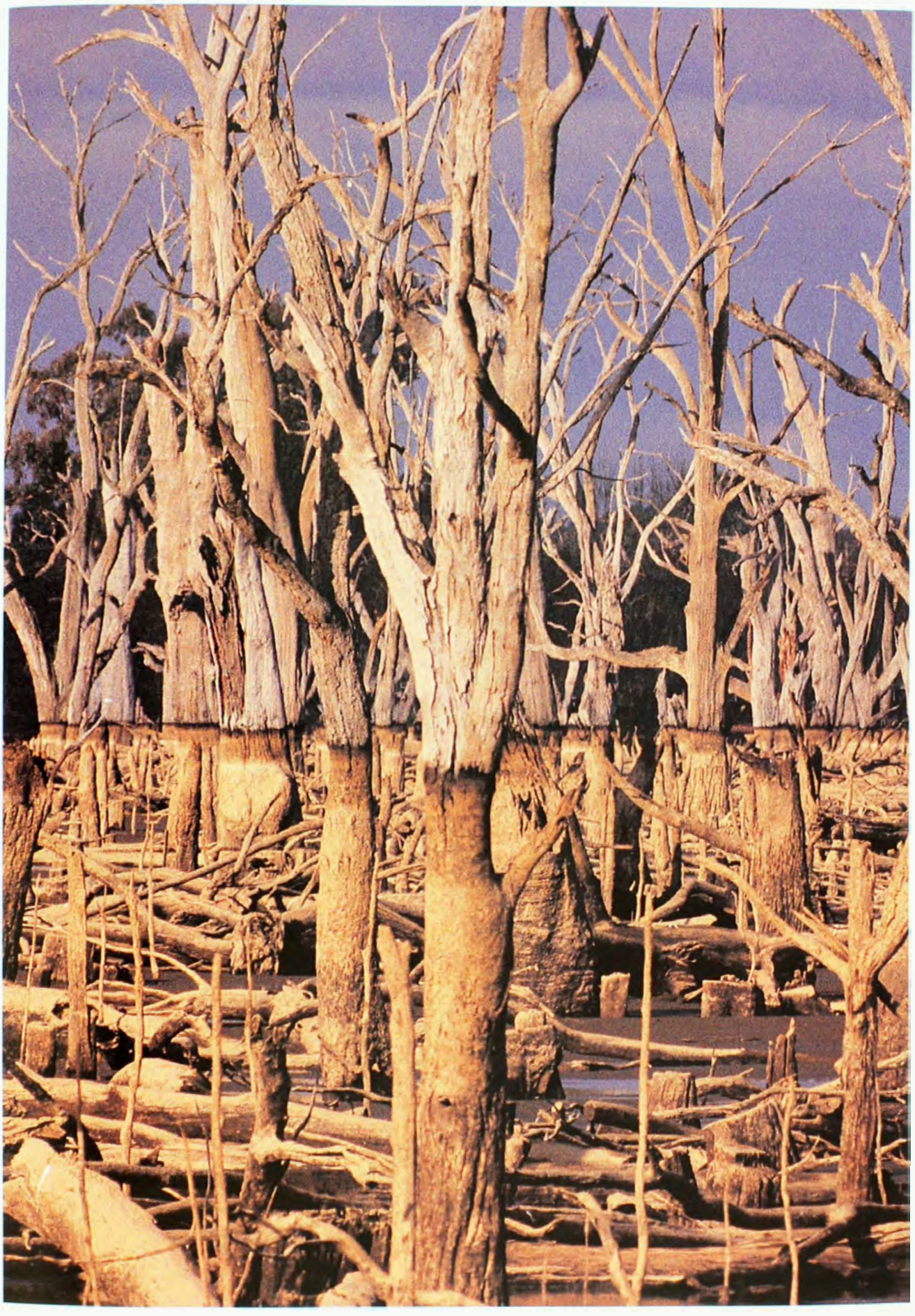
Pitman, R.L., Palacios, D.M., Brennan, P.L., Balcomb, K.C.I. & Miyashita, T., 1999. Sightings and possible identity of a bottlenose whale in the tropical Indo-Pacific: Indopacetus pacificus? Mar. Mam. Sci. *15: 531–549.*

DR MEREL DALEBOUT HAS JUST COMPLETED HER PH.D. AT THE UNIVERSITY OF AUCKLAND, NZ, INVESTIGATING EVOLUTIONARY RELATIONSHIPS AND SPECIES DIVERSITY IN BEAKED WHALES. SHE WOULD LIKE TO THANK STEVE VAN DYCK, VIC COCKCROFT AND GRAHAM ROSS FOR VALUABLE DISCUSSION AND ACCESS TO SPECIMENS.

On a per capita basis, Australians generate more greenhouse gas emissions than any other nation. Some of the major sources are road transport, power generation (especially hydro-power), heavy industry, land clearing and flatulent livestock. This picture was taken at Wollongong three to four years ago.

pictures that bite

BY REG MORRISON



The gradual decay of drowned forests such as this one in Lake Mulwala, Victoria, is a rich source of methane, the most potent and dangerous of all natural greenhouse gases.

Dazzled by morning sunlight, this Common Brushtail Possum (*Trichosurus vulpecula*) epitomises the plight of wildlife all around the world as the growing human population reduces the natural environment to a sterile parody of itself.

If an insect had inflicted this damage on one of Tasmania's ancient rainforests, no expense would be spared to eradicate it. This, however, is an example of clear-felling by wood-chippers near Scottsdale in north-eastern Tasmania.

Australia's most polluted river, the King, in south-western Tasmania, used to wind through dense Gondwanan rainforest. Nothing lives now among the pools of toxic mine effluent that fringe its rotting, treeless banks.

After dark

For what could be called the 'acid-eaters', night-time is party-time.

The rock lily *Dendrobium speciosum* 'eats acid' during the day. By opening its pores only at night, this orchid can survive in dry, rocky habitats.

PHOTOS: JAMES PLAZA ALBUM

WHEN ASKED BY A LATE-night radio host about what plants do at night, my first response was "Not much". By day, flowers buzz with pollinators, buds open, leaves unfurl, and young stems head skywards toward the light. But when the sun sets, the party's over. Or is it? Plant lives are as varied as our own.

Let's start with the nine-to-fivers, those plants that work hard all day (albeit basking in the sun) and then shut up shop for the night. A typical plant, say a gum tree or a rose, spends the day using the sun's energy to convert carbon dioxide from the atmosphere into oxygen and sugars, a process appropriately called photosynthesis. These nine-to-fivers also 'respire', like we do, during the day and night, taking in oxygen through breathing pores called stomata and extracting energy for growth from their sugar stores. While respiration during the day is overwhelmed by photosynthesis (at a ratio of 30 to 1), at night more oxygen is consumed than carbon dioxide. Happily, the levels of oxygen taken up are so low that there is no shortage of oxygen at night for us. (That old practice of removing flowers from sick rooms at night was thus in vain!)

For what could be called the 'acid-eaters', night-time is party-time. These plants soak up carbon dioxide at night, store it as acid, and then convert it back to carbon dioxide again during the day so they can use it with sunlight to produce sugars and oxygen. Why do they do this? You get a hint by the sort of plants that do this: most cacti, some succulents, native rock lilies (*Dendrobium* spp.) and some of the bromeliads (such as the Pineapple, *Ananas comosus*). These are plants that need to conserve water. If they opened their pores during the day to take in carbon dioxide, they would dehydrate. Instead they open up in the cooler night air, capture their gas, then 'eat acid' when the sun rises.

This type of photosynthesis is genetically determined but environmentally controlled (high rainfall will invoke normal photosynthesis in an acid-metabolising plant). Although this complex cycle has only recently been fully understood, Benjamin Heyne wrote to the Linnean Society of London in 1813 of his discovery that leaves of certain succulents tasted tangy in the morning but were bland by midday.

Even the nine-to-fivers do more than just controlled-breathing at night. Leaves fold and curl, flowers furl. Why risk damaging your beautiful petals or soft leaves when there is nothing for them to do? The birds and bees that assist in fertilisation are not active and, unless the plant is into acid, there is no activity on the photosynthesis front. Any contraction of plant parts will also reduce water loss. Night-shy flowers include garden bulbs such as tulips (*Tulipa* spp.) and crocuses (*Crocus* spp.), native sun orchids (*Thelymitra* spp.), and various daisies from Australia and elsewhere. And check out your overgrown veggie patch—the Carrot (*Daucus carota*) droops its entire flowering structure at night.

Other plants close up at night to keep insects in, rather than out. The most well-known of this 'bed-and-breakfast' club is the Amazon Lily (*Victoria amazonica*). Its flowers open white, scented and warm. Beetles love this mix and are attracted inside the bloom. They become preoccupied with food and sex, oblivious to the fact that as night falls the flower not only closes, but also withdraws under the surface of the water. Next morning the flower emerges again, but this time pink, odourless and cool. The slightly rattled beetles take pollen from the flower to the next white, scented and warm bloom they can find.

Lots of plants use this heat ploy. The large reproductive cones of cycads, for example, warm up in the evening, beckoning weevils to take pollen from male to female cones. Often a particular weevil species is restricted to one species of cycad. Many members of the

BY TIM ENTWISLE

aroid family (including the gigantic Carcass Flower, *Amorphophallus titanum*, growing in the Royal Botanic Gardens Sydney, and the familiar garden staples, *Philodendron* and *Monstera*) have a flower stalk that generates heat at night to help release fragrances and then to keep the night-time visitors comfortable. Plentiful food and privacy put roving beetles in an amorous mood, and they often mate amongst the flowers. One intriguing aroid, *Typophonium brownii*, mimics a pile of mammalian faeces to attract dung beetles, which then become trapped overnight and get covered in pollen.

Other flowers display their wares more overtly after dark. Sweet-smelling, light-coloured flowers, often white or pale yellow and easily visible in the evening gloom, attract nocturnal insects. Moths hover over the flowers and, because they don't need any platform to land on, these night bloomers often have neat, regular flowers. Jasmines (*Jasminum* spp.), the so-called Night-scented Jasmine (*Celestrum nocturnum*), gardenias (*Gardenia* spp.) and the aptly named Moonflower (*Ipomoea alba*) are examples of this moth-pollinated clan.

Another band of flowers emits a musty or rank odour at night. They are dingy in colour (greenish-yellow, brownish or purple) and often have dangly bits attached to the petals or other flower parts. They are the bat-attracters. Bats like something to hang onto—the dangly bits—and preferably with the flowers facing the right way—that's upside down to us. Look at the flowers of tropical garden plants such as the Sausage Tree (*Kigelia pinnata*), bananas (*Musa* spp.), Cup of Gold (*Solandra maxima*), and the fantastically named Midnight Horror (*Oroxylon indicum*). A recent study revealed that some plants are even 'loud' to bats (see "Noisy Flowers", *Nature Aust.* Autumn 2000). The flower of *Mucuna holtonii*, a Central American vine, acts like a sound-reflecting mirror and draws bats to it. If the distinctive concave petal is removed, the flower cannot echo ultrasonic signals and remains unpollinated.

Closer to home, flying-foxes pollinate or spread the seed of many Australian rainforest trees, undoubtedly playing a key role in the regeneration of some rainforest remnants. Eucalypts in these areas often have light-coloured flowers and produce more nectar at night apparently to attract these nocturnal visitors. Gliding and tree-climbing marsupials, with relatively poor vision but a well-developed sense of smell, are also active at night, but their role in dispersing the seeds of strong-smelling, dull-coloured fruits is unclear.

Beetles become preoccupied with food and sex, oblivious to the fact that as night falls the flower not only closes, but also withdraws under the surface of the water.

But it's not all fun and games. Plants are constantly measuring and analysing the world around them to decide when they should flower, start a growth spurt, or germinate. Your lawn and vegetable garden are key examples of monitoring stations: some clovers (*Trifolium* spp.) and strawberries (*Fragaria* spp.), for example, flower late in autumn as the days become shorter and, of course, the nights longer. The trigger for these changes is referred to as 'day length', but experiments have shown that an intense pulse of light during the night will uncock the trigger. The response is therefore due to the length of the dark period—broken into two short nights in the study—not the total amount of daylight. The night rules!

So plants are not idle at night. I haven't even mentioned leaves that shimmer in the moonlight or plant allies such as algae and fungi that glow in the dark; perhaps these are best discovered on your next evening stroll. What you won't see, however, are plants that live exclusively in the dark realm. The bizarre Australian native underground orchids (*Rhizanthella* spp.) and close allies (*Thismia* spp.) bloom beneath the leaf litter, never exposing their pale flowers, or indeed their rudimentary leaves and stem, to the light of day. Now that's really living for the night. □

The flowers of the Spotted Sun Orchid (*Thelymitra ixioides*) close up at night to protect the fragile petals and sepals.

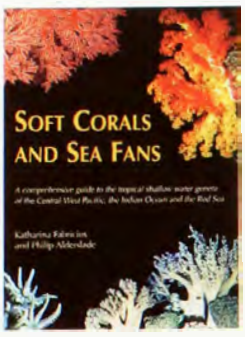
FURTHER READING

Attwell, B.J., Kriedemann, P.E. & Turnbull, C.G.N., 1999. Plants in action: adaptation in nature, performance in cultivation. *Macmillan Education Australia: South Yarra.*

Bown, D., 2000. Aroids: plants of the Arum family. *2nd ed. Timber Press: Portland, Oregon.*

DR TIM ENTWISLE IS DIRECTOR OF PLANT SCIENCES AT THE ROYAL BOTANIC GARDENS SYDNEY.

reviews



Soft Corals and Sea Fans

By Katharina Fabricius and Philip Alderslade. Australian Institute of Marine Science, Qld, 2001, 264pp. $66.00rrp.

THIS GUIDE TO ONE OF THE MAJOR COMPONENTS OF CORAL REEFS is welcome and, being authored by two of the leading workers in the field, ensures it is comprehensive. No other guide to this group exists. The guide includes some superb photos of the animals *in situ*, which will greatly facilitate identification in the field. Katharina Fabricius brings detailed knowledge of the ecology of the group and Phil Alderslade, a taxonomist, supplies details about the structure of the skeleton, which provides many of the diagnostic features used to distinguish the many genera of soft corals and sea fans.

The introductory sections are excellent and they clearly define the coelenterate groups covered in the book and those that await treatments. Certainly my experience with recreational divers is that they often find the classification of the coelenterates rather confusing and in future I will direct them to this guide.

My only gripe with what has been a major undertaking to even document all the genera present in the Central-West Pacific, the Indian Ocean and the Red Sea, is that, while a description of each family is given, no attempt has been made to provide a key. Such a key would have made the identification to genus far easier. Many people will be forced to flick through the pictures of all the genera in order to decide which ones they have seen or photographed. Obviously developing such a key would have been difficult, but not impossible. Perhaps future editions could include an interactive CD using either LUCID or Delta, and the illustrations provided in the guide.

Apart from this gripe, the book is well produced and very reasonably priced. It will be useful to coral-reef biologists, photographers and also to tourist divers trying to identify these often spectacular animals that are commonly encountered on the reef.

—PAT HUTCHINGS
AUSTRALIAN MUSEUM

The Ballad of Big Al (Walking with Dinosaurs Special)

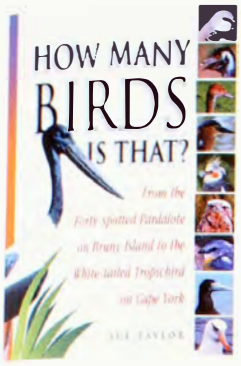
ABC DVD, 2001, running time 58 minutes. $24.95rrp.

"THE BALLAD OF BIG AL", a sequel to the spectacular BBC series "Walking with Dinosaurs", chronicles the hard life and times of a single carnivorous dinosaur (*Allosaurus* species) during the Jurassic period in what are now the Badlands of Wyoming. This half-hour film follows Al from a hatchling through adulthood to his eventual demise. Utilising the digitally based technology perfected in "Walking with Dinosaurs", computer-generated animals have been superimposed over real-life landscapes. The film achieves a surprising degree of realism in both the look and motion of the dinosaur animations and in the recreation of the lush, green Jurassic American West.

However, it is Al's hard-luck tale that 'humanises' this ripping yarn. The storyline is based on information from a single, substantially complete *Allosaurus* specimen recovered from the Badlands in the early 1990s. Upon inspection, it was obvious to researchers that this rather hapless dinosaur had suffered numerous and varied injuries, most of which had healed during his life but at least one of which may have caused his somewhat premature death (he is believed to have been a young adult when he died). Forensic pathology provided clues to the possible causes of these injuries and the effect they might have had on Al as he attempted to navigate through his often treacherous times. Al's motto was to live fast, die young and leave a scientifically important corpse.

The visually stunning DVD format is a winner. Scenes such as one of a herd of *Diplodocus* crossing a searing salt flat are artworks in themselves. Extras include a look at the excavation and laboratory work behind Al's reconstruction, a photo gallery, and a look at the conception of the story through its storyboards. "The Ballad of Big Al" is a great companion piece to "Walking with Dinosaurs" and is an incentive to begin building your DVD library if you, like me, haven't yet bought into this timely new technology.

—ANNE MUSSER
AUSTRALIAN MUSEUM



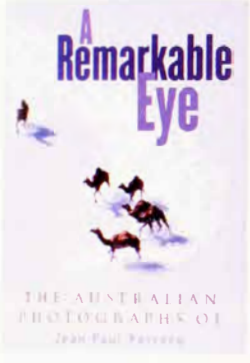
How Many Birds Is That?

By Sue Taylor. Hyland House Publishing, Vic., 2001, 160pp. $34.95rrp.

THE AUTHOR STATES THAT SHE IS UNASHAMEDLY A TWITCHER. I prefer to make a distinction between twitchers and birdwatchers and I think she falls into the latter category. Sue Taylor is obviously passionate about birds, their behaviour and habitat. She is knowledgeable. This book is about her quest to make the 600 club. For the non-birders out there, this is what twitchers do; they try and see as many species as possible and then tick them off a list. However, this book is so much more than that. Taylor has chosen eight areas where she has had unusual sightings and experiences. From her beginnings in the Victorian Goldfields, through Far East Gippsland and ending in Cape York, she tells her story. The tone is conversational and light, with many anecdotes and interesting pointers for birdwatchers. How do you distinguish between a Brown Goshawk and Collared Sparrowhawk (the obvious distinction being the shape of the tail)? "Round, frown and brown" for the Brown Goshawk and "square stare" for the Collared Sparrowhawk. Brown Goshawks have a round tail and look like they are frowning, while Collared Sparrowhawks have a square tail and appear to stare.

The audience for this book includes twitchers, birdwatchers and travellers to Australia who are interested in exciting birding areas to visit. Taylor's quest spans four decades of birdwatching and she still hasn't quite made it to the 600 club. Good luck.

—LEONIE LEMMER
AUSTRALIAN MUSEUM



A Remarkable Eye: The Australian Photographs of Jean-Paul Ferrero

By Jean-Paul Ferrero. Penguin Books, Vic., 2001, 144pp. $60.00rrp.

THE TITLE SAYS IT ALL. Jean-Paul Ferrero saw things differently from most of us. "You can spend an entire day doing nothing except waiting for the right moment", he once said, and this breathtaking collection of his Australian photographs is a celebration of his sense of timing, his tenacity and his remarkable, creative "eye". He also just happened to be a master of photographic techniques!

Through *A remarkable eye* we can share some of his "right" moments: the cover shot of camels splashing across a salt lake, one Estuarine Crocodile snatching a Barramundi, another lurking in murky water behind the ghostly image of an egret—its next meal?

His aerial landscapes are also carefully captured moments. Perhaps (as he said) he did not see his work as art, but I can't think of any other way to describe some of these images.

In the words of his colleague and friend Mike Gillam, "We are fortunate that photographers leave so much of themselves behind."

—KATHIE ATKINSON

Significant Flora of Cradle Mountain Day Walk Areas

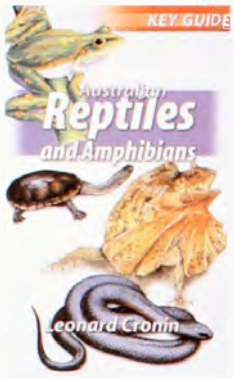
By Dick Burns. Distributed by Cradle Mountain Park Shop, Tas., 2001, 80pp. $10.95rrp.

IF YOU PLAN TO GO HIKING, WALKING OR SIMPLY STROLLING in and around the Cradle Mountain region then this little hip-pocket guide is essential. The author Dick Burns does a wonderful job at enlightening us to the vast array of vascular plant species and communities that you come across while walking in Cradle Mountain National Park. The identikit, while only 80 pages thick, gives the reader a broad description of the plant communities within the region, a brief overview of the geology of Cradle Mountain and a pictorial identification of the most common vascular plants one might see while walking.

Burns's use of colour photographs to aid in plant identification really helps. Not only is the mature plant represented but the cone/flowers are photographed as well. His descriptions are concise and easy to understand, and both taxonomic and common names are given. In each description Burns includes the names of several walking tracks where you are likely to sight the described plant or community.

Unfortunately the book does not deal with the common non-vascular plants, such as lichens, mosses, bladderworts etc., that are seen throughout the Cradle Mountain region. Apart from this one personal gripe, it is still a wonderful little book and, if you plan to visit the Cradle Mountain National Park, drop into the Cradle Mountain Visitors Centre where you can buy a copy.

—SUE LINDSAY
AUSTRALIAN MUSEUM



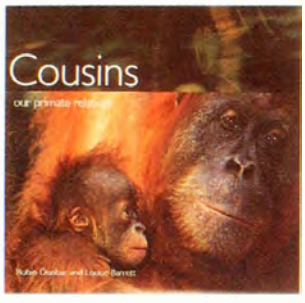
Australian Reptiles and Amphibians

By Leonard Cronin. Envirobook, NSW, 2001, 224pp. $35.00rrp.

THIS BOOK SHOULD PROVE VERY USEFUL TO FIELD NATURALISTS. It does not illustrate every Australian reptile and frog but, as it states, it has "carefully selected" species representative of different families, and includes the most commonly encountered species and those most likely to be noticed. The book starts with an introduction that gives an overview of Australian reptiles and amphibians. This is followed by more specific sections on limbless reptiles (snakes and legless lizards), amphibian adaptations and snake bite treatment. Instead of a formal key there is a 'visual key' with small versions of the main species illustrations grouped into categories of frogs, turtles, lizards, snakes etc. You can glance at these to find the picture that best matches your specimen, then turn to the associated page number to see if your specimen matches the text as well. Each species illustrated is accompanied by half a page of information including a distribution map, description, behaviour, breeding notes (development), diet, habitat, size and status. Instead of a photo, a painted illustration highlights key diagnostic features.

Four artists were involved in producing these paintings and, as a result, the style is mixed. Nevertheless the animals are all clearly recognisable and will aid in identification, which is the purpose of a field guide. This book won't necessarily help you if you find an obscure reptile or amphibian, but should make a handy guide to those species you're most likely to meet.

—MARTYN ROBINSON
AUSTRALIAN MUSEUM



Cousins: Our Primate Relatives

By Robin Dunbar and Louise Barrett. BBC Worldwide, 2000, 240pp. $54.95rrp.

PRODUCED AS AN ACCOMPANIMENT TO THE BBC TV SERIES "Cousins", this book provides a fascinating insight into the intriguing lives of our close relatives, the other primates. With so many of the 230-odd primate species recorded worldwide currently threatened by habitat loss or hunting, this book provides a timely and authoritative account of the origins, diversity, behaviour and general ecology of this wonderful group.

Cousins is easy to read, beautifully presented and full of superb photographs. It is divided into four main sections. The first traces the evolution of primates from the time of the dinosaurs through to their place in the world today. Subsequent sections focus on the three main groups of primates, the prosimians (meaning 'before apes'), monkeys and apes, using recent research to highlight key aspects of their biology. Interspersed throughout the book are "Special Features" that explore topics such as the bushmeat trade, "stink fights" among lemurs, and the function of humour in our own species. Another particularly useful feature of the book are the "Family Portraits". These sections profile individual primate groups or species by summarising key information about their biology.

This book is highly recommended to anyone with even a passing interest in the world of our fellow primates.

—SANDY INGLEBY
AUSTRALIAN MUSEUM

Dangerous Creatures of Australia

By Martyn Robinson. New Holland, NSW, 2002, 96pp. $16.95rrp.

AUSTRALIA'S REPUTATION AS A LAND JUST WAITING TO BITE YOU is not sullied by Martyn Robinson's excellent little book. Within a compact, pocket-sized format, Robinson provides an entertaining and informative account of our biting, stinging, sucking, cutting, goring, impaling, clawing, kicking, dive-bombing and just plain poisonous fauna.

The book is visually pleasing with a lively mix of interesting text and eye-catching colour plates and arranged in four major sections based on animal size and habitat. Both general and particular topics, including first-aid, are presented for each animal group in the form of "Frequently Asked Questions", interspersed among the excellent species descriptions.

There are few obvious inaccuracies—one arresting typographical error has funnel-web spiders being "up to 60 cm long", and their presence in northern Queensland is omitted.

This is an excellent pocket guide to Australia's dangerous creatures. It is highly recommended as an everyday ready reference manual. It would also make a thoughtful gift for any newly arrived overseas visitor.

—MIKE GRAY
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

Great Lakes Wildlife Rescue (NSW) Inc.
"Huntley" Lakes Way
BUNGWAHL NSW 2423
Ph: 02 4997 6157
Contact: Margaret Seal

Membership: $16.50 Single, $22 Family

WIRES

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

Membership: $40.00

BIRDS

Canberra Ornithologists Group
26 West Street
QUEANBEYAN NSW 2620
Ph: 02 6272 2110
Web: *www.canberrabirds.dynamite.com.au*
Contact: Kathy Walter

Membership: $35.00

Hunter Bird Observers Club
PO Box 24
NEW LAMBTON NSW 2305
Contact: Marion Walker

Membership: $20.00

Threatened Bird Network
415 Riversdale Road
HAWTHORN EAST VIC 3123
Ph: 03 9882 2622
Web: *www.birdsaustralia.com.au*
Contact: Network Coordinator

EDUCATION

CSIRO's Double Helix Science Club
PO Box 225
DICKSON ACT 2602
Ph: 02 6276 6643
Web: *www.csiro.au/helix*
Contact: Kasia Kucharska

Membership: $27.00

Marine Education Society of Australasia
PO Box 461
EAST BENTLEIGH VIC 3165

Membership: $55.00 Individual, $125.00 Institution

ENVIRONMENTAL

Nature and Society Forum Inc.
GPO Box 11
CANBERRA ACT 2601
Ph: 02 6288 0760
Web: *www.natsoc.org.au*
Contact: Sue Gilbert

Membership: $30.00 Single, $15.00 Concession, $50.00 Corporate

The Earth Sanctuaries Foundation (ESF)
PO Box 1135
STIRLING SA 5152
Ph: 08 8370 9422
Web: *www.esf.org.au*
Contact: Cheryl McEgan

Membership: $45.00 Single, $30.00 Concession, $60.00 Family

INSECTS

Butterfly & Other Invertebrates Club Inc.
PO Box 2113
RUN CORN QLD 4113
Ph: 07 3206 6229
Contact: Lois Hughes

Membership: $12.00 Single, $17.00 Family

MUSEUMS

QLD Museum Association Inc.
PO Box 3300
SOUTH BRISBANE QLD 4101
Ph: 07 3840 7632
Web: *www.qma@qm.qld.gov.au*
Contact: Carol Middleton

Membership: $20.00 Single, $40.00 Family, $15.00 Concession

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: $85.00 Family, $68.00 Single, $50.00 Concession

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

Membership: $90.00 Family, $70.00 Single

NATURAL HISTORY

Dinosaur Club
Australian Museum
6 College Street
SYDNEY NSW 2010
Ph: 02 9320 6223
Contact: Cathy Lamond

Membership: $15.00

Sydney Fungal Studies Group
5 Dawes Street
LITTLE BAY NSW 2036
Ph: 02 9661 4898
Web: *http://argus.appsci.usyd.edu.au/fungi/*

Membership: $25.00 Single $35.00 Joint (Family), $10.00 Student

REPTILES & AMPHIBIANS

Frog & Tadpole Study Group of NSW Inc.
PO Box 296
ROCKDALE NSW 2216
PH: 0419 249 728
Web: *www.fats.org.au*
Contact: Arthur White

Membership: $30.00 Single (Frogcall & Herpetofauna), $35.00 family (Frogcall & Herpetofauna), $20.00 Single (Frogcall only), $25.00 Family (Frogcall only)

Frog Group (RANA) Inc.
PO Box 1104
BROADBEACH QLD 4218
Ph: 07 3875 7215
Web: *http://www.wildsuburbia.net/rana/rana.htm*
Contact: Val Bonner-Burrowes

Membership: $16.00 Family, $11.00 Single, $5.00 Child under six

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

ARE YOU A CLUB SECRETARY?

Nature Australia's Associate Society Scheme is designed to help your club or society with free publicity, funds and member benefits. Call on (02) 9320 6119 for more details.

q&a

Greengrocer with the Blues

Q: *I am a keen cicada observer and last summer I came across a Greengrocer that was a beautiful shade of blue. Can you explain?*

—Peter Franklin
Mt Cola, NSW

A: The Greengrocer (*Cyclochila australasiae*) is usually green but orange-yellow and blue forms may occur. The blue form, known as the Blue Moon, is rarely encountered. The green pigment of most cicadas is insectoverdin, a common colouring for green insects that comes from a mixture of yellow and blue compounds. These, mixed, give the usual green form. When blue pigment is absent, individuals are yellow; and on rare occasions when the yellow pigment is absent, blue individuals result. The blue is very unstable and quickly fades when the cicadas die.

—Max Moulds
Australian Museum

Feather Legs

Q: *I was bushwalking on my property near Braidwood last autumn when I happened to see a strange-looking insect with feathery legs walking up the trunk of a* Eucalyptus *tree (see photo). What kind of insect is this?*

—Jane Lamont
Bellevue Hill, NSW

A: Your photo clearly shows a feather-legged bug (*Ptilocnemus* sp.). These fascinating insects are true bugs (order Hemiptera) and have piercing, sucking mouthparts. A few *Ptilocnemus* species seem to produce a secretion that attracts ants. When the ants mouth the secretion they become paralysed and this enables the bug to suck out their juices. There are several Australian species and they are all quite small, approximately one centimetre in length. They shelter beneath tree bark or rocks, usually in association with an ant colony. The Australian Museum would appreciate any specimens of this group of insects.

A feather-legged bug (*Ptilocnemus* sp.).

—Martyn Robinson
Australian Museum

Sexing Magpies

Q: *I have been puzzled for some time by the gender of one of a pair of local Magpies. Although her behaviour had all the hallmarks of femaleness, her nape feathers are as snowy white as her mate's. Now that I have confirmed that she is indeed female, I presume that grey nape feathers are not necessarily a female characteristic or is my Magpie a rarity?*

—A. Drover
Crows Nest, NSW

A: In mated pairs of Magpies, the female usually has a greyer nape than the male, in whom this region is snow white. Individuals of the same sex can exhibit considerable variation in this colour. Your seemingly anomalous female may be towards one extreme of this character. Another contributing factor could be the age of the bird. It has been observed in a number of

Not all green grocers are green.

STUART HUMPHREYS NATURE FOCUS

species that older females take on some of the colouration of adult males. Your bird may be of an advanced age in Magpie years.

—Walter E. Boles
Australian Museum

Losing Feathers

Q: *I have a couple of Magpies that regularly call on me. Every year in about January one of them, I think the male, loses all his white feathers at the back of his neck. All his other plumage looks fine. The stubs that remain look very scruffy, even a little bloodied. What would cause this? Also a Kookaburra that is a regular visitor seems to loose all its tail feathers at about the same time. Is that a result of nesting, perhaps squeezing into too small a hole?*

—P. Hacker
Ashgrove, Qld

A: Kookaburras, like other kingfishers, nest in hollows. Entering and leaving the cavity, and moving around within the nest chamber, can lead to increased abrasion of the tail feathers. The loss of these feathers from this behaviour would seem extreme, but the periodicity of your observations suggest that this results from a regular event, of which breeding seems the most likely. The cavity may be narrower than the optimum while not actually preventing the birds from passing through it or rearing young.

The Magpie's annual loss of nape feathers is also a periodic event, but the reasons are less obvious. Subordinate birds may lose feathers in this region as a result of harassment and pecking by more dominant individuals. However, the fact that your bird is part of a pair and returns regularly is characteristic of an individual that has successfully maintained a territory. A subordinate bird would be expected to have been expelled from the area. It is possible that your bird has a genetic or parasitic disorder that causes the feather loss you observe, although the latter would probably not show up with this degree of regularity.

—Walter E. Boles
Australian Museum

Answers to Quiz in Nature Strips (page 18)

1. *Mountain Ash* (Eucalyptus regnans) **2.** *Stephen Jay Gould* **3.** *Western Australia and Tasmania* **4.** *Three* **5.** *A jellyfish* **6.** *Burnett or Mary River* **7.** *No man's land* **8.** *No* **9.** *Leadbeater's Possum* **10.** *Rocks*

Australian Museum/Nature Focus

Pic Teaser

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, *Nature Australia* Magazine. Please don't forget to include your name and address. The first correct entry will win a copy of *A photographic guide to mammals of Australia*. Winter's Pic Teaser was a larva of a crayfish (*Ibacus* sp.).

The end of natural evolution

Humans are replacing the natural factors that have shaped evolution in the past with artificial factors that will shape it in the future.

MOST PEOPLE ARE FAMILIAR with the two common ways humans destroy nature: causing local populations and entire species to go extinct, and moving species to places where they do not occur naturally (see *Nature Aust.* Summer 2000–2001). But there is a third way humans destroy nature. This is by changing the environmental conditions under which species will evolve in the future. Humans are replacing the natural factors that have shaped evolution in the past with artificial factors that will shape it in the future. These changes are often so subtle that they are below the recognition threshold of most people. However, because the changes are additive, at some stage they will become noticeable even to the average person.

Everything humans do affects the evolutionary conditions and hence evolutionary future of other species. This includes changing the levels of naturally occurring substances such as carbon dioxide and water in the air or particulate matter in water, or changing intangible things like heat and wind velocity. More seriously, it includes the introduction of chemical compounds that have never before been seen in nature, or of predators, parasites and pathogens that have never before been encountered. It also includes the introduction of genes into species that have never before contained those genes (see *Nature Aust.* Autumn 2002).

Even our policies that control how we deal with animals changes their evolution. Game laws and fishing regulations often dictate that only certain sizes or one sex be killed, that is, removed selectively from the gene pool. Conservation programs and captive-breeding programs often favour individuals that might not have been so favoured in nature. Commercialisation of flora and fauna will deem some individuals commercially more desirable than others and favour them in ways that nature might not. Animal welfare saves individuals that in nature would have died and therefore have had less chance of passing on their 'bad' genes.

Conscious human influence has turned the Grey Wolf into the Dachshund, the Jungle Fowl into the chook, and an Asian minnow into the Goldfish.

How much can human influence actually change species? The answer can be seen in the history of domestication and animal and plant breeding. Conscious human influence has turned the Grey Wolf into the Dachshund, the Jungle Fowl into the chook, and an Asian minnow into the Goldfish. Unconscious human influence has caused some insect populations to evolve resistance to both natural and novel poisons and to change colour, and bacteria to become resistant to antibiotics. All this has happened in at most a few thousand years, a twinkling of an eye in evolutionary time. In some cases it has happened in just a few years.

Does any of this matter? That depends on your perspective. If you are just interested in seeing species continuing to persist on Earth, regardless of what they look like and what their interaction with other species are, then it probably doesn't. But if you stand in awe of the product of 3.6 billion years of evolution before the advent of humans, then the changes are sad to see.

Can anything be done about this? Obviously not, since the 'solution'—the extinction of humans—while removing the 'cause' would also remove the only source of concern. But perhaps there are two things we can do. First, we can think about how our actions are likely to affect the evolution of other species and try to mitigate the impact. This will not solve the problem. It will only slow the inevitable and allow a few more humans to enjoy the way nature was before human influence becomes pervasive. And second, we should think about harvesting some of what is passing away on a daily basis and preserving it so that future generations can see 'what was'.

If there had been biologists toward the end of the Cretaceous and they had had warning of the evolutionary impact of the impending asteroid strike, what would we have wanted them to preserve so we could better understand today what the world was like on the eve of that change? An academic question? Not at all, because we are in virtually the same situation today. But today the impact is ourselves.

BY ALLEN E. GREER

DR ALLEN E. GREER IS A PRINCIPAL RESEARCH SCIENTIST AT THE AUSTRALIAN MUSEUM.

THE LAST WORD IS AN OPINION PIECE AND DOES NOT NECESSARILY REFLECT THE VIEWS OF THE AUSTRALIAN MUSEUM.

SUBSCRIBE TO NatureAustralia

Save time and money by having Nature Australia delivered to your door!

In the next issue...

- *Cicadas*
- *Purple-necked Rock-wallabies*
- *Magpie-larks*
- *Princess Parrots*
- *Dinosaurs*
- *Origins of Human Art*
- *Dingoes*

Summer issue on sale December 2002

Toll-free Subscription Hotline: (1800) 028 558

See reverse for details of back issues

NEW SUBSCRIBER YES!

PLEASE SEND A SUBSCRIPTION FOR

❑ 3 years for $97.90 *(overseas $A116-surface, $A176-airmail)*
❑ 2 years for $69.30 *(overseas $A83-surface, $A123-airmail)*
❑ 1 year for $36.30 *(overseas $A45-surface, $A65-airmail)*
Prices are GST inclusive where applicable.
❑ Start this subscription with _____ issue

Name _____
Address _____
Suburb/Town _____ Postcode _____

Payment by ❑ Cheque ❑ Money Order ❑ Bankcard ❑ Visa ❑ Mastercard ❑ American Express

My card number is _____ Expiry Date /

SIGNED _____ CARDHOLDER'S NAME (Print) _____

❑ *Tick if you require a GST tax invoice.*

NatureAustralia

Cheque or card authority has to accompany order. Make cheques payable to 'Australian Museum'. *Nature Australia* is a quarterly magazine, with issues released in March, June, September and December. Please allow up to 12 weeks for delivery of first issue (unless backdated). Prices valid to December 2002. PHONE THROUGH CREDIT CARD ORDERS ON ☎1800 028 558. SUBSCRIBE BY FAX 02 9320 6073.

SPRING 2002

GIFT SUBSCRIPTION YES!

I WOULD LIKE TO SHARE MY FACINATION WITH NATURE WITH SOMEONE ELSE

❑ 3 years for $97.90 *(overseas $A116-surface, $A176-airmail)*
❑ 2 years for $69.30 *(overseas $A83-surface, $A123-airmail)*
❑ 1 year for $36.30 *(overseas $A45-surface, $A65-airmail)*
Prices are GST inclusive where applicable.
❑ Start this subscription with _____ issue

To _____
Address _____
Suburb/Town _____ Postcode _____
From _____
Address _____
Suburb/Town _____ Postcode _____

Payment by ❑ Cheque ❑ Money Order ❑ Bankcard ❑ Visa ❑ Mastercard ❑ American Express

My card number is _____ Expiry Date /

SIGNED _____ CARDHOLDER'S NAME (Print) _____

❑ *Tick if you require a GST tax invoice.*

NatureAustralia

Cheque or card authority has to accompany order. Make cheques payable to 'Australian Museum'. *Nature Australia* is a quarterly magazine, with issues released in March, June, September and December. Please allow up to 12 weeks for delivery of first issue (unless backdated). Prices valid to December 2002. PHONE THROUGH CREDIT CARD ORDERS ON ☎1800 028 558. SUBSCRIBE BY FAX 02 9320 6073.

SPRING 2002

SEND THIS CARD AND PAYMENT POSTAGE FREE TO:

BACK ISSUES

Australian Museum
Reply Paid 66752
Darlinghurst NSW 2010
Australia

SEND THIS CARD AND PAYMENT POSTAGE FREE TO:

Australian Museum
Reply Paid 66752
Darlinghurst NSW 2010
Australia

SEND THIS CARD AND PAYMENT POSTAGE FREE TO:

Australian Museum
Reply Paid 66752
Darlinghurst NSW 2010
Australia

BACK ISSUES AND SUPPLEMENTS

PURCHASE ANY OF THESE FOR $3.30 EACH INCL P&H AND GST

ISSUE #	CONTENTS
23/3*	• Tracking Echidnas • The Story of 'Ene' • Tasmanian Tiger's Sister
24/12	• Frogs and Drugs • Creatures of the Earth's Ancient • Central Rainforest
25/1	• Wandering Albatross • Right Whales • New Investigations • Irish Spiders
25/2	• Owls • Platypus • Dinosaur Sex • Koala Diet
25/3	• Dugongs • Killer Rats • Red Goshawk
25/4	• Wallabies • Stick Insects • Parrotfish • Tree Dwellers
25/5	• St Kilda Penguins • Fox Control • Clash of the Carnivores
25/8	• Turtles • Boyd's Forest Dragon • Whitewinged Choughs
25/9	• Numbats • Dugongs • Introduced Vermin • Whales
25/11	• Echidnas • Tree-kangaroos • Octopuses • Mammal Pollination
26/1	• Bloodworms • Tusked Frog • Wattle Birds • Lyrebirds • Tornadoes
26/2	• Peregrine Falcons • Red Crabs • Flying-foxes • Ground Frogs • Ice Man
26/3	• Cockroaches • Kakapo • Blue-tongue Lizards • New Holland Mouse
26/4	• Green and Golden Bell Frog • Possum Spotlighting • Ibis • Humans & Dinosaurs

Available at $5.50 each (including postage & handling and GST)

26/5	• Boobies • Velvet Geckoes • Giant Squids • Ice Ages • Earthworms
26/7	• Glossy Black-Cockatoos • Mosquitoes • Brush-tailed Rock-wallabies
26/8	• Rock Ringtail Possum • Magpie Geese • Butterfly Mating • Origin of Life on Earth
26/9	• Striped Possum • Cane Toads • Snake Penises • Shy Albatross
26/10	• Port Jackson Sharks • Wedge-tailed Eagles • Humans in Australia • Marsupial Carnivores • Brown Tree Snakes
26/11	• Crimson Rosellas • Marsupial Moles • Mud-dauber Wasps • Butcherbirds • Crocodiles as Dinosaurs
26/12	• Grey Nurse Shark • Cassowary • Box Jellyfish • Centipedes • Giant Bear Cuscus
27/1	• Eclectus Parrots • Healing Honey • Velvet Worms • Desert Skinks
27/2	• Malleefowl • Dugongs • Great Barred Frog • Hagfishes
27/3	• Hairy-nosed Wombats • Killer Whales • Seabirds • Ancient Snakes • Mosses • Antechinuses
27/4	• Leadbeater's Possum • Dogs and Humans • Humpback Whales • Barn Owls • Jabirus
27/5	• Kookaburras • Lungfish • Jumping Spiders • Sea Snakes • Lost Giants

SUPPLEMENTS

S2 Tracks Through Time —The Story of Human Evolution—a look at our origins @ $10.94 each including postage & handling and GST

* Denotes limited stock

BACK ISSUES/POSTERS/CATALOGUES/LIBRARY BOXES ORDER FORM

Qty	Issue/Suppl. No	Price $
	BODY ART CATALOGUE @ $20.00	
	TRACKS THROUGH TIME @ $10.94	
	2004 HAT POSTER COLLECTION @ $12.00 per set	
	LIBRARY BOXES @ $14.23 each	
	TOTAL $	

Post to:
NATURE AUSTRALIA, AUSTRALIAN MUSEUM,
REPLY PAID 66752, DARLINGHURST NSW 2010
(or phone 1800 028 558 toll free or fax 02 9320 6073)

Name _____

Address _____

Suburb/Town _____ **Postcode** _____

Debit my ❑ Bankcard ❑ Visa ❑ Mastercard ❑ American Express EXPIRY DATE

Card Number

Signature

Cardholder's Name (print)

Cheque or card authorisation must accompany order. Please make cheques payable to Australian Museum

BACK ISSUES AND SUPPLEMENTS

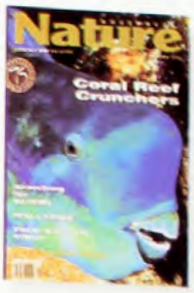
23/7

24/12

25/1

25/2

25/3



25/4

25/5

25/8

25/9

25/11

26/1

26/2

26/3

26/4

26/5

26/7

26/8

26/9

26/10

26/11

26/12

27/1

27/2

27/3

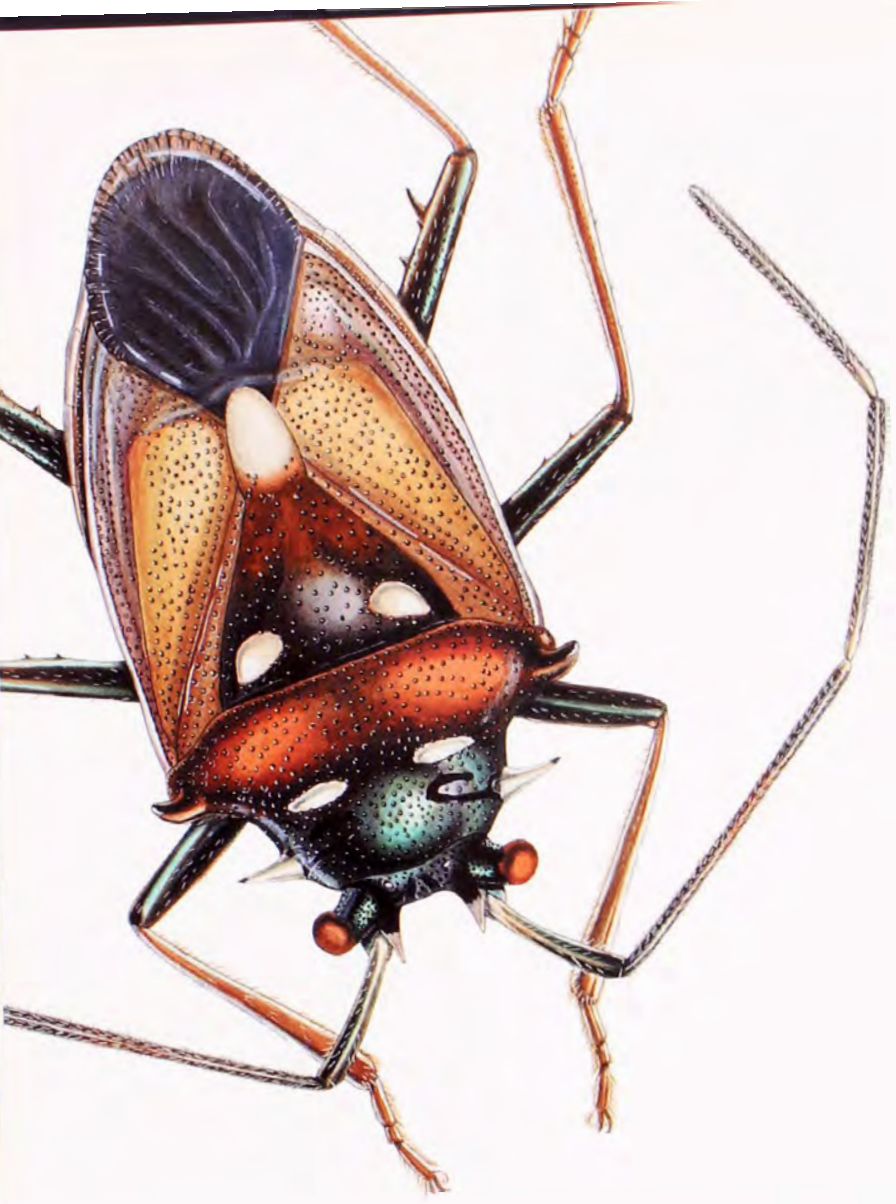
27/4

27/5

NatureAustralia library box

HOLDS TWELVE ISSUES OF THE MAGAZINE. FINISHED IN DURABLE, DARK GREEN PVC, IT WILL ENSURE YOUR COPIES REMAIN IN MINT CONDITION.

TO ORDER USE THE FORM OPPOSITE



IMAGES FROM SCIENCE

Australian Museum Artists 2002 • 7 September to 24 November

The first ever exhibition of scientific drawings, paintings and photography by Australian Museum artists will be on display at the Australian Museum from 7 September to 24 November 2002.

Don't miss this stunning showcase of 14 artists' unusual and intricate scientific images that are used to record and interpret the Museum's research and collections.

A range of activities will accompany the exhibition including artist demonstrations and lectures most Sundays.

AUSTRALIAN MUSEUM
1827–2002
175
YEARS OF DISCOVERY

ART & ABOUT
the city as a canvas

ted by the City of Sydney and AMP

6 College Street, Sydney (cnr William Street, opposite Hyde Park) NSW 2010
Ph (02) 9320 6000 www.amonline.net.au Open from 9.30am to 5pm every day.