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NatureAustralia

Winter 2005 Volume 28 Number 5

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

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

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

Proudly printed in Australia by Penfold Buscombe

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

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

nsw arts

The Australian Museum is a statutory authority of, and principally funded by, the NSW State Government.

Published 2005 ISSN–1324–2598

NATURE AUSTRALIA is proud winner of the 1987, '88, '89, '90, '91, '92, '93, '99, 2000, 2002, 2003 and **2004 Whitley Awards** for Best Zoological Periodical, and the 1988 & '90 Australian Heritage Awards.

FRONT COVER
Pheasant Coucal (*Centropus phasianinus*) chicks beg to be fed.
PHOTO BY CYRIL WEBSTER

up front

As with many things in life, it seems the more we learn about our fauna, the more surprises there are in store for us. Take the Pheasant Coucal for example. When it comes to rearing young coucals it's the male that steps up to the nest and takes on the responsibility. For this non-conformist behaviour to take place, the male should be producing less testosterone— that hormone responsible for fighting and suppressing parental instincts like feeding and incubation. But does it?

Then there's the case of the cuscus that fooled science. The Northern Common Cuscus is a relatively large possum that, for many years, scientists believed was capable of colonising vast oceanic archipelagos on natural rafts washed out to sea by storms and floods. But what was really going on was very different, with both humans and possums making the most of what the other had to offer.

Also in this issue we discover just what tricks and traps orb-weaving spiders weave into their webs, meet a frog capable of living in acidic water, follow two scientists' desire to built native-animal-friendly freshwater traps,

TOM HEINSOHN

Northern Common Cuscus.

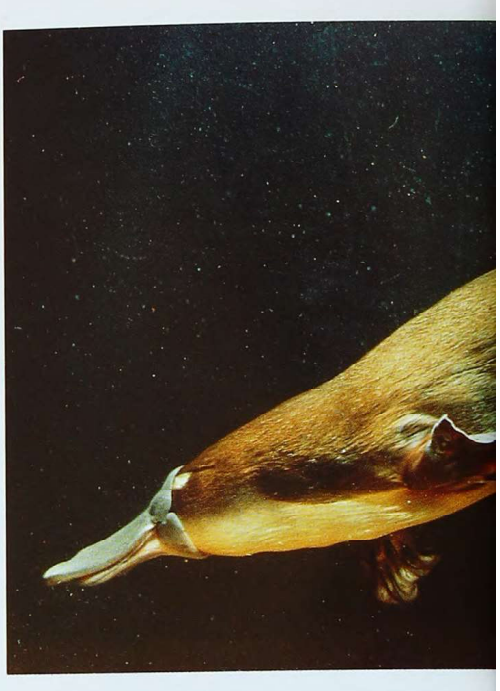
and delve into the incredible world of the termite colonies of our northern region.

— JENNIFER SAUNDERS
Publishing Manager

ALEX McWILLIAM

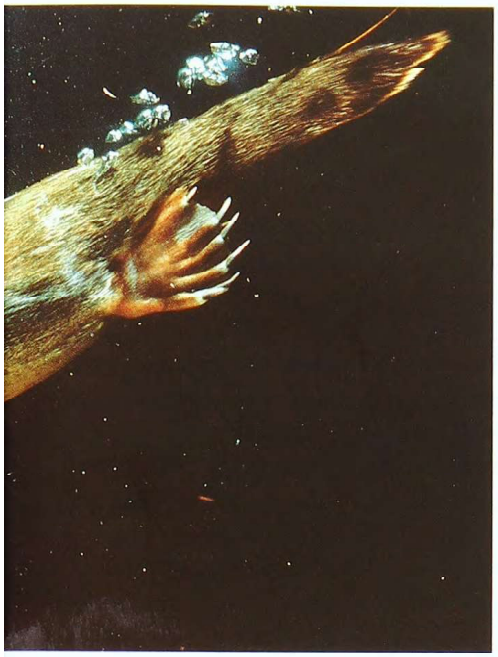
Pheasant Coucal.

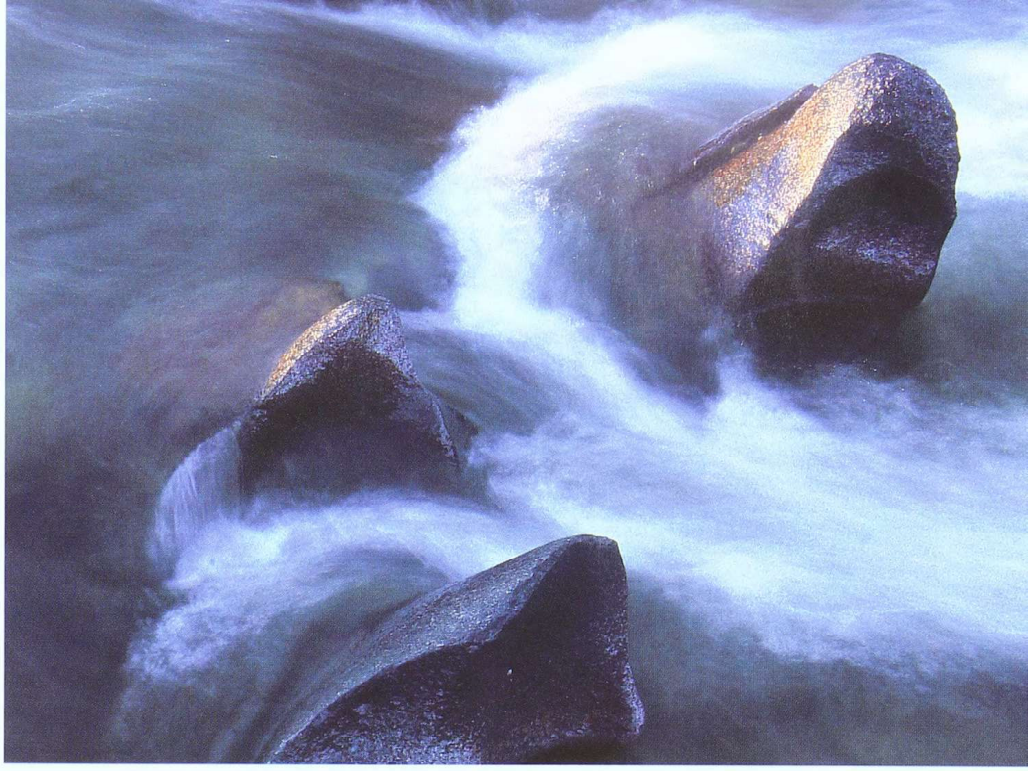
contents



ARTICLES

REGULAR FEATURES





RARE & ENDANGERED

Wallum Froglet

Despite its ability to breed in water with the acidity of vinegar, the Wallum Froglet is sensitive to environmental change.

BY CRAIG FAULKNER

22

WILD THINGS

Saline Solutions?

There is no simple cure for the 'creeping white cancer' that afflicts much of the Australian landscape.

BY TIM LOW

24

PHOTOART

Impressionist Streams

Beautiful water views from the lens of Andrew Dennis.

BY ANDREW DENNIS

26

GLOBAL SPOTLIGHT

Reptilian Cows?

The Giant Anteater seems more at home in a book of make-believe animals than in the pages of a natural-history magazine.

BY SIMON D. POLLARD

68

BEING HUMAN

This Sporting Life

How did different sports begin? Is sport a preparation for life's battles, or were we just born to run?

BY RICHARD FULLAGAR

70

THE SECRET LIFE OF PLANTS

Size Matters

The biggest flower. The tallest tree. The widest trunk. The largest canopy. Are there limits to the growth of plants?

BY TIM ENTWISLE

72

THE LAST WORD

Back to Nature

Why do we spend ridiculous amounts of money on our pets and have an irresistible urge to feed the wildlife? It's in our genes.

BY CECILY MALLER

80

COLUMNS

letters

Humans Not All Greedy

Tim Denham's article about Papua New Guinea (*Nature Aust.* Autumn 2005) is excellent. I can now see clearly Jared Diamond's error in assuming that all cultures are like his own: greedy for more of everything. Many of the old cultures have no desire to expand beyond their own resources or dominate other peoples, animals or land. Our perpetual desire for more is not a characteristic to be proud of. It shows a lack of wisdom and may eventually destroy us.

—Alexandra Seddon
Pambula, NSW

Endangered Quolls

Just thought that you might be interested to know that I received a letter from the Federal Minister for the Environment and Heritage Ian Campbell yesterday, informing me that the Northern Quoll (*Dasyurus hallucatus*) has been listed as Endangered under the *Environment Protection and Biodiversity Conservation* Act 1999 and the "Biological effects, including lethal toxic ingestion, caused by cane toads (*Bufo marinus*)" have been listed as a Key Threatening Process under the Act. Hopefully this will aid the conservation of the quolls and other fauna affected by the toads.

There is still no sign of recovery at the Mary River site where the quolls became extinct in January 2003 (see *Nature Aust.* Spring 2004). The East Alligator site has three females left (from an original population of 45!). Unfortunately I will not be able to determine the persistence or timing of extinction of this population as funding for the Kakadu study was not renewed.

—Meri Oakwood
Envirotek, Nana Glen, NSW

Menopause and Mother-in-Laws

Richard Fullagar in "Childhood's Beginning" (*Nature Aust.* Summer 2004–2005) expresses a common view about menopause when he refers to "the advantages of grandmothers (who live beyond menopause to assist in child rearing)." However, he doesn't explain why other animals don't use menopause to extend the life of helpful old females. The following speculation of mine explains why life beyond menopause only really makes sense for humans.

Humans are unusual in that only men are able to hunt even though there would have been occasions in our history when women would have needed a reliable share of the meat to survive.

Marriage was the solution to this female dilemma. However, the only women who succeeded were those who, unlike just about all

HANS AND JUDY BESTE/AUSTRALIAN MUSEUM

It's official: the Northern Quoll is Endangered, and Cane Toads are to blame.

other female animals, had changed into 'sexy apes', becoming sexually receptive most of the time.

In Darwinian terms, marriage to a sexy ape only made sense if the children the hunter was supporting were his own. The problem for the hunter was that good hunting meant being too far away from his wife to protect her from other opportunistic males.

Fortunately for the hunter, his mother could keep a sharp eye on her daughter-in-law while they gathered food together, provided menopause had helped extend her life.

A menopausal old lady is not fast enough or strong enough to directly stop any hanky panky. She would have needed something else that is unusual about humans if she was to protect her son's interests: a language that is complex enough to tell tales, compare subtle observations with other old ladies, and to put moral pressure on those who might be tempted.

Humans are the only species that have all of the characteristics required for menopause to make sense.

—John Davidson
Chapel Hill, Qld

Fairy Circles

In regard to "Fairy Circles" (*Nature Aust.* Autumn 2005), could they be the result of large, dead (now totally decomposed) animals? The soil at the centre of the circles would be highly (too?) fertile, and may perhaps inhibit plant growth.

—Karen Montgomery
Urana, NSW

The fairy circles are arranged in a relatively regular pattern. If they represented the remains of dead animals, I would expect a clumped or random pattern.

—Gretel van Rooyen
University of Pretoria

Dating Service for Stone-curlews?

I was delighted to see the familiar face of a Bush Stone-curlew on the cover of *Nature Australia* (Autumn 2005). A pair of these birds has lived in our retirement village complex for some years. In the 18 months I have lived here, they have hatched at least three clutches of two chicks. One chick of each hatching has survived to adulthood and moved away. Where do they go? Do they find a mate? While it is important to preserve areas of natural habitat for our wildlife, it is encouraging to know that it is possible for them to cohabit with us. Perhaps we could provide a 'dating service' to progeny of isolated pairs of Bush Stone-curlews. I'm sure there are other secluded residential complexes that would enjoy watching and protecting wildlife if given the chance and the knowledge. Our pair perseveres despite lawn mowers, people and vehicles. They regularly raise offspring. It would be good to know that the young birds could find a mate of their own.

—Gretel Quinn
Runaway Bay, Qld

When Less is More

I note with interest Barrie Gillings's observations on the increasingly common occurrence of two, rather than three, molars in each quadrant of the human dentition (*Nature Aust.* Autumn 2005). In my own family, genetics has gone askew, with at least three generations being dentally deficient. Neither my father nor any of his five children had wisdom teeth. In addition, several of my deciduous teeth were never replaced, one (a molar) lasting well into my fifties when it split in two. I must admit, however, that I've had few teeth problems throughout life and am still functioning dentally with my original set. In view of the number of my friends who have spent fortunes on orthodontists for their children, not to mention root-canal therapy and surgery for impacted wisdom teeth, I am wondering whether I carry a mutation that might have well proved highly adaptive for human evolution!

—Anne Drover
North Sydney, NSW

HANS AND JUDY BESTE, AUSTRALIAN MUSEUM

Bush-stone Curlew.

For the Record

The scientific name of the Little Broad-nosed Bat, shown in the lead spread of the "Solar-powered Bats" article (*Nature Aust.* Autumn 2005), is *Scotorepens greyii*.

Nature Australia **requests letters be limited to 200 words and reserves the right to edit them for sense. Please supply a daytime phone number and type or print your name and address clearly. The best letter in this issue will receive a copy of *Rocks and fossils*. The winner this issue is John Davidson.**

Winter

Compiled by Geordie Torr and Martyn Robinson

Winter-flowering Zig Zag Wattle (*Acacia macradenia*).

DENSEY CLYNE

WATTLE HAPPEN?

Up to a third of wattles (*Acacia* spp.) flower in winter. Superficially, this seems like utterly the wrong thing to do, as the weather is cold and bleak and there are few insects about to ferry pollen around. But although this is true, by the same token, the few insects that are still active at this time of year have fewer flowers to visit and hence the winter-flowering wattles have the field stacked in their favour. And with so little choice, the next flower that an insect visits is far more likely to be of the same species—so the chance of a successful pollination is further increased.

W.P. ARMSTRONG

Despite many species having a heavy scent, wattles don't provide their pollinators with a floral nectar reward like many other flowers—it's the abundant pollen itself that is the attractant. Pollen is rich in protein and, with spring breeding seasons approaching, many animals are grateful for the nutritional bounty it offers. The timing also benefits the wattles, allowing them to set seed and germinate early in springtime and get a head start on rival seedlings of other, later-flowering, plants. Winter flowering also ensures that there's enough moisture around to support mass flowering and prolongs the life of the flowers themselves.

To learn more about winter wattles, visit **www.abc.net.au/science/scribblygum/july2003/default.htm**

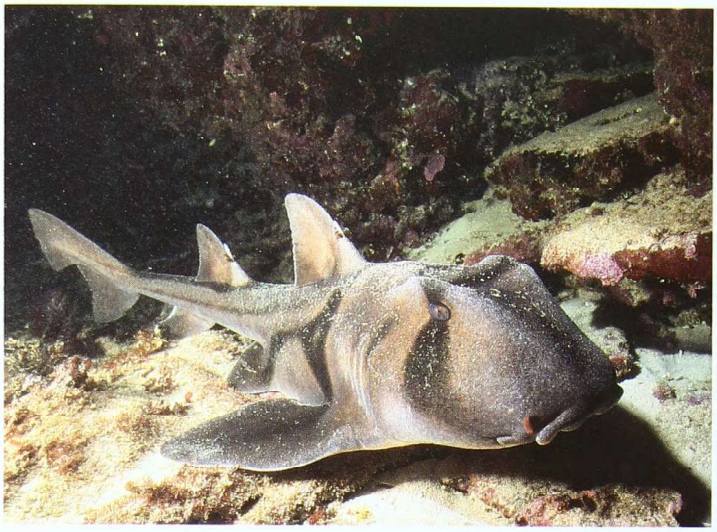
VOMIT THAT WALKS

The wet weather of winter has arrived with a vengeance and, after a lengthy downpour, you notice a strange pile of Dog vomit on the back lawn in a shady spot—strange because you don't own a Dog. Chancing upon it a few hours later, the 'vomit' has definitely moved a few centimetres. What's going on?

'Dog vomit' slime mould *Fuligo septica*.

This mobile vomit is a multinucleate slime mould—probably a species called *Fuligo septica*, which feeds on organisms in rotting vegetation. Neither plant nor animal nor fungus, slime moulds are usually allied with the latter. Like fungi, they sexually reproduce by spores. These are usually produced when the slime mould has finished feeding and moves into a patch of bright light. Spore-producing bodies rise up from the mass and sooty-looking spores blow off in the wind to 'germinate' somewhere damp. Other slime moulds have an animal-like incarnation where they are found as free-living amoebae that are much like white blood cells. In this form they reproduce asexually by dividing in two.

It's perhaps no surprise that such a bizarre life form has inspired a science-fiction film—who could forget that early Steve McQueen vehicle, "The Blob"? Although there are many different species of slime mould and several types, colours and shapes, none is likely to take over the world



EVA BOOGAARD LOCHMAN TRANSPARENCIES

Port Jackson Shark.

anytime soon. But don't get too complacent—a slime mould recently solved a maze. Not bad for an organism without a brain.

For some more fascinating facts about slime moulds, visit **http://rainforestaustralia.com/Slime_Moulds.htm**

STACKS OF SHARKS

If you're a diver and you're willing to brave the frigid temperatures both in and out of the water, winter offers the chance to witness something rather special. The cooler months represent the breeding season of the Port Jackson Shark (*Heterodontus portusjacksoni*), a harmless bottom-dwelling species with a rather unshark-like diet of sea urchins and molluscs. Come the winter, the sharks often form impressive aggregations in rocky caves and gullies during the day—dozens of sharks stacked on top of one another awaiting nightfall, when they will begin feeding and courting.

The sharks aren't restricted to their name place, and are widely distributed from the southern Queensland coast south to Tasmania and west to Geraldton on the mid-Western Australian coast. Some travel more than 800 kilometres to reach the breeding sites, and a few wayward individuals have even been recorded in New Zealand.

As in all sharks and rays, fertilisation is internal, via the strange fleshy pelvic fin extensions, referred to as claspers, of the males. The shark's odd spiral-shaped eggs are soft when laid and the females have been reported to pick them up with their mouths and wedge or screw them into rock crevices so they won't wash away.

For more about PJs, as they're known to divers, see *Nature Aust.* Spring 2000 and visit **www.amonline.net.au/fishes/students/focus/heter.htm**

FROM THE COLLECTION

AUSTRALIAN MUSEUM

*This Southern Grass Skink (*Pseudemoia entrecasteauxii*) was collected in December 1943 by Australian herpetologist Stephen J. Copland from near Kiandra on the Southern Tablelands. It is mainly an alpine and cool-climate species, being found in the highlands of New South Wales, southern Victoria, Tasmania and some of the Bass Strait Islands. There it can be found in forest, woodland and heath in the colder situations right down to the coast.*

During winter, this species often forms hibernating balls where several individuals cluster and coil up together to wait out the cold months. By bundling up together, they reduce the chance that they'll freeze, the larger mass of flesh retaining heat longer than a solitary lizard would.

At this time of year, many female Southern Grass Skinks will have a higher sperm count than the males. This is because mating occurs in autumn and the females store the sperm inside their bodies through winter. When spring arrives, the females begin to ovulate and fertilisation takes place. However, this species doesn't lay eggs; rather it produces live young that are nourished via the reptilian equivalent of a placenta. Once again, this is related to the cool climate in which the lizards live. As soon as the eggs are laid they are at the mercy of the elements and predators. By retaining them inside her body, the female can better protect them and also speed up their development by warming them as she basks in the sun.

For more on this fascinating skink, visit **www.parks.tas.gov.au/wildlife/reptile/Grasssk.html**

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, RACHEL SULLIVAN, ABBIE THOMAS, GEORDIE TORR AND PAUL WILLIS ARE REGULAR CONTRIBUTORS TO **NATURE STRIPS**.

Ribbiting Viewing

Those melodious male frogs we hear on a warm summer's night play to a tough crowd. The females they serenade don't just judge them on the sounds they make, but also on their visual performance.

In a novel experiment by Gil Rosenthal (Boston University) and colleagues, female Túngara Frogs (*Physalaemus pustulosus*) were given the chance to respond to the songs of suitors produced in concert with video playback (*Anim. Behav.* 68: 55). In their sound suite with flat-screen monitor, the female frogs were played movies of male Túngara Frogs, which inflate their vocal sac when calling. The researchers played footage of males with their sacs inflating in sync with the frog's song, as well as footage of deflated males dubbed over the same tune. The female frogs were also shown footage of a pulsing rectangle to determine whether it was simply the movement that attracted females. But it was the image of the ballooning vocal sac combined with the croak that proved to be significantly more popular amongst the females, which responded by leaping towards the screen.

Since females prefer a full audio-visual display from performing males, this may explain why so many amphibian species have highly patterned and colourful vocal sacs, many of which become much brighter during courtship. The combination of ribbiting viewing and calling helps a female pinpoint her suitor in the swamp.

—K.H.

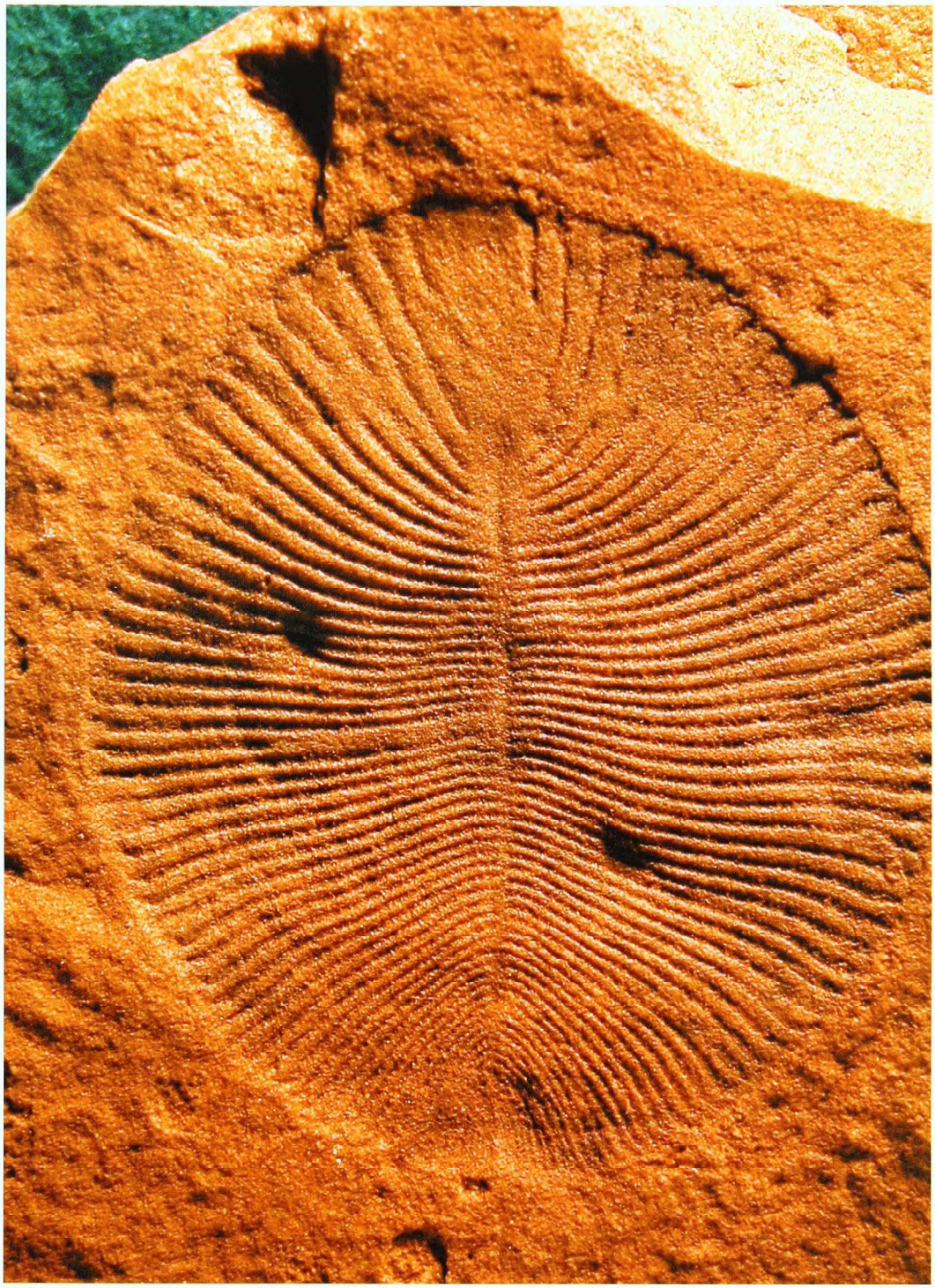
Dino Growth Spurt

Although we often think of dinosaurs as massive creatures, the reality is that only some of them were really enormous. But how did these ones get to be so big? There are two main strategies. Either they lived a long time and just kept growing, or they may have had a fantastic growth spurt during some part of their lives.

Working out which growth strategy a particular dinosaur used is hampered by not having a good understanding of how old

GUNTHER SCHMIDA/LOCHMAN TRANSPARENCIES

Audio-visual display by the Orange-thighed Frog (*Litoria xanthomera*)?



COURTESY JIM GEHLING

***Dickinsonia costata*, at nine centimetres long, was a flattened, segmented worm-like animal from the newly declared Ediacaran Period.**

individuals are. You really need a continuous growth series, from hatchlings right through to old age.

By studying *Tyrannosaurus* and its close relatives, Greg Erickson (Florida State University) and colleagues had perhaps the most comprehensive growth series known for any group of dinosaurs. Analysis of the growth rings in the bones showed that *T. rex* reached its five-tonne adult weight in a short but startling spurt during its teenage years (*Nature* 430: 772). From around the age of 12 until their early 20s, the average *T. rex* was packing on a whopping 2.1 kilograms in weight a day. This study also showed that close relatives, while having similar life spans, did not have such an explosive teenage growth spurt and, consequently, never got so big.

But, as Erickson *et al.* point out, there was a price to be paid for *T. rex*'s feverish growth. The James Dean of Dinosaurs, *T. rex* lived fast and died young, reigning at its adult size for only a few short years before a death at around the age of 28.

—P.W.

A New Age Begins

The 'periods' of the geological time scale, such as Triassic and Jurassic, not only divide up Earth history into standard units, but also refer to major phases in its biological evolution. For instance, the Cretaceous Period (about 145–65 million years ago) marks the final phase of the reign of the dinosaurs, and ends with the meteorite impact that caused their extinction. Similarly, the Cambrian Period (542–495 million years ago) has long been the earliest period characterised by complex animal life. Prior to this, all life was assumed to be simple microbes.

However, in the 1940s, large, bizarre pancake-like fossils were discovered in pre-Cambrian deposits in the Ediacara Hills in South Australia, and later also in Russia, North America and Africa. These included the disc-shaped *Tribrachidium*, the leaf-shaped *Rangea*, and the eliptical *Dickinsonia*, and demonstrated that there was a radiation of complex animals before the Cambrian. After spirited debate at the March 2004 meeting of the International Union of Geological Sciences (the official body that names geological ages), a proposal by Andrew Knoll (Harvard University) and colleagues was accepted, and this phase in the evolution of our planet is now officially known as the Ediacaran Period (*Nature* 305: 621).

While students might groan at having yet another tongue-twisting name to memorise, the rest of us should celebrate that Australia can now lay claim

DR STUART MILLER, LOCHMAN TRANSPARENCIES

Adelie Penguins don't take any chances when it comes to leaping out of the water

to its own slice of Earth history—the first new geological period recognised in over a century.

The Ediacaran Period begins around 620 million years ago, when the world finally warmed up after a global ice age that froze even the equator, and ends 542 million years ago, when most of the Ediacaran creatures were replaced by more advanced Cambrian forms. A sequence of rocks in Enorama Creek in the Flinders Ranges documents this interval and will now serve as the standard reference for geologists the world over. Proposed sites in other countries were less informative or more forbidding. For instance, a Canadian location was rejected because, as Jim Gehling (South Australian Museum) puts it, "you need to get there by helicopter and then fight off the bears".

—M.L.

Pop-up Penguins

As they near an iceshelf, Adelie Penguins (*Pygoscelis adeliae*) launch themselves up out of the water to land on the edge of the ice above. If they miss, the consequences can be dire. Hungry Leopard Seals (*Hydrurga leptonyx*) constantly patrol these waters, hoping to make a meal of a penguin with a bad aim.

In these leaping feats, penguins can jump up to three metres above sea level. It's quite an effort and usually repeated many times a day, so Ken Yoda (Kyoto University) and Yan Ropert-Coudert (National Institute of Polar Research, Tokyo) wondered whether penguins try to minimise the amount of energy they expend leaping out of the water (*J. Zool., Lond.* 263: 1).

Part of the challenge is that penguins, like all animals that dwell in both air and water, have a distorted view of the world. When they look up at an iceshelf from under the water, the cliff they see is more than 1.3 times higher than it actually is, because of the way that water bends light.

The researchers filmed 23 penguins leaping onto iceshelves, predicting they would follow a trajectory that minimised distance and angle, and therefore effort. To their surprise, they found that penguins jumped higher and farther than they needed to in order to make a safe landing. It seems the penguins aim for the refracted image of the edge of the ice, rather than adjusting their jump to land where the edge really is.

While not very efficient, this minimises a penguin's chances of missing its foothold and falling back into the sea, suggesting penguins would rather waste a bit of energy than risk becoming dinner for a Leopard Seal.

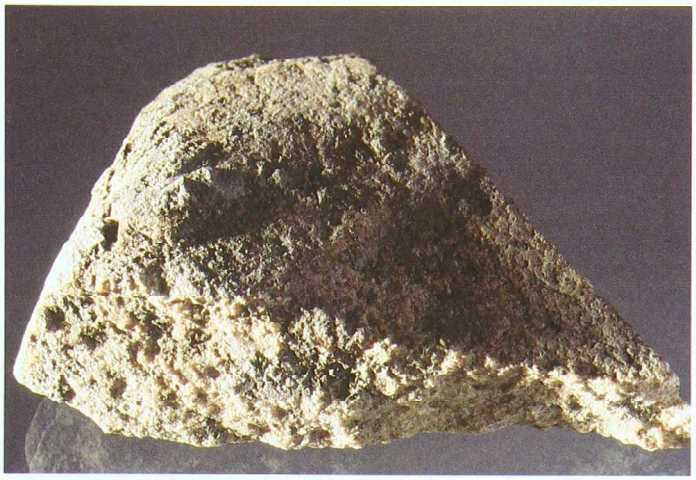
—A.T.

First Flours

Discoveries of starch on stone tools are helping to rewrite the history of food production, to explain the emergence of modern human behaviour, and to shed light on why some societies went down the

path of agriculture. Many starchy plants like tubers and seeds (our main sources of carbohydrates) have distinctive microscopic granules that survive archaeologically.

Dolores Piperno (Smithsonian Institution, Panama) and colleagues found starch granules diagnostic of wild barley (*Hordeum* sp.) and possibly wheat (*Triticum* sp.) on a 23,000-year-old flat basalt slab from the Israeli site of Ohalo II (*Nature* 430: 670). Charred seeds of various grasses are preserved at the site—perhaps the best preserved hunter-gatherer 'village' known in the Upper Palaeolithic world of the last ice age—but starch on the basalt 'work surface' shows exactly what type of plants were processed and how the seed husks were removed before further grinding to make flour and dough for cooking. It would be at least 12,000 years before wheat and barley were so cultivated and genetically modified that we would call them domesticated crops. Seed-grinding stones, about 30,000 years old, have also been found in Australia.



Part of a 30,000-year-old seed-grinding stone from Cuddie Springs, New South Wales.

Stones for grinding flour and peeling tubers demonstrate culinary sophistication, and their first appearance may mark the emergence of modern humans. Philip van Peer (Catholic University of Leuven, Belgium) and his research team excavated a 200,000-year-old site on Sai Island, Sudan (*J. Hum. Evol.* 45: 187). They found distinctive stone-tool kits (called Sangoan), ochre, sandstone slabs and polished quartzite cobbles with starch granules (possibly from seeds)—all suggesting some of the earliest behavioural evidence of modern humans before they dispersed out of Africa.

—R.F.

Wide-mouthed Snakes

My best friend in primary school had a habit of pulling silly faces, and I remember his mother telling him to stop it otherwise he'd look that way forever. Of course, nobody ever took that remark seriously, but recent work by Fabien Aubret (University of Western Australia) and colleagues shows that it might be true, at least for

COURTESY J. FIELD & G. BRITTON

some reptiles (*Nature* 431: 261).

Eastern Tiger Snakes (*Notechis scutatus*) living on desolate islands possess longer jaws than their mainland relatives and are forced to tackle larger prey (seagull chicks as opposed to frogs and mice). The researchers investigated whether these large jaws are due to hard-wired genetic differences or were growth responses induced by exposure to larger prey.

They raised some mainland snakes on small mice and others on large mice, and did likewise for two groups of island snakes. The results were more complex and interesting than expected.

At birth, the island tiger snakes had slightly longer jaws than the mainland snakes, indicating that the differences were partly genetic. However, island snakes raised on a diet of large prey grew bigger jaws than did their siblings given smaller prey. Mainland snakes showed no such ability to tailor their growth to their diet. The large jaws on island tiger snakes are therefore the result of both nature and nurture: they are born with bigger gapes, but are also able to increase their gapes further during growth if continually forced to swallow large prey.

—M.L.

Pigeon Highways

Homing pigeons have long been thought to follow man-made structures like highways and railways on their homeward journey, but accurately tracking the birds was difficult using available technology.

COURTESY HANS-PETER LIPP

Homing pigeons fitted with GPS satellite-tracking devices have shown they like to stick to the roads.

Recently, however, Hans-Peter Lipp (University of Zurich) and colleagues attached miniaturised GPS satellite-tracking devices to

GUNTHER SCHMIDA/LOCHMAN TRANSPARENCIES

Some Eastern Tiger Snakes are able to tailor their jaw size to their diet.

the backs of these specially bred Rock Doves (*Columba livia*) and found that, not only do the homing pigeons follow roadways, but they also frequently stay on a road until they can turn at an intersection—even if it makes the journey longer (*Curr. Biol.* 14: 1239).

During the three-year study, the researchers analysed more than 200 flight paths, each 20–80 kilometres in length, made by pigeons travelling back to their loft from various locations around Rome. They found that, when the birds were released from familiar sites, pigeons that had previously flown the course tended to fly along the same roads or railway tracks as before.

The researchers say the birds have a remarkable ability to switch from one navigational strategy to another depending on circumstances. The study birds followed roadways primarily in the early-to-middle sections of their journeys, probably to help get a fix on their position using their inbuilt compass. Closer to home they switched strategies, relying on topographical features such as hills and villages to help them 'home in' on their loft.

Even though following roads may add to the journey, the early benefits of staying on course seem to compensate for the extra distance travelled. The researchers also suggest that following the same road over and over again allows the birds to be on autopilot, meaning brain power can be devoted to tasks like keeping an eye out for predators.

—R.S.

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Well-defined cheek patches maketh the Great Tit.

Fortune Favours Tidy Tits

Many birds possess flashy features, such as a long tail or colourful plumage, to advertise their sexual suitability to mates. The message is: "Look at me. I've got great genes and would make a great parent. You can't do better." But some birds also have more subtle features that convey similar information.

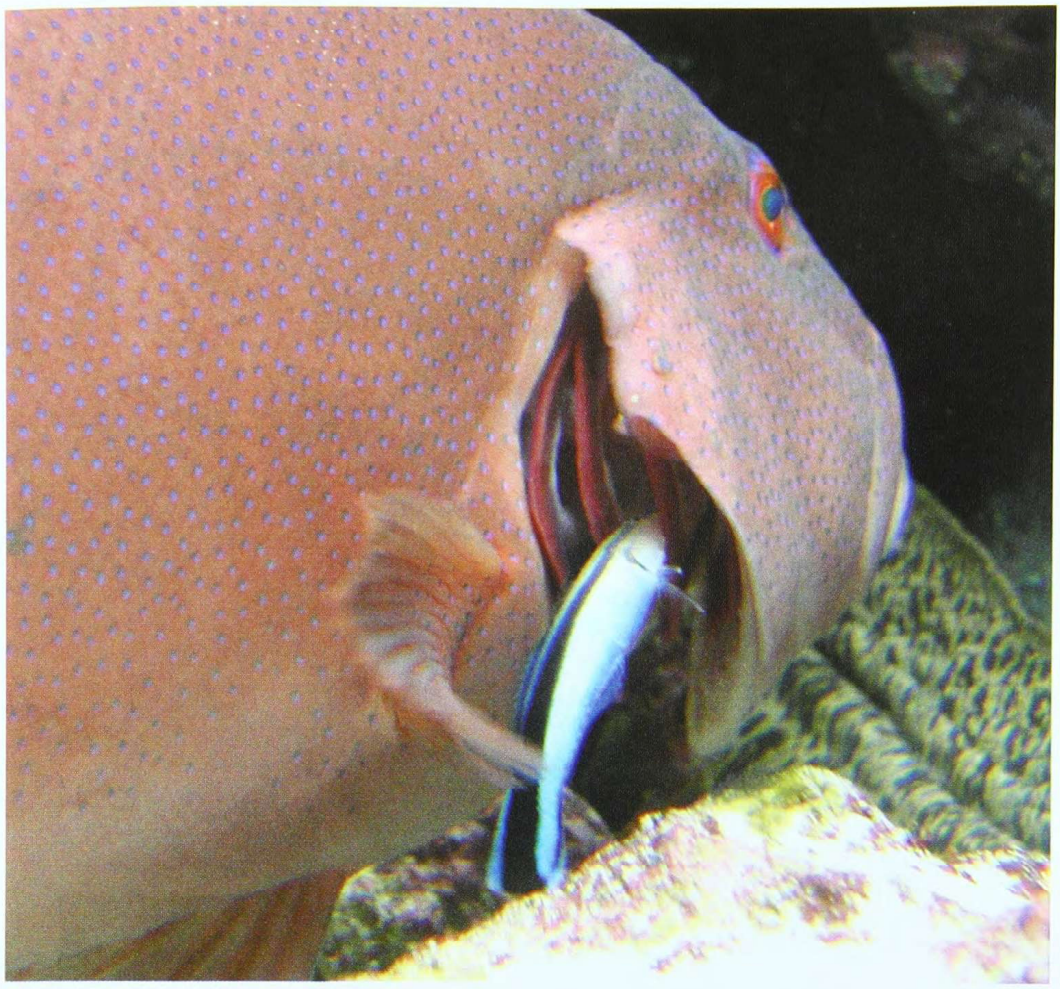
Great Tits (*Parus major*) have large, white, teardrop-shaped cheek patches that they display to other tits. Mostly these patches have sharply defined edges that make them stand out from the surrounding black feathers.

Because the patches play such an important function in intra-specific communication, UK researchers Peter Ferns (Cardiff University) and Shelley Hinsley (Centre for Ecology and Hydrology, Monks Wood) wondered what would happen if the patches were slightly dishevelled. They used a black dye to make the edges of cheek patches appear uneven in some tits, then observed how they coped in the wild (*Anim. Behav.* 67: 261).

Tits were more aggressive to birds with less immaculate cheek patches, forcing them to feed where they were likely to be attacked by sparrowhawks. Meanwhile, the tits with neat patches got to feed in the safer area close to cover. Tidy tits were also more likely to survive to the end of winter and to produce heavier chicks when food was scarce.

The face is particularly vulnerable to wear and tear, and messy-edged cheek patches may signal that the bird is infested with mites or ticks or has been pecked by other birds. Any tit on the hunt for a mate would be well advised to keep itself looking neat and tidy.

—A.T.



COURTESY ALEXANDRA GRUTTER

How does the Bluestreak Cleaner Wrasse avoid being eaten by its client, the Coral Trout?

Cleaner Contracts

Every marine-life devotee has seen footage of queues of large, hungry-looking fish patiently waiting for their turn at the cleaner-fish station. But how do cleaner fish, which pick the parasites out of their normally piscivorous clients' mouths, ensure they don't end up as dinner? Alexandra Grutter (University of Queensland) thinks she has the answer: they distract them with a sensual, fins-on dance.

Previous work had suggested that, in such symbiotic cleaning relationships, cleaners are at risk from hungry clients, as well as those whose parasite load has been reduced and whose subsequent need for the cleaner's services has declined.

To determine whether cleaner and client behaviours differed with client hunger levels and parasite loads, Grutter tested how these factors affected the interactions between the Bluestreak Cleaner Wrasse (*Labroides dimidiatus*) and the piscivorous Coral Trout (*Plectropomus leopardus*).

She found that tactile dancing, in which the cleaner rubs the client with its body and fins, occurs more frequently when cleaners are exposed to hungry clients, regardless of the client's parasite level (*Curr. Biol.* 14: 1080). Grutter suggests that tactile dancing may be a pre-conflict management strategy that is elicited by the client's behaviour. But just how a cleaner fish recognises that a client is hungry is unknown.

—R.S.

Constipated Snakes

Most people would agree that when it comes to poo—and the potentially toxic by-products of digestion that it contains—out is better than in. In the animal world, however, that's not always the case. Some snakes, according to Harvey Lillywhite and colleagues at the University of Florida, appear to have evolved a supplementary use for faeces that sees them retaining it for extraordinarily long periods of time.

There's a great deal of variation between species in the time it takes for food to pass from ingestion to defecation (known as the gut passage time, or PT). For birds or mammals, this can be a matter of hours, days or weeks. In other vertebrates, it can be even longer.

While there is nothing particularly remarkable about the one- or two-day PTs of tree snakes, which are characterised by slender, agile and slightly built bodies, it's a different story for the big bulky ground-dwelling members of the viper and boid families. In some of these species, PTs can be as long as 420 days!

Why would a snake hold on to its poo for well over a year? Lillywhite and colleagues believe it may function as a kind of ballast that helps stabilise the movements of heavier species. While faeces retained for long periods in humans can cause disease and even injury, in snakes it seems to behave more like an inert brick than a toxic waste product, and may even enhance water and nutrient uptake.

—K.McG.

Doting Dinos

Were dinosaurs caring parents? A startling fossil from China sheds unprecedented light on this question.

Qingjin Meng (Dalian Natural History Museum, China) and colleagues describe the discovery of an adult parrot-beaked dinosaur (*Psittacosaurus* sp.) huddled around the remains of 34 juveniles (*Nature* 431: 145). Although the gender of the adult can't be determined, the young appear to be larger than hatchlings, suggesting that the group had been together for some time after the young's emergence from their eggs. And a clutch of 34 individuals seems to be rather large for this species, raising the prospect that perhaps this is a creche from a couple of breeding pairs—a tantalising possibility of far

An adult parrot-beaked dinosaur (*Psittacosaurus* sp.) huddled with the remains of 34 young, from China.

COURTESY DALIAN NATURAL HISTORY MUSEUM

more complex parental behaviour in dinosaurs than had previously been suspected.

But why were the young dinosaurs all together, and how did they come to all die at the same time? We may never know. Perhaps (and most likely) they were huddled together for protection. Unfortunately the sediment around them had been turned over by plants and burrowing animals after the dinosaurs' internment, so it's impossible to establish why they died together. Perhaps they were in a burrow that collapsed. A burrowing dinosaur? Now there's another possible behaviour we had never even dreamt of!

—P.W

COURTESY SIMON M. READER

Dunking Birds

Why do Carib Grackles dip their food in water before eating?

Many of us have dunked an Arrowroot biscuit into our tea or sucked up coffee through a Tim Tam. We do it because it tastes good, or simply for fun. But why do other animals dunk their food?

Over 25 bird species are known to dip their food in water before eating it in the wild. Possible functions might be to wash it clean of debris or toxins, or to soften it to aid ingestion. To investigate, Julie Morand-Ferron and colleagues (McGill University, Montréal) offered wild Carib Grackles (*Quiscalus lugubris*)—a type of American blackbird—fresh versus dry bread, and clean versus sandy bread, in the vicinity of a puddle (*Anim. Behav.* 68: 1267). In the first experiment, the grackles appeared to prefer fresh bread to dry (judging from the shorter feeding trials using fresh bread), and dunked the dry bread more frequently than the fresh (6.4 per cent compared with 3.4 per cent). In the second experiment, grackles took the clean bread more quickly than the dirty bread, but the rate of dunking was not significantly different (2.9 and 2.8 per cent). These two experiments suggest that, for Carib Grackles, dunking helps to soften food.

It is also possible that grackles use dunked food as a sponge to carry water to nestlings. But because the breeding state of grackles that flew away with dunked food was unknown, this idea remains to be tested.

And who are we to say that grackles don't also dunk for fun? This is unlikely, however, because the act of dunking exposes grackles to an increased rate of theft from other greedy grackles. In these experiments, neighbouring grackles pinched 14.6 per cent of dunked food compared with just 3.8 per cent of non-dunked food. In another experiment where food was placed midway between two puddles, the rate of dunking was higher at the puddle with fewer grackles, and when dunking did occur at the higher-density puddle, the rate of theft was six times higher than at the low-density puddle.

—G.H.

DENNIS SARSON/LOCHMAN TRANSPARENCIES

Combining sex and dinner in Redback Spiders increases the number of offspring produced. But why?

Dying for Sex

Sex and death are intimately entwined in the spider world. Many a male spider has learnt that the price of procreation is a meal for his mate—and he's the main course. But why do they submit to this rather gross violation of their civil liberties?

In the case of male Redback Spiders (*Latrodectus hasselti*), which actually present their abdomens to the females' jaws while copulating, the answer seems to be that combining sex and dinner increases the number of offspring they father. Males that make the ultimate sacrifice copulate for longer than males that live to mate another day—25 as opposed to 11 minutes—and the longer males copulate, the more spiderlings they produce.

The problem is that no-one knows why copulating for longer results in more offspring. The general assumption is that it results in a greater number of sperm being transferred to the female.

To test this assumption, Lindsay Snow and Maydianne Andrade (University of Toronto at Scarborough) compared the amount of sperm transferred in copulations that they terminated after five, 10 and 20 minutes, with that transferred in copulations allowed to run their normal course. It turned out that the majority of the sperm was transferred during the first five minutes of copulation, so increasing copulation time by hanging around to get eaten was unlikely to result in increased sperm transfer.

However, the researchers found that cannibalised males did still transfer a greater number of sperm than escapees. Females that eat their partners tend to sit very still while doing so, whereas those few that don't eat their partners (mainly because they are not hungry) move about the web, actively pushing the male's abdomen away from their jaws throughout insemination. This 'interference' behaviour, the researchers suggest, might somehow hinder the rate of sperm transfer in uncannibalised males.

—G.T.

Dung Bait

Once upon a time, tool use was held up as the characteristic that set us humans apart from the other animals. But then along came a group of Chimps that used grass stems to fish for termites and the spell was broken. Soon they were joined by everything from

COURTESY RON WOLFF

Burrowing Owls lure dinner with dung.

QUICK QUIZ

1. *What is the chemical symbol for tin?*
2. *Which country formally ratified the Kyoto Protocol on climate change in November 2004, thus enabling it to become law?*
3. *Do 'thick-knees' have fur, fins or feathers?*
4. *What do you call the upper shell of a turtle?*
5. *Which has the shortest wavelength—blue or red light?*
6. *Can snakes hear?*
7. *How high is Mount Everest to the nearest kilometre?*
8. *From which of your parents do you inherit your 'mitochondrial DNA'?*
9. *What forms when a star collapses?*
10. *Why do kangaroos lick the insides of their forearms?*

(Answers on page 79)

Egyptian Vultures using stones to break open Ostrich eggs to Caledonian Crows bending bits of wire to get food rewards in the lab. And now a species of owl has joined this august group. Their choice of tool? Poo.

A blind taster can't tell the difference between the flavour of the beans.

Burrowing Owls (*Athene cunicularia*) spend most of their days standing motionless outside their burrows. If prey wanders by, they will pounce on it. Scattered around them are pieces of mammalian dung, which the owls will often replace if removed.

Burrowing Owls are one of the main predators of dung beetles, so Douglas Levy (University of Florida) and colleagues decided to test whether or not the owls were using the dung as bait for the beetles (*Nature* 431: 39).

But first they had to discount the alternative explanation—that the owls were using the dung to mask the smell of their nest from their own predators (foxes, coyotes, raccoons, snakes etc.). The ground is a dangerous place to nest, after all. The researchers created 50 nest burrows, placed five quail eggs in each and then put cow dung outside every second burrow. All but one nest was raided by predators and the presence of dung had no effect on the time before the nests were destroyed.

So then they tested the bait hypothesis by removing all of the dung, regurgitated pellets and beetle parts from the burrow entrances of two owl populations, and placing cow dung outside half. Owls with dung at their door consumed ten times more dung beetles and six times more dung-beetle species than dungless owls. Clearly, using dung as a tool to catch dinner works.

—G.T.

Kitticcino

What does the most exotic and expensive coffee in the world taste like? Kopi Luwak, as it is known, is described as "earthy, syrupy, with rich jungle and chocolate undertones". Yet knowing how it's made may leave a bitter aftertaste, for Kopi Luwak gets its unique flavour from the Indonesian Palm Civet (*Paradoxurus*

hermaphroditus). These cat-like animals love gorging on the sweet flesh of coffee cherries. Once the civet has digested the fruit, the beans are excreted intact, collected from the faeces, then dried and roasted to produce the rare brew.

Since people are paying US$50 for a cup of Kopi Luwak, Massimo Marcone (University of Guelph, Canada) decided to investigate the effect of the civet's gut on the coffee, by comparing the properties of civet-processed beans with untreated beans (*Food Research Internatl* 37: 901). In a process known as intestinal fermentation, gastric juices and digestive enzymes penetrate the coffee cherry, causing proteins to break down and the beans to become brittle and dark in colour. Since proteins make coffee bitter, less protein means less bitterness.

So if Kopi Luwak is so superior, is there any way of increasing its production so we can all enjoy fermented coffee? Currently less than 250 kilograms of Kopi Luwak is harvested annually in Indonesia and, with instability in the region, Marcone has suggested we should look to the birthplace of coffee—Ethiopia—to provide a delicious and cheaper alternative. Marcone has established that African Civets (*Civettictis civetta*) also eat coffee cherries. Since these creatures conveniently deposit their faeces in communal piles called civetries, there could be a whole new source of semi-digested beans to be exploited by coffee aficionados.

So far, analyses show that the African Civet's internal fermentation isn't quite as efficient as the Indonesian Palm Civet's, but the difference is so slight that a blind taster can't tell the difference between the flavour of the beans. However, if you're a purist and you want the rarest, finest cup of coffee in the world, you'll just have to wait for the Indonesian civet to pass the beans.

—K.H.

FURTHER READING

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

ERWIN & PEGGY BAUER/AUSCAPE

Could the African Civet be persuaded to produce delicious fermented coffee beans?

Gum drops and sticky dates

The Mistletoebird wasn't so much wiping the seed onto the branch but wiping it off its cloaca.

IF YOU FEEL SQUEAMISH WHEN THE TV news flashes pictures of sweating drug couriers being apprehended with their bowels so back-filled with rubber-wrapped crack they're afraid to sneeze, then the subject of Mistletoebirds might not be for you. Because theirs too is a tacky world of parasites and packed rectums, and the undercover delivery of goods so volatile that once unloaded might easily cause the loss of life or limb. But you'd never know it to look at them.

The first hint I ever had that all was not quite kosher with these flashy scarlet-and-blue bullets was when, not long ago, I parked my car under one at our railway station. Birds often get a bit shifty just before they powder their nose and I watched and waited for the inevitable splat on my duco. But when the moment of relief arrived, the little bird did a strange thing and turned its body sideways *along* the direction of the branch and, with a dab of its derriere, deposited a huge glistening dropping not on my car's crusty bonnet, but on the branch it was standing on.

Why the leviathan poo? Why the dab-and-wipe?

Although the humungous dropping was clearly all the bird's own doing, it was not all the bird's own making. Most of it was a stow-away mistletoe seed, bold as a baked bean and dressed up to ride the tucker chute without the important bits digesting.

And why the big wipe? When I mentioned this incident to museum colleague Kieran Aland recently, he smiled and said "Haven't you ever been to a kids' birthday party where they put on a mistletoe spitting contest? You give each spitter a freshly peeled mistletoe seed then tell them there is a prize for the one who can spag it out the farthest. But you don't need a prize or a tape measure because, in spite of all the puckering and sputtering, the sticky seeds never get farther than up their noses or down their chins...something about the fibres or glug on the seed makes it impossible to spit them out!"

And then it clicked that the Mistletoebird (*Dicaeum hirundinaceum*), which plays the same sort of party game every day, wasn't so much wiping the seed on (to the branch) but wiping it off (its cloaca).

I'm very glad I didn't rush into print with this dazzling bit of railway research, because as it turns out people in England had twigged to the bizarre relationship between birds and mistletoe seeds as early as the 16th century! Up until then most informed people believed that mistletoe plants propagated naturally from bird droppings. This was in keeping with the widely held principle that life generated spontaneously from dung.

Two Anglo-Saxon words reflected this connection; *missel* meaning 'dung/excrement/shit' and the *toe* suffix (which was originally *tan*) meaning 'twig'. So mistletoe originally meant 'shit-twig'. Some authors, however, lay the derivation in the lap of the (European) Mistle Thrush (*Turdus viscivorus*), noting that mistletoe often sprouted from its droppings, that is, mistletoe was literally 'twig of the Mistle Thrush'.

How charming to think next Christmas you could be kissing under the shit-twig! What *was* that tradition all about? Apart from the obvious excuse for a pash, it's hard for any Aussie to think of a less romantic tradition than kissing under a sprig of scungy old parasite that grows on every second gum

Although the humungous dropping was clearly all the bird's own doing, it was not all the bird's own making.

Mistletoebird

Dicaeum hirundinaceum

Classification
Family Dicaeidae. Sole member of the family in Aust.

Identification
Plump, finch-sized. Male, royal blue-black dorsally, scarlet throat and chest connected by black midline slash to scarlet vent. Female dull grey-brown, pink under vent.

Distribution
Throughout all mainland States where mistletoe occurs. Interestingly, both mistletoes and Mistletoebirds are absent from Tas.

Biology
Solitary, monogamous. Staple diet mistletoe berries, but also eats insects and other berries. Best known for soft cobweb nest built by female and hung like a baby's booty among leafy twigs. Breeds Oct-Mar. (or when its local mistletoe fruits), 3 white eggs.

BY STEVE VAN DYCK

The male Mistletoebird feeds his chicks in the characteristic cobweb nest.

ATHAL TOLHURST

tree (there are around 950 species of mistletoe in the family Loranthaceae throughout the world, 60 of which are endemic to Australia)!

But once upon a time mistletoe held its place among the most sacred and magic of plants. According to European folklore it symbolised life and fertility. Cut branches could ward off evil spirits and witches and even extinguish fires. And, if fed to the cow that calved first in the New Year, would bring good luck to the whole herd. The Gauls used it as an aphrodisiac and a cure for sterility, and the Celts made an extraordinary connection between its parasitic nature and Christ's cross, calling it *l'herbe de la Croix*, in the belief that after Christ's death on a cross made (allegedly) of mistletoe wood, the tree was cursed and could only then exist as a 'beggar' and parasite on other trees.

When you transport all these 'virtues' to Christmas in the northern hemisphere the kissing thing makes more sense. At that freezing time of the year just about the only plants to bear leaves and fruit are the mistletoes, so, given all their other qualities too, if you kissed under one, some of the abundant fertility might rub off and your house could be blessed with the fecundity of a rabbit burrow.

These days most of us aspire to having more real estate than children, and few of us ever give mistletoe a second thought. But the Mistletoebird's obsession is all-consuming. In fact, as quickly as ten minutes after eating a juicy mistletoe berry, the muscular stomach (strictly reserved for insects whose remains are regurgitated as pellets) has been automatically bypassed, the process of outer-seed slime digestion is completed in the alimentary canal (gut) and the Mistletoebird is ready to make the drop, big time.

Once out in the open and a few days after delivery, a club-footed sucker grows out of the time-bomb seed and makes contact with the substrate. If that surface is a small, thinly barked branch and not a car bonnet, enzymes secreted by the stalk ulcerate a fissure through which the mistletoe's 'roots' ultimately tap in to share the host's precious water and minerals.

While a host plant might live for over 100 years, individual mistletoe plants usually don't live beyond a few decades. But in that time, although they may kill the host's branches out beyond the mistletoe's point of entry, they provide berries, nectar, fodder and shelter for a multitude of animal species.

And who choreographs most of this? The flamboyant little Virgin Blue courier that flashes around with a song in its heart and a clinger in its dinger. □

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

Wallum Froglet

The ability of a frog to breed in such acidic surrounds is surprising to most people.

THE WET COASTAL HEATHLAND on the north coast of New South Wales can be a tough place to work, especially on a steamy night when mozzies and humidity are at their peak. Yet this is where ecologists like me spend a large proportion of time, searching for a variety of rare and threatened frog species, including the ever-elusive and somewhat cryptic Wallum Froglet (*Crinia tinnula*).

In terms of being a readily recognised frog species, the Wallum Froglet is far from the top of the list. Most *Crinia* frogs are so similar that they may only be told apart by genetic analysis. Like all *Crinia* species, the Wallum Froglet is small, ranging in size from 16 to 18 millimetres long. From a distance, Wallum Froglets appear as small brown frogs that might seem a little, well, plain. It is only on close inspection that one can appreciate the varied grey, brown, black and white patterning of the species. Small size, similarity to other species and an outwardly 'plain-Jane' appearance have all undoubtedly contributed to the Wallum Froglet being little studied, and consequently not much is known about its biology.

The Wallum Froglet, once in the hand and with the aid of a lens, can be distinguished from other *Crinia* species by a white or light brown belly, a relatively pointed snout, and a mid-line of white dots on the throat (but this can be variable). However, in terms of establishing the presence of the Wallum Froglet at a given location, the best method often doesn't require for a specimen to be captured at all. Although the term 'surveying for frogs' may conjure images of hip-waders and dip nets, the reality is that often all one needs to do is sit and listen. The males of most frog species call in a distinctive manner that can be readily differentiated from all other species. In the case of the Wallum Froglet, the call is a cricket-like tinkling that is easily distinguished from the various whirs, bleats and plops emitted by other frogs typically found in the wet heathland community.

The call is a cricket-like tinkling that is easily distinguished from the various whirs, bleats and plops emitted by other frogs.

Somewhat unusual for Australian frogs is the Wallum Froglet's preference for calling during the cooler months of the year. Like its appearance, however, this feature is also variable and the frog can sometimes be heard calling even when the heathland sands threaten to burn holes in your soles.

Wet coastal heathland is a harsh environment by most standards and is characterised by the presence of acidic waters. Although the term 'acid frogs' brings to mind images of frogs that burn your skin when you handle them, it is in fact a collective term used to refer to frogs, including the Wallum Froglet, that breed in the acidic waters of wet coastal heathland. The Wallum Froglet is often detected at locations where the pH of the water is less than five and I have known it to occur at locations where the pH of the surrounding water was around 3.5 (vinegar has a pH of between 2.4 and 3.4). The ability of a frog to breed in such acidic surrounds is surprising to most people who share a common conception that

BY CRAIG FAULKNER

frogs are good indicators of environmental change due to their sensitivity.

Alas, despite its seeming robustness, the Wallum Froglet is in fact sensitive to unnatural changes in its surrounds. The greatest threat to this species' survival is the destruction and degradation of coastal wetlands for development, and the associated changes in water quality.

Despite the fact that the Wallum Froglet is listed as Vulnerable in both New South Wales and Queensland, it is not listed under the Federal *Environment Protection and Biodiversity Conservation Act* 1999. The National Parks and Wildlife Service is currently developing Recovery Plans for a number of threatened frog species, including the Wallum Froglet.

Hopefully, with the aid of such plans, decisions on the future development of our coastal zones will ensure that the tinkling call of the Wallum Froglet does not, like some of our other native amphibian species, fade further into obscurity. □

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CRAIG FAULKNER IS AN ECOLOGIST WORKING ON THE NORTH COAST OF NEW SOUTH WALES WHO REGULARLY CONDUCTS SURVEYS FOR RARE AND THREATENED FROG SPECIES.

H. EHMANN

Saline solutions?

Salinity is accused of derailing ancient cultures in Mesopotamia, China and Latin America, and it could undo us here.

The samphire *Sarcocornia quinqueflora* is so well-adapted to saline mudflats it often dominates them exclusively.

I CAN REMEMBER A TIME WHEN 'salinity' was just a word for describing seawater. Today it's a term of dread that defines dying landscapes stricken by that 'creeping white cancer'. Australia, it seems, is a badly managed land with vast supplies of buried salt ready to rise up and destroy. Salinity is accused of derailing ancient cultures in Mesopotamia, China and Latin America, and it could undo us here.

It's a very difficult problem to reverse. Not only should salty sites be reclothed with salt-tolerant plants, but surrounding lands should also be planted up with shrubs and trees deep-rooted enough to lower the groundwater, which brings up the salt in the first place. Most plants cannot help but absorb soil salt, even though it blocks their inner functions. When exposed to high salinities they may even lose water through their roots and wilt, because saline soil has such low water pressure that water flows from the plants back into the soil.

Most plants cannot help but absorb soil salt, even though it blocks their inner functions.

'Halophyte' is the name given to those plants that cope well with salt. There are some that survive by blocking uptake of salt by their roots, but most of them absorb the salt and excrete it through leaf glands, or store it internally.

Australia, with its long and varied coastline and slightly saline inland plains, has a rich flora of indigenous halophytes, including mangroves, saltmarsh plants and saltbushes. Saltmarsh plants such as Seablite (*Suaeda australis*) and samphires (*Sarcocornia* and *Halosarcia* species) are succulent, storing salt in vacuoles that bloat their leaves or stems. Mangrove trees excrete their salt through leaf glands.

The outback is surprisingly rich in halophytes, including various samphires found around saltpans and the super-successful saltbushes (*Atriplex* species) and bluebushes (*Maireana* species). Saltbushes store salt in bladder cells on the leaf surface where much of it washes away after rain. Some of the inland halophytes have evolved from seashore plants, and sometimes the same species can be found on beaches as well as far inland on saline plains.

Some halophytes are planted just to stabilise the soil, on saline mine spoil for instance, but usually they must offer good returns before farmers will grow them. The focus in Australia is on creating viable pastures for Cattle and Sheep. Saltbushes are already a major grazing resource over half a million square kilometres of the outback, including leading wool-producing regions and prime organic beef properties. Old Man Saltbush (*Atriplex nummularia*) and Creeping Saltbush (*A. semibaccata*) are so highly prized that farmers overseas now grow them. Other species show great promise as well. Stock often avoid saltbushes when sweeter grasses are available, partly because of the salt content, but turn to them in dry times when other feed is scarce, often eliminating them during drought. Halophytic grasses excrete their salt through leaf glands and they offer a sweeter meal.

Agronomists tackling salinity have a very big wish list. They want a Santa's sack full of easily grown, deep-rooted, nutritious plants, including grasses, legumes, shrubs and trees, suited to sites

BY TIM LOW

of all salinities ranging from waterlogged discharge zones to surrounding non-saline areas, and promising high enough returns that landowners will choose to grow them. Unfortunately, most attention is going into foreign plants. Plants targeted for improvement even include weedy species such as African Lovegrass (*Eragrostis curvula*) and Hexham Scent (*Melilotus indicus*). Weed authorities are alarmed because pasture plants are notorious for having spawned many of Australia's worst weed problems. One shrub planted to repair saline land in 1991, Kochia (*Bassia scoparia*), multiplied so fast that an eradication campaign was mounted, at a cost of $176,000. Many halophytes can grow in non-saline soils and they may become versatile weeds.

One or two agronomists are trialling native plants as a safer alternative but even these may pose a risk. Many farms with scalded land lie far removed from places where native halophytes grow, and importing them entails a risk—they may thrive where they are not wanted.

In this not-quite-winnable war against degradation one thing is certain—the vegetated landscape of Australia will change. That transformation needs to be managed carefully by those with an eye on conservation and the larger picture. Otherwise, salinity will be costed by future generations not just in land and water lost to salt, but also in land and water lost to weeds. □

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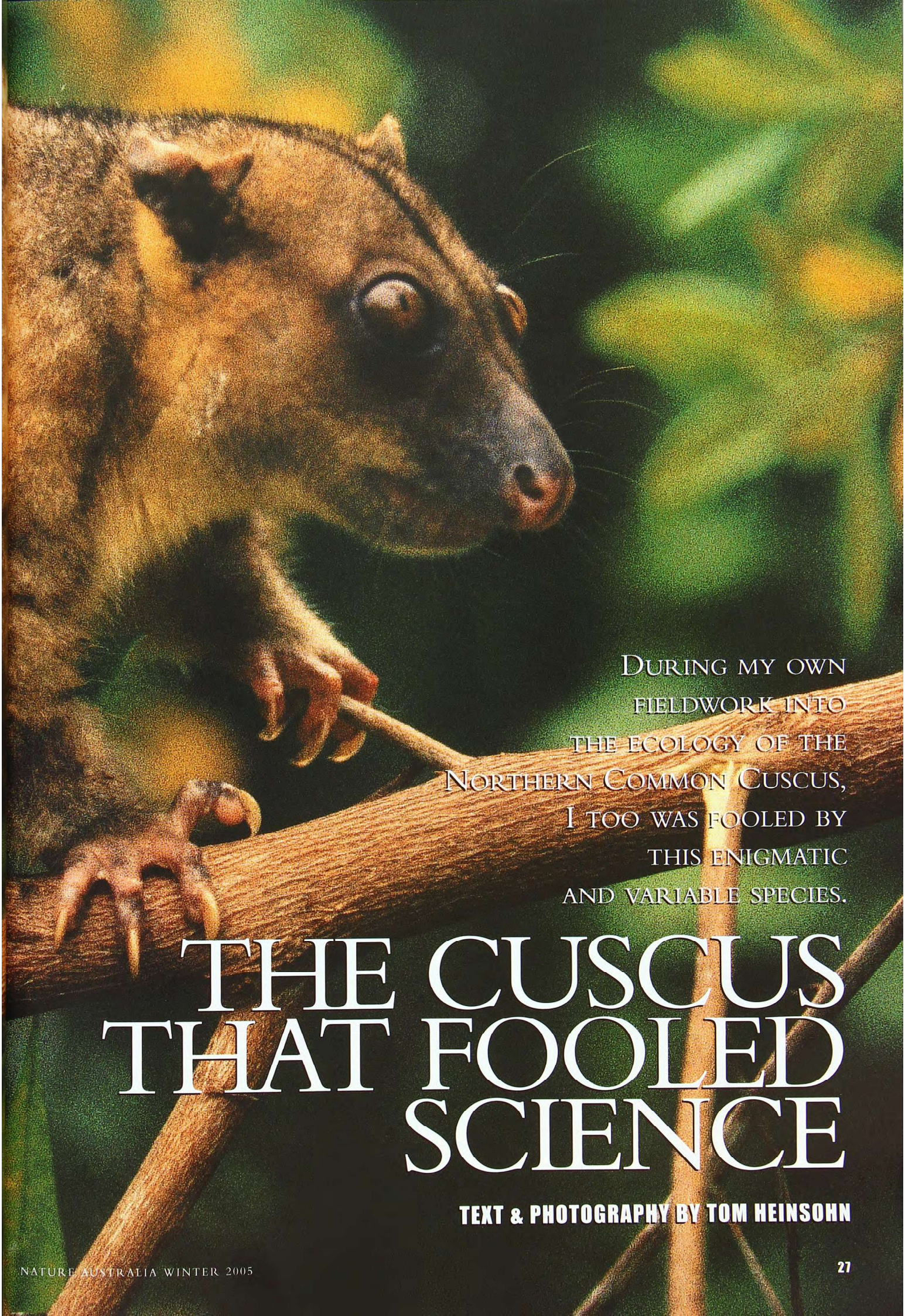
TIM LOW IS A BIOLOGIST AND AUTHOR OF SIX BOOKS, INCLUDING *FERAL FUTURE* AND *THE NEW NATURE*.

PHOTOS: TIM LOW

In western New South Wales, Old Man Saltbush once formed vast stands on alluvial plains, although most of these were eliminated long ago by hungry Cattle, Sheep and Rabbits. This plant is now cultivated abroad as stock feed, and in California it has become a weed.

Adult female Northern Common Cuscus of the smaller *Phalanger orientalis breviceps* subspecies in New Ireland, Papua New Guinea. It weighs just 2.5 kilograms.



During my own fieldwork into the ecology of the Northern Common Cuscus, I too was fooled by this enigmatic and variable species.

THE CUSCUS THAT FOOLED SCIENCE

TEXT & PHOTOGRAPHY BY TOM HEINSOHN

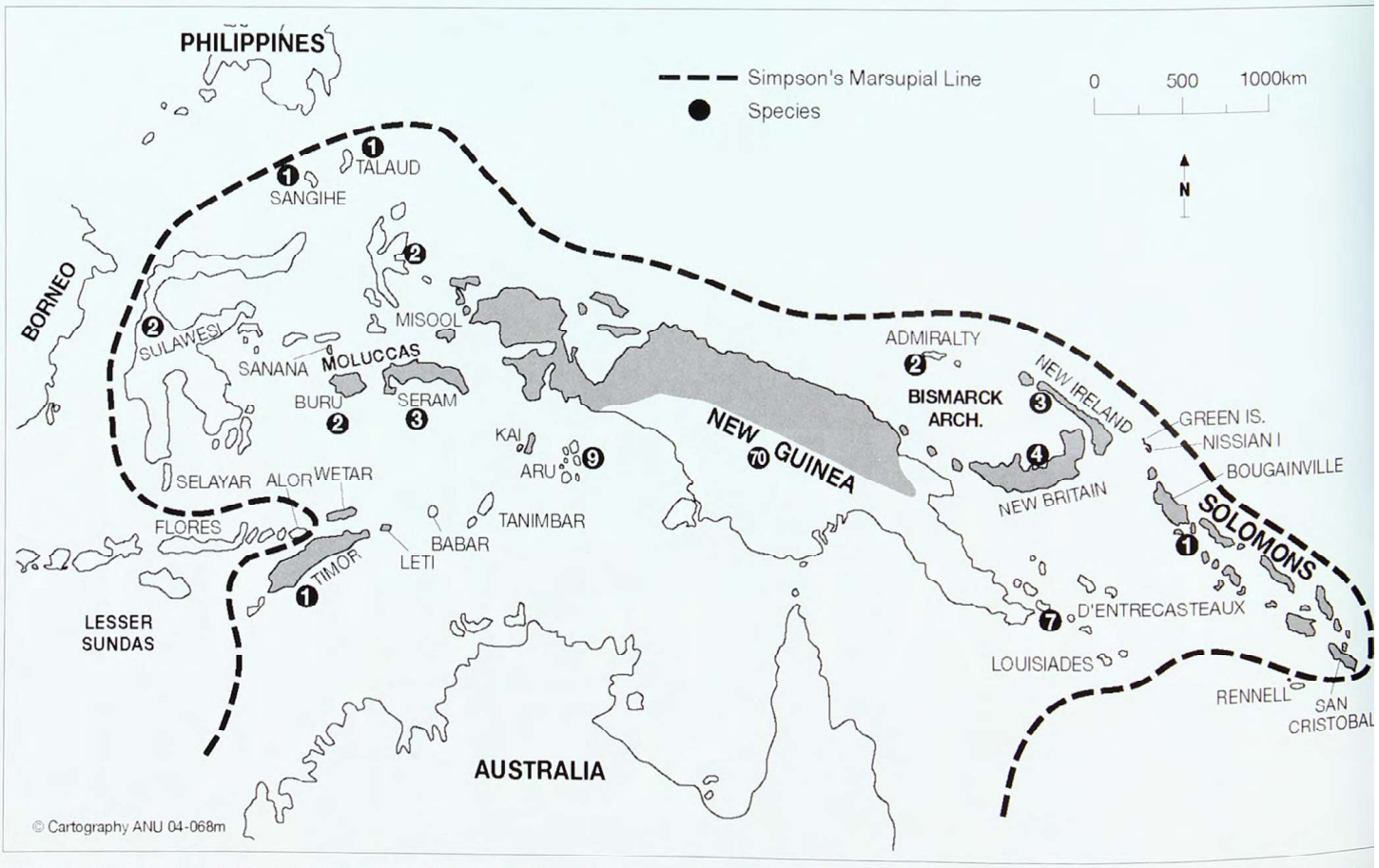
MARSUPIALS ARE NOT renowned for their intelligence, yet in the Australasian Region there exists a humble possum that has managed to fool many of the world's leading biologists, including famous zoogeographer George Gaylord Simpson. The creature in question is the Northern Common Cuscus (*Phalanger orientalis*) and it did this by unwittingly duping scientists into believing that it was a great mariner, capable of colonising vast oceanic archipelagos on natural rafts washed out to sea by storms and floods. In reality however, this possum was quite averse to the sea, but adept at exploiting its economic value to humans in order to hitch much more speedy rides in canoes and other prehistoric watercraft to colonise new lands. So to what degree did the Northern Common Cuscus fool science?

Perhaps the most famous and frequently cited zoogeographic map of the distribution of Australasian marsupials is that produced by Simpson in 1961 and later reproduced in his book *The geography of evolution* (1965). It contains the cumulative wisdom of seminal zoogeographers from the time of Alfred Russel Wallace onwards, and purports to show the natural distributional limits of marsupials in the Australasian Region. This is defined by an imaginary boundary—Simpson's Line—that marks the marsupial frontier. Also included are the known numbers of marsupial species per major island group (see map). Curiously though, much of the marsupial frontier in the Solomon Islands (northern Melanesia) and Timor Islands (Lesser Sundas) is due to the presence of a single species, the Northern Common Cuscus, which is now thought to have been introduced by humans, over a long period of time, throughout the oceanic (non-continental) part of the animal's range. This begs the question, what is the species' original natural distribution, and how can it be differentiated from that which is due to human intervention? This requires a closer look at this enigmatic cuscus.

View from a canoe of the southern coast of Seram, Indonesia, with 3,020-metre-high Mt Binaiya in the background. Here the Northern Common Cuscus (*Phalanger orientalis orientalis*) has been recorded from sea level to just below the summit area.

THE NORTHERN COMMON CUSCUS is a relatively large phalangerid possum (same family as Australian brushtails) that is thought to be native to the lowland, hill and lower-montane forests of northern New Guinea where it occurs up to an altitude of about 1,500 metres. It is nocturnal and arboreal, and the bulk of its diet consists of leaves and fruit. Although often found resting by day amidst thick masses of foliage in the crowns of trees or in vine tangles, its preferred den is in a well-secluded tree hollow and individuals may have several favoured den sites or resting spots per home range. In dense lush rainforest with ample foliage, Northern Common Cuscuses can subsist in an area of less than a hectare, whereas in less productive habitats of light forest, larger home ranges may be required.

The Northern Common Cuscus is used throughout its range as a game, food and trade animal, and occasional pet. It is sometimes hunted out in the



Map showing the distribution of the Northern Common Cuscus (*Phalanger orientalis*), Simpson's Marsupial Line, and the number of marsupial species per area.

Adult male Northern Common Cuscus of the larger *Phalanger orientalis orientalis* subspecies in Timor, weighing in excess of four kilograms.

vicinity of villages, although in some Muslim areas in Indonesia and Seventh Day Adventist areas in Melanesia, where religious dietary taboos have led to the virtual abandonment of cuscus hunting, the Northern Common Cuscus can be seen living in and around well-treed villages. Its large lower incisor teeth are sometimes used in necklaces or as traditional engraving tools.

Although there is an enormous amount of circumstantial evidence of captive cuscuses being carried in canoes as pets or for food, trade and ceremonial purposes, the penny didn't drop about its status as an introduced species in many areas until the late 1960s. This happened when British archaeologist Ian Glover began excavations in East Timor and discovered that the bones of cuscuses made a sudden appearance in archaeological deposits of middle Holocene age (about 4,500 years ago), at the same time as domestic and other introduced animals—a clear indication that the species had probably been introduced to Timor by prehistoric humans.

ITS LARGE LOWER *incisor teeth are sometimes used in necklaces or as traditional engraving tools.*

Some decades later, during extensive excavations fostered by the Lapita Homeland Archaeological Project, archaeologists began to discover similar evidence of species introductions in the northern Melanesian islands (Bismarck Archipelago and Solomon Islands), the best evidence coming from a series of well-preserved cave sites in New Ireland. Here, where evidence of first human colonisation dates back to about 40,000 years ago, humans appear to have introduced the Northern Common Cuscus at a staggeringly early date of about 20,000 years ago, making it the oldest recorded episode of animal translocation. Now, as a consequence of these discoveries, much of the Northern Common Cuscus' oceanic distribution from San Cristobal (near the eastern edge of the Solomon Islands) to the Bismarck Archipelago, and to the Moluccas and Timor in the far west, is thought to be due to long-term human agency. This exposes the naivety of Simpson's Line as the supposedly natural limit of marsupial distribution.

But this is not the only way that the enigmatic Northern Common Cuscus has fooled science. In New Guinea, scientists have long speculated why the species reaches its fairly modest altitudi-

nal limits in the lower-montane zone. One theory put forward by some scientists was that this essentially lowland species was unable to cope with cooler mountain climates and reached its natural ecophysiological limit in the lower-montane zone at 1,200 to 1,500 metres. Another theory was that the Northern Common Cuscus was limited by competition from specialist montane cuscuses, such as the Mountain Cuscus (*Phalanger carmelitae*) and Silky Cuscus (*P. sericeus*). What eventually solved the debate was a realisation that Northern Common Cuscus populations introduced to various high oceanic islands had in effect created a vast natural laboratory in which to test the competing theories.

Of particular interest was the 3,020-metre-high island of Seram in the Moluccas, which had moist rainforest habitats that mimicked those in New Guinea, but lacked possums other than the Northern Common Cuscus, and one other probably introduced lowland species, the Common Spotted Cuscus (*Spilocuscus maculatus*). If the ecophysiology camp was right, then in Seram, the Northern Common Cuscus would fade out at about 1,500 metres, as in New Guinea; whereas if the competitive-exclusion camp was right, then in the

Fataluku hunter in East Timor. Dogs are used to detect and flush out a variety of quarry, while the blowpipe with poisoned darts is mostly used to bring down smaller game such as birds, Long-tailed Macaques and Northern Common Cuscuses.

Northern Common Cuscus

Phalanger orientalis

Classification

Family Phalangeridae.

Identification

Two subspecies: *P. o. orientalis*, northern NG, Moluccas and Timor Islands, 2.5–4.5 kg; *P. o. breviceps*, Bismarck Archipelago and Solomon Islands, 1.0–2.5 kg. Coat colour variable with dark grey, brown, reddish brown, light grey and white colour morphs, often with dark dorsal stripe. Ears small, but prominent. Lower half of prehensile tail naked.

Habitat and Distribution

In NG found in closed forest from sea level to 1,500 m. On high oceanic islands, such as Seram, with fewer competitors, extends up into montane forest over 2,500 m. Natural distribution includes northern NG and some adjacent land-bridge satellites, but most likely introduced to Bismarck Archipelago, Solomon Islands, Moluccas, Timor Islands and Senana by prehistoric humans.

Biology

Arboreal, nocturnal, sleeps in tree hollow or amidst thick vegetation. Eats mostly leaves and fruit. Typically 1–2 pouch young. Breeding may be continuous in constantly moist parts of range, but may be seasonal elsewhere.

relative absence of competitors, it would probably reach considerably higher altitudes.

At first the ecophysiology camp seemed to be winning. An article by Oldfield Thomas in 1920 reported that the Northern Common Cuscus had been collected in Seram only at up to 1,500 metres. But then in 1987, a British Operation Raleigh expedition collected several cuscuses at, and well above, 2,500 metres in cool moist upper-montane forest on Mt Binaiya, the island's highest peak; furthermore, these particular animals had acclimatised by developing thicker and longer fur than those from the hot humid lowlands. This clearly demonstrated that it was most likely competition, rather than environment, that had depressed the altitudinal range of the Northern Common Cuscus on the New Guinea mainland. Furthermore, it was probably only the fading out of suitable habitats that had prevented the cuscus from reaching right to the rocky summit of Mt Binaiya. The ecophysiology theory was sounding lame.

DURING MY OWN FIELDWORK INTO the ecology of the Northern Common Cuscus, I too was once fooled by this enigmatic and variable species. In 1990, in lowland swamp forest sites in Tigak country in northern New Ireland, I had been observing how both of the island's introduced cuscuses, the Northern Common Cuscus and the Common Spotted Cuscus, gathered together to feed at prolifically fruiting trees such as the 'Water Gum' (*Syzygium acutangulum*). Here in New Ireland the local subspecies of Northern Common Cuscus (*Phalanger orientalis breviceps*) weighed only about 2.5 kilograms, compared with the local Common Spotted Cuscus (*Spilocuscus maculatus maculatus*), which reached about 3.5 kilograms in weight. This size advantage enabled the larger Common Spotted Cuscus to be dominant and occupy prime feeding sites with large clusters of fruit. The smaller Northern Common Cuscus, on the other hand, was forced to give large adult spotted cuscuses a wide berth and occupy lesser feeding sites.

Adult male Common Spotted Cuscus (*Spilocuscus maculatus maculatus*) in lowland rainforest in far north-western New Ireland, Papua New Guinea, weighing just over three kilograms.

I OBSERVED TRULY FEROCIOUS *and powerfully built Northern Common Cuscuses weighing up to 4.5 kilograms. They looked like cuscuses on steroids!*

The New Ireland observations led me to assume that the Common Spotted Cuscus, which weighs up to about five kilograms in some mainland New Guinean subspecies, would always be dominant over the Northern Common Cuscus. I was soon disabused of this assumption after travelling to Seram and Timor, where I observed truly ferocious and powerfully built Northern Common Cuscuses (*Phalanger orientalis orientalis*) weighing up to 4.5 kilograms. They looked like cuscuses on steroids! Indeed in Seram, they appeared to frequently outsize the local Common Spotted Cuscus (*Spilocuscus maculatus chrysorrhous*), and had a reputation among Nuaulu hunters for being very feisty to handle. It seemed here there could be a strange turning of the tables, where the Northern Common Cuscus may be dominant over the Common Spotted Cuscus. I too had been duped by the variability of the species, which exposed the Achilles heel of scientific assumption.

But what of the Northern Common Cuscus itself? What was its Achilles heel? Well, as it turned out, the chink in the armour of this species, with regard to vulnerability to human hunters, was its strong reliance on smell for communication. Unlike some other cuscuses that produce milder scents, the Northern Common Cuscus produces a very pungent secretion from a gland near the cloaca, which it uses to scent-mark den trees and other parts of its home range, perhaps in an effort to warn off rivals or attract mates. The odour is so strong that it is quite detectable, even to humans without hunting Dogs, and consequently often betrays the location of sleeping or active animals to hunters who are then able to focus their visual searches and zero in on their quarry. Indeed, I have observed the use of olfactory detection by hunters throughout the species' range from the Solomon Islands to Timor, and have even adopted the method myself when estimating Northern Common Cuscus densities in a patch of bush.

Curiously though, perhaps at a macro level, it is the Northern Common Cuscus that has benefited from being readily captured and utilised by humans, because the interaction has enabled it to colonise whole new archipelagos of islands. This begs the thought that perhaps, in an evolutionary sense, the Northern Common Cuscus is exploiting humans as much as we are exploiting it. By assuming it to be merely a hapless victim of human predation, have we once again been duped by this humble but enigmatic marsupial? □

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ATHAL TOLHURST

ORB-WEAVING SPIDERS LEAVE LITTLE TO CHANCE, INSTEAD TAKING A VARIETY OF STEPS TO SWING THE ODDS IN THEIR FAVOUR.

COME TO MY PARLOUR

BY MARK A. ELGAR

This species of *Argiope* builds a discoid decoration to attract prey.

ORB-WEAVING SPIDERS

are no slouches when it comes to improving the likelihood that the web intercepts the flight of an insect.

THERE IS SOMETHING QUITE exquisite about the webs of orb-weaving spiders early in the morning, when their simple, symmetrical designs are highlighted by beads of dew. Marvelling at these structures that are literally built out of thin air, you quickly forget their more sinister purpose. That is until the sticky web intercepts a flying insect, which the spider then dispatches with consummate efficiency.

Of course, you have to be rather lucky to see an orb-web spider actually capture its prey. Such events are not common, and anyone observing these spiders will realise that they spend almost all of their time motionless, becoming active only when the silk of the web arrests a potential meal. Indeed, orb-weaving spiders are textbook examples of so-called 'sit-and-wait' predators, a term used to describe those species that do not actively pursue their prey, but rather remain in the same place waiting for prey to come within striking distance. One might also infer from this description that orb-weaving spiders take a relatively passive role in acquiring food. However, it is becoming increasingly clear that they are no slouches when it comes to improving the likelihood that the web intercepts the flight of an insect. Indeed, Mary Howitt describes the behaviour of web-building spiders in her nursery rhyme "The Spider and the Fly" more aptly than she might have realised.

There are at least two ways in which orb-weaving spiders can influence the rate at which insects encounter their webs. The first is to build a web where insects are likely to fly, and to move away from areas where the web might get damaged by animals that cannot be eaten. The second is to attract insects to the vicinity of the web, thereby increasing the number of potential victims it can snare.

EVERYONE KNOWS THAT NOCTURNAL insects are attracted to artificial lights, a fact frequently exploited by entomologists who use specially constructed light traps to collect insects. In Europe, the spider *Nuctenea sclopetaria* similarly exploits the nocturnal insects' penchant for artificial light. In Vienna, the handrails along the footbridges that cross the Danube Canal provide excellent attachment points for the orb-webs of *N. sclopetaria*. Artificial lights illumi-

JOHN & VAL BUTLER/LOCHMAN TRANSPARENCIES

The orb-weaver *Eriophora biapicata* wrapping a grasshopper. Orb-weaving spiders are able to capture quite large prey items.

ATHAL TOLHURST

(Above) Male Imperial Blue Butterflies use the scent of ants to locate places where females are laying eggs or where pupae are about to turn into adults. Orb-weaving spiders also use the scent of ants to position their webs in areas likely to catch butterflies.

(Right) A larva of the Imperial Blue Butterfly is tended by many ants, which defend it from predators and other enemies.

ATHAL TOLHURST

nate some sections of the handrails, while other sections remain unlit. Astrid Heiling (University of Vienna) noticed there were more spiders on the well-lit handrails than on the darker handrails (see "Spiders Enjoy the Bright Lights", *Nature Aust.* Spring 2000). More importantly, it turned out that the foraging success of spiders in the well-lit areas was considerably higher than that in the darker areas, and this was due entirely to the encounter rate with prey. It is possible that *N. sclopetaria* simply prefers to build webs in a well-lit environment. However, the distribution of the spiders along the footbridge may reflect the outcome of each individual's foraging success, with

BRIAN CHUDLEIGH

The webs of golden orb-weavers (*Nephila*) often form dense aggregations, with the resident females ensuring the support threads are positioned where they do not get broken by passers-by and sometimes resulting in a tunnel of webs.

spiders abandoning those sites that provide poor pickings and eventually settling in a rewarding location.

Finding a good location by moving the web from place to place until the spider experiences excellent foraging success seems a bit hit-and-miss. Three Australian species of orb-weaving spiders, *'Araneus' ebernus, 'Cyclosa' fuligina-ta* and another unidentified species, don't leave matters to chance. These spiders often aggregate at the tops of *Acacia* plants. It turns out that, not coincidentally, these plants also have clusters of pupae of the Imperial Blue Butterfly (*Jalmenus evagoras*).

Naomi Pierce (Harvard University) is unravelling the intriguing mutualistic relationship between Imperial Blues and the workers of several species of *Iridomyrmex* ants. The ants protect the butterfly larvae and pupae from various predators and parasitoids; in return, the ants obtain a reliable source of nutrients produced by the caterpillars. The adult butterflies are attracted to the pheromones (chemical signals) released by the ants. Females use the pheromones to indicate which plants they should lay their eggs on, since the protective ants will find the caterpillars more quickly if the ants are already on the plant. Males use the ant pheromones to locate egg-laying females, or pupae with soon-to-emerge females.

The sight of large numbers of orb-weaving spiders around the pupal clusters of Imperial Blues can be unsettling because the beautiful butterflies are frequently caught in the webs. Pierce and I wondered whether the spiders, like the butterflies, are attracted to the ant pheromones. A simple field experiment, in which the spiders could choose between trees with and without ants, confirmed our suspicion that the spiders preferred to build webs on plants with ants. This is quite a remarkable example of a predator improving its foraging success by 'eavesdropping' on the communication system of its prey.

While spiders benefit by building their webs in places where there are many prey, they should also avoid places where their webs are likely to be damaged by non-prey animals. Silk is expensive to produce so any damage to

JIM FRAZIER

***Nephila pilipes* with a Ulysses Butterfly *(Papilio ulysses)*. Butterflies, once caught in the web, are easily dispatched because their large wings become entangled in the sticky web.**

the web can be costly. The footpaths that run along the northern shoreline of Sydney Harbour are sometimes enclosed by silken archways formed by numerous webs of the golden orb-weaver *Nephila plumipes*. Curiously, the threads supporting these webs are always just above head height, and it would appear that the spiders arrange the threads so that you don't walk into them. As it happens, the reason you don't get caught with silk on your face is because that happened to someone else. When my student Kate Chmiel and I deliberately damaged one side of the web of St Andrew's Cross Spiders (*Argiope keyserlingi*), the spider responded by moving the location of the web in the direction away from the side that was damaged.

THE IDEA THAT ORB-WEAVERS CAN attract flying insects to the vicinity of the web is more contentious. The webs of many orb-weaving species, but especially those belonging to the genus *Argiope*, are 'decorated' around the centre of the orb with special silk that is different from the sticky silk that captures prey. These conspicuous decorations come in a variety of shapes and sizes, including single lines, discs, or crosses. Why these decorations are incorporated into the webs of spiders is still controversial, despite being described over 100 years ago by the French entomologist Eugène Simon who referred to them as 'stabilimenta', believing that they somehow stabilise the web. Others have suggested the decorations provide protection from the heat of the sun, or a warning signal to non-prey animals, which then avoid damaging the web, but none of these explanations has proved particularly satisfactory.

Cay Craig (Harvard University) provides a more intriguing explanation. Many insects are attracted to UV light, since this can reveal gaps in the vegetation or may indicate appropriate flowers with pollination rewards. Craig suggested that the conspicuous web decorations reflect UV light and thus attract insects to the vicinity of their webs. In other words, the spiders increase their foraging success by exploiting the visual sensory systems of flying insects. Data from studies of several *Argiope* species, including a comprehensive study of *A. versicolor* by Daiqin Li and colleagues (National University of Singapore), provide compelling support for this idea. First, the silk of the decorations reflects UV light, which is not the case for the sticky capture silk. Second, the webs of these spiders capture more prey if the spider has spun silk decorations. Finally, laboratory experiments confirm that flying insects approach webs with

DENSEY CLYNE

The web of an orb-weaving spider, literally built out of thin air, is a remarkably efficient means of capturing flying insects.

decorations more frequently than webs without decorations.

While supportive, the data also create a puzzle. If silk decorations are so good at attracting prey, why aren't they incorporated into the webs of all spiders? We wouldn't expect them in nocturnal species, and this is indeed the case. But there are a great many diurnal (day-active) spiders that don't have silk decorations. More significantly, there is considerable variation in the size of these decorations within species that typically build them. The answer probably depends on the cost of the decorations. For example, my colleagues and I found that spiders invested more silk in their decorations when building webs in dim conditions compared with light conditions, and we argued that more silk was necessary in dim conditions in order to maximise UV reflectance and thus attraction to prey. However, another explanation for the varied investment in web decoration derives from the unwanted attention of predators.

DEBRIS BANDS CONTAIN

plant material, which spiders do not eat. Why aren't the spiders more particular about their rubbish?

Adult and juvenile praying mantids *Archimantis latistylus* are often found in the same habitat as the webs of St Andrew's Cross Spiders, where they routinely seek out vegetation adjacent to an orb-web, and then pluck the spider from the web. Matt Bruce, Marie Herberstein (both now at Macquarie University) and I discovered that mantids find decorated webs more attractive than webs without decorations. Consequently, the risk of predation for St Andrew's Cross Spiders might be lower if the spiders incorporate fewer decorations when they locate their webs in dense vegetation. This is exactly what happens, and we argue that the degree of web decoration is a trade-off between the conflicting signals of prey- and predator-attraction. Evidently, there is no such thing as a free lunch.

THE WEBS OF CERTAIN GOLDEN orb-weavers in the genus *Nephila* are adorned not with attractive decorations but rather with the discarded remains of their meals. My colleagues and I first thought that these bands of debris, suspended in the support threads above the central hub, were caches of food. Perhaps spiders that experience high capture rates of prey could subdue and store any excess prey items, consuming them at some later stage when food was scarce. Some support for this idea comes from an experiment, in which large, food-deprived orb-weavers (*N. edulis*) with a band of debris in their webs did not lose as much weight as similar-sized spiders without a debris band. However, the idea is less satisfactory because small spiders, which also incorporate debris bands into their webs, lost weight regardless of whether they did or did not have a debris band. More importantly, collections of debris bands from the field revealed the entirely surprising discovery that they contain plant material, which spiders do not eat. If debris bands are not food caches, why aren't the spiders more particular about their rubbish?

The answer is quite straightforward: it is not a cache of food for later consumption, but rather a cache of rotting material that attracts more food. The larvae of certain insects, including many species of flies, feed on rotting and decomposing organic material. The adults are attracted to the odours released by the bacteria responsible for decomposition, since that indicates good places to lay eggs. We were able to show that Sheep Blowflies (*Lucilia cuprina*) are attracted to the debris bands, although they become less so as the debris dehydrates. Golden orb-weavers overcome this problem by adding new prey items or other pieces

The webs of the golden orb-weaver *Nephila edulis* contain bands of discarded prey items that attract certain flying insects to within the vicinity of the web.

of organic debris to their webs, thereby attracting a constant supply of insects. In other words, the smelly debris bands of *Nephila* function in the same way as the visually conspicuous silk decorations of *Argiope*.

Orb-weaving spiders certainly sit and wait in their webs, and the number of insects flying in the vicinity of the web largely determines their foraging success. However, these spiders leave little to chance, instead taking a variety of steps to swing the odds in their favour. □

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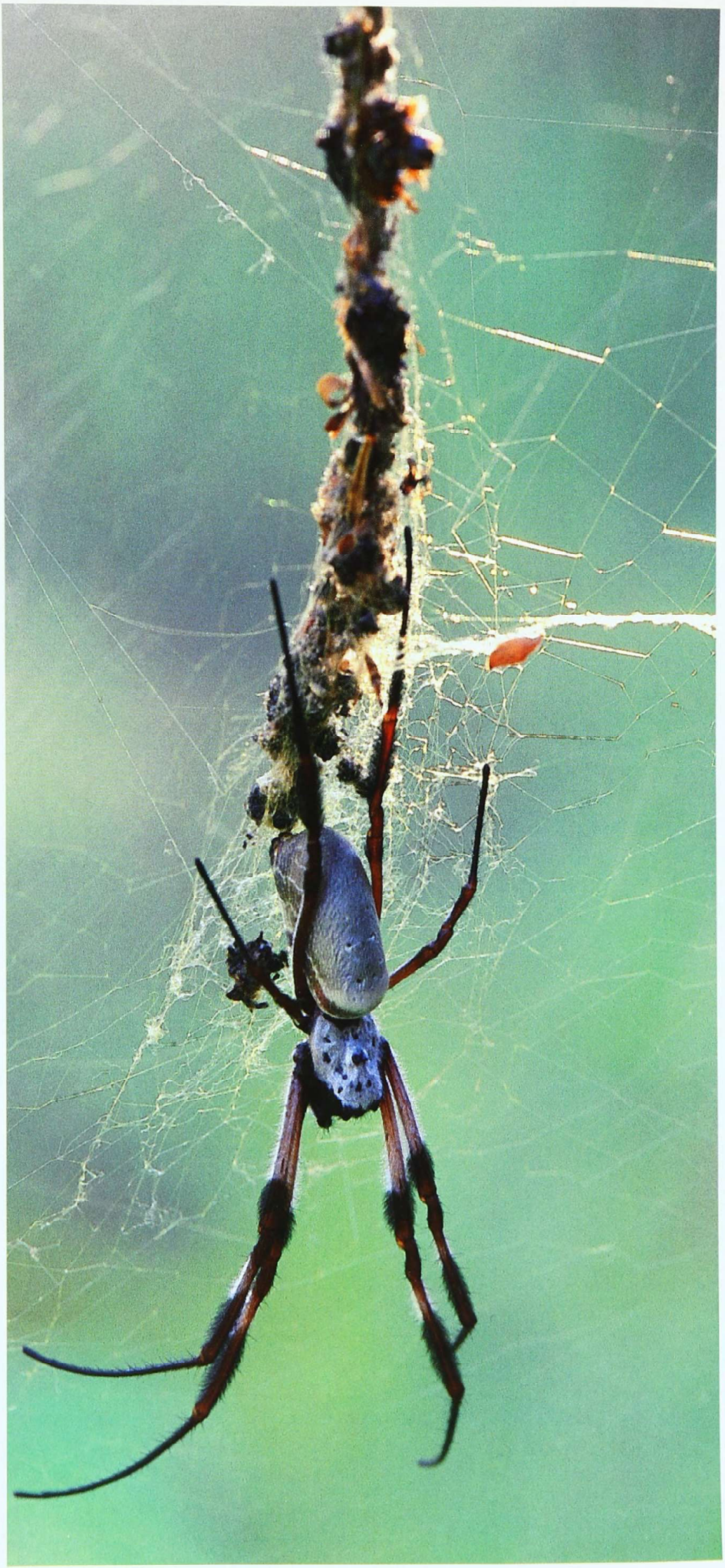
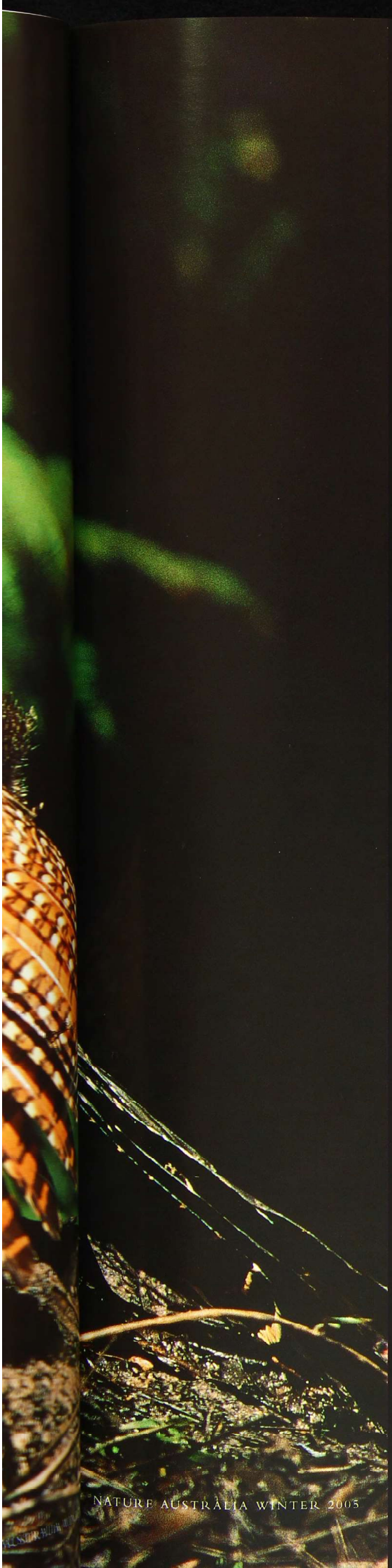


ANDREW DAVOLL / LOCHMAN TRANSPARENCIES

SIMON NEVILL/AUSTRALIAN MUSEUM PHOTOGRAPHERS

Pheasant Coucals (also known as Swamp Pheasants) need to bask in the sun occasionally to dry off their feathers.



I WAS CONVINCED
I HAD SOLVED THE MYSTERY OF
SEX-ROLE REVERSAL IN THE
PHEASANT COUCAL.

ODDBALLS *of* THE BIRD WORLD

BY GOLO MAURER

IT WAS BY CHANCE, NOT BY CHOICE, that my harmless Ph.D. project on the behaviour and ecology of Pheasant Coucals turned into a study of bird testicles, and my social life into a mess. Parties can get long and lonely when you admit to looking at birds' balls for a living! So, given the risks, what sort of bird did it take to change the course of my study mid-track?

The Pheasant Coucal (*Centropus phasianinus*), or Swamp Pheasant as it is also commonly known, is not a pheasant but a rather unusual cuckoo. Nonetheless the name Swamp Pheasant gives a pretty good idea of the bird's lifestyle: after six months of fieldwork that did not once see me walk home with dry feet, I can confirm that Swamp Pheasants live in swamps. They also look like pheasants, with their large size, long tail and brown wing-barring, and they spend most of their time on the ground like them too. So it is no surprise that the early settlers, most of whom lacked spectacles, mistook them for game birds. They soon learned, however, that coucals differ from their European look-alikes in a small yet significant detail: while pheasants make a great roast, coucals taste appalling! Of course from a scientific point of view there are other distinguishing characteristics.

AFTER SIX MONTHS

of fieldwork that did not once see me walk home with dry feet, I can confirm that Swamp Pheasants live in swamps.

Although the Pheasant Coucal is a cuckoo by trade, it does not use the method of breeding for which this group of birds is famous. All other Australian cuckoo species show a behaviour known as brood parasitism. They do not incubate or rear their young themselves but lay their eggs in the nests of other birds, where the cuckoo eggs then get incubated for free. After the cuckoo chick hatches, it kicks all other eggs and young out of the nest and the host parents end up slaving away to raise the killer of their kids. Most of the world's cuckoo species, however, are not party to this extraordinary deception; and neither are Pheasant Coucals. Instead they take care of their young themselves. But don't be fooled; coucals still do not raise their young the way most other birds do.

In 95 per cent of birds and all mammals, the roles of the sexes in reproduction are set: males compete with each other for females and often also defend territories. Females can choose a male of their fancy but bear the burden of raising the young largely on their own. Maybe because of this clear pattern in nature, for a long time similar sex roles in human society were accepted as a given. Today we understand that the sex roles in animals are not static but evolve in response to the ecological conditions experienced by the species. With the changing sex roles in modern

LORRAE McARTHUR

A two-day-old nestling exhausted after a morning of begging, feeding and growing.

ALEX McWILLAM

While males deliver most of the food, female Pheasant Coucals also help feed their young, especially when the nestlings get older.

human society it becomes increasingly interesting to look at species that do not conform and to identify conditions and mechanisms that go along with alternative sex roles.

Pheasant Coucals are one of those 'non-conformists'. In coucal society the male builds the bulky yet well-camouflaged nest in a grass clump or pandanus palm. Even before the nest is completed, the female lays a clutch of four eggs and leaves the male to complete the nest and incubate the eggs on his own for about 15 days. After the eggs have hatched, it is again the male that does most of the work. Nestlings get fed about 50 times a day, mainly with frogs, grasshoppers and stick insects. The male delivers 80 per cent of the food, while only 20 per cent is delivered by the female. The young are ready to leave the nest 15 days after hatching. At this stage the juveniles have turned into rather awkward-looking birds. While their feet are almost adult size, their body weight and wing length is only about half that of their parents. Consequently, the young explorers are yet to fly properly or catch their own food; in fact the only thing they are really good at is running away. During this early fledgling period the male stays with the juveniles for another three weeks, feeding and protecting them until they have finally learned to fly and fend for themselves.

CLEARLY, RAISING COUCAL KIDS IS A man's job, but how does all this tie in with testicles? The basic idea is very simple and relates to hormones, or more precisely testosterone. Testosterone has two main effects. It increases aggression and fighting performance, making males more competitive. It also suppresses parental instincts such as feeding and

ALEX McWILLAM

(Above) The author (right) and field assistant M. Süsser measure Pheasant Coucal nestlings.

ALEX McWILLAM

'Fledgling' Pheasant Coucals fly like a brick but their legs are already strong enough to outrun most researchers.

incubation. Testosterone therefore simultaneously influences both sides of the sex-role equation—competition and care.

Since testosterone is mainly produced in the testicles, it makes sense that a species' testicles should reflect its sex roles. As a rule of thumb, the bigger the testicles, the more testosterone they produce. We expect males of species with big testicles to have high testosterone levels and consequently to show little inclination to engage in parental care. By the same token, males of species with small testicles should have low testosterone levels and engage more in parental care. Obviously, the male Pheasant Coucal with its extensive parental care falls into the second category and should thus have small testicles.

But how can we measure bird testicles? Where are they and what do they look like? Unlike mammal testicles,

Pheasant Coucals not only hunt insects but also take frogs, lizards, birds and even snakes.

Pheasant Coucal

Centropus phasianinus

Classification

Order Cuculiformes (cuckoos), family Centropodidae (coucals). Approx. 30 other *Centropus* spp. occur throughout Africa and South-east Asia.

Identification

Large (males 55 cm, females 65 cm), pheasant-like bird with long tail, and deep hooting calls.

Habitat and Distribution

Open woodlands and swamps often along watercourses with dense understorey. Along north and east coasts of Aust., rarely more than 300 km inland, NG, East Timor.

Biology

Not brood parasites (unlike other Aust. cuckoos). Breeds Sep.–May, 3–5 eggs, incubated 15 days, chicks fledge in 15 days. Males have major role in incubating and feeding young.

which are conveniently attached to the outside of the body, bird testicles are hidden inside the body cavity. (This adaptation probably makes flying a lot easier and more comfortable, especially in winter.) In the birds' body cavity the testicles can be seen as two yellow structures in the shape of broad beans, resting above the gut, each of them connected by a long tube to the cloaca, the bird's combined organ for copulation and excretion. In the majority of bird species, the left testicle is between 20 and 50 per cent bigger than the right. This degree of asymmetry is quite unusual in the Animal Kingdom and examples from other groups are scarce. In mammals the best-known case is probably man. In humans, however, the location of the bigger testis varies with handedness and the difference in size is usually less than five per cent. Reports of more extreme cases of asymmetry in humans, such as the ones conveyed in the popular World War 2 song about the anatomical details of Nazi leaders, are more likely based on artistic liberties than scientific facts.

If Pheasant Coucals, with their reversed sex roles, have small testicles as predicted, how could this have come about, assuming they evolved from an ancestor with classical sex roles and large testicles? For a paired organ like the testicles, a reduction could have been achieved in two ways. Either both sides of the organ were reduced equally, or one half was reduced dramatically. The latter way of size reduction seems to be the more popular one in bird evolution. For example most female birds (except the flightless kiwis and some raptors) have lost their right ovary, presumably to cut down on weight and facilitate flight. Male Pheasant Coucals might have used a similar trick and decreased the size of only one of their testicles in order to reduce overall testicle size and testosterone production.

THE PHEASANT COUCAL

is almost alone among the world's approximately 9,700 bird species in having an extremely reduced left testicle.

When I started my research on the testicles of Pheasant Coucals, I expected to find one normal-sized and one extremely reduced testicle. Luckily I did not have to pry open any coucals myself to test this idea. Instead the Australian Museum, the Australian Wildlife Collection and the Queensland Museum kindly provided me with the testicle measurements collected on their Pheasant Coucal specimens. And it is an exciting picture that emerges from those data.

AS PREDICTED, ONE OF THE TESTICLES in Pheasant Coucals is reduced. Surprisingly, however, it is the *left* testicle that has shrunk, the very testicle that is usually the bigger one in birds. While in most birds the left testicle makes up around 55 to 60 per cent of the combined size of both testicles, it is around 25 per cent in the Pheasant Coucal. Apparently Pheasant Coucals have cut down on testicle size quite drastically. But even more remarkable than the magnitude of this reduction is its direction. The Pheasant Coucal is almost alone among the world's approximately 9,700 bird species in having an extremely reduced left testicle. Except for his coucal cousins, from Africa and Asia, which raise their young in a similar fashion to our Pheasant Coucal, only a few terns, pigeons and domesticated fowl show a bigger right than left testis. The latter three groups, however, have classic sex roles and the extent of their testicular asymmetry is nowhere near as extreme as in the coucals. As for males of other sex-role-reversed species (Emu, jacanas, some button-quails etc.), they provide much less care than coucals, with their young becoming independent almost immediately after hatching. Therefore we would not expect a strong reduction of testicle size in these species as we do for the coucals.

I was convinced I had solved the mystery of sex-role reversal in the Pheasant Coucal. I only needed to make sure now that the reduction of the left testicle really leaves Pheasant Coucals with a combined testicle size much smaller than that of cuckoo species with classic sex roles. So I asked museums all over the world to send me measurements of the testes of their cuckoo specimens for comparison with my Pheasant Coucal data. In the end I had information for 18 of the world's 136 cuckoo species, and it soon became clear that the testicles of Pheasant Coucals are actually much bigger than expected for a cuckoo their size. This result was quite a surprise, considering all the other cuckoos in the competition had two perfectly well developed testicles and the Pheasant Coucal didn't. I was forced to conclude that, by cuckoo standards, Pheas-

ant Coucals have an *immense* right testicle, which more than compensates for the reduction of the left. There went my brilliant theory on testicle size and parental care in Pheasant Coucals.

So how can one explain extensive male parental care in a bird whose overall testicle size is large? Perhaps the answer lies not in the testosterone production at all, but in the intricate biochemical processes that 'translate' hormones into a complex behaviour like parental care. Male Pheasant Coucals might, for example, produce a 'normal' amount of testosterone but decrease the number or efficiency of the enzymes that 'convert' this testosterone into behaviours. Today we are only just beginning to understand these complicated interactions between hormones and behaviour. Non-conformist species like the Pheasant Coucal play an important role in unravelling those interactions because they make us question conventional knowledge and thus drive us to a better understanding of the way we and other animals work. □

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ROB DRUMMOND

In their non-breeding plumage, Pheasant Coucals are so well camouflaged that people initially believed coucals left Australia in winter.

GORDON GRIGG

Meridional *Amitermes laurensis* mounds in a depression in Arnhem Land. Meridional mounds are only found in seasonally waterlogged or flooded habitats.

IT'S TIME TO ACKNOWLEDGE HOW REMARKABLE OUR NORTHERN AUSTRALIAN TERMITE FAUNA REALLY IS.

TERRACOTTA HERBIVORES

BY PETER JACKLYN, DAVID BOWMAN & YUJI ISAGI

WE GAZED ACROSS THE shimmering plain and admired the great heard of terracotta herbivores. Terracotta herbivores? Well how else do you described the great mound-building, grass-eating termite colonies that dominate the savannas of northern Australia?

Drive from Alice Springs to Darwin and you can't fail to be impressed by the sheer density of termite mounds that appear to outnumber Cattle and kangaroos by a thousand to one. Few places in the world have such a large biomass and diversity of grass-eating termites. This Australian termite fauna may be as ecologically and evolutionarily significant as our marsupials, a point that has been largely under-appreciated by biologists and naturalists alike.

Possibly termites are not regarded as celebrity biodiversity because of negative connotations of 'white ants' that wreck homes and undermine lives. Perhaps because of their beguiling external simplicity, termite mounds are seen just as honorary rocks. It's time to acknowledge how remarkable our northern Australian termite fauna really is.

THERE IS NO DOUBT THAT TERMITES challenge our ways of thinking about animals. On one level they are a group of insects that have evolved a highly social behaviour. Like ants, many bees and some wasps, termites have developed a way of surviving in the world by living in large cooperating groups and then hiving off what in other animals are bodily functions to specialised groups of individuals. Reproduction is handled by one or more queens, defensive behaviour is largely restricted to soldier termites, and the tasks of nest building, food gathering and waste excretion are the jobs of the worker caste. The castes of a termite colony are not simply the result of some invertebrate pecking order; they are strikingly different insects created by an unusual growth pattern that sees most larvae in a colony become workers or soldiers, retaining juvenile features of stumpy legs, thin skins and undeveloped eyes, yet specially fitted out for labour or defence.

As many authors have observed, including Eugène Marais in his famously absorbing book *The soul of the white ant* (1937), thinking of a termite colony as a 'composite animal' has advantages over seeing it as a great metropolis ruled by a queen and guarded by soldiers. So on another level we can think of termite colonies as single organisms whose delicate innards—the worker and soldier termites—are protected, often by a mound of thick earth.

As one would expect with any vital feature of an organism's 'body', natural selection appears to have changed the form of mounds so they are adapted to meet the rigors of different environments. Consider, for example, the grass-eating mound-builders in the genus *Amitermes*, the termites that construct vast agglomerations of columns and domes across northern Australia. On some seasonally flooded grassy plains in the far north, rank upon rank of giant tombstone-shaped *Amitermes* mounds abound—mounds so spectacular that they are a 'must see' on many naturalists' itineraries and, in fact, are one of the few examples of insects being a major ecotourist drawcard. All these mounds have a cross-section like an aeroplane wing and almost without exception are aligned north–south, like the needle of a magnetic compass.

At least two species build such 'magnetic' or meridional mounds in northern Australia: *Amitermes meridionalis* south of Darwin and *A. laurensis* in a broad range from Arnhem Land across to Cape York Peninsula. As far as we know, such bizarre mounds are found nowhere else in the world. *Amitermes laurensis* is particularly interesting because this species builds a variety of mounds from large magnetic types to small dome-shaped ones. The magnetic mounds of both species are only found in seasonally flooded or waterlogged plains, whereas the small domes of *A. laurensis* occur on better-drained soils. *Amitermes* builds small dome mounds on

GORDON GRIGG

***Amitermes laurensis* workers emerge from a broken meridional mound in Arnhem Land, Northern Territory. At one level they can be seen as individual insects but they can also be seen as functioning like vital organs within a larger organism—the colony.**

Termites

Classification
Order Isoptera ('equal-winged'). Commonly referred to as 'white ants' because of pale bodies of workers. Over 2,600 described species worldwide, including at least 250 in Aust. (and many more to be described).

Biology
Social insects that live in colonies. Diet consists almost exclusively of cellulose, from dead grass, wood and other plant material depending on species. Special micro-organisms in gut assist in breakdown of cellulose.

Distribution
Most Aust. species found in tropics, with numbers dropping off towards the south.

Mounds
Relatively few Aust. species build conspicuous mounds. Fewer than 20 species (in 5 genera) responsible for most mounds in northern Aust. These include mostly grass-eating species, such as *Nasutitermes triodiae*, which builds 'cathedral' mounds in the far north, and *Amitermes meridionalis* and *A. laurensis*, which build 'magnetic' mounds.

Status
Although termites are often thought of as pests, fewer than 6% Aust. species fit this description.

DAVID CURL

It may seem like a tropical paradise but the habitat of meridional mounds like these *Amitermes meridionalis* can be harsh: cool and parched in the dry season and then underwater in the wet.

well-drained country throughout the tropics; it is the magnetic mounds that are unusual. Could these extraordinary mounds be the result of a termite colony 'body' adapting to an extraordinary environment?

Over 60 years ago the great Australian termite biologist Gerald Hill (Council for Scientific and Industrial Research) noted that having a north–south aligned plate for a mound evened out the heat load during the day, with the eastern face heating up rapidly in the morning, the thin spine offering a small target for the midday sun, and the western face making the most of the last rays of the sun in the afternoon. Having a mound shape that stabilises temperature in this way makes sense in these floodplains, particularly in the dry season. The plains become bone dry and hot during the sunny days and chilly during the night. However, flooding in the wet season prevents the termites from retreating to subterranean galleries to exploit the insulating properties of the soil. Perhaps these magnetic mounds are an efficient way of creating large, solar-powered, thermally stable living spaces for a colony of fragile insects trapped above the ground.

The idea that the mounds are solar

panels has been supported by one of us (Peter Jacklyn), who showed that the average orientation of different populations of *Amitermes meridionalis* mounds varied between locations and that such variation keeps the eastern face at a stable temperature during the day by compensating for local variations in climate. For example, to counteract prevailing cool south-easterly winds during the dry season, the mounds in windier locations are oriented so they capture more sunlight on their eastern face. This remarkable trick of building a vertical solar panel with a precise orientation so as to maintain a thermal balance could only be an adaptation for the winter dry-season months when the sun angles are low and the sky is cloud-free. In the summer wet season, when solar angles are steep and the sky is often cloudy, such minor variations in the angles of the mounds have little effect on the mound temperature.

But still, as pointed out by Gordon Grigg (University of Queensland) who pioneered research into these mounds, why construct such a thin mound so subject to fluctuations in temperature that it needs to be precisely oriented to keep it thermally stable? Why not build a roly-poly fat mound that would maintain a more even temperature? The need for ventilation of the living space within these mounds may well play a role here.

Why also do the magnetic mounds of *Amitermes laurensis* and *A. meridionalis* grow to be so much larger than the dome mounds constructed by *A. laurensis* on higher ground? Perhaps a number of dome mounds are connected underground to form a larger colony. However, in flooded areas, such subterranean connections are difficult to maintain and the mounds in these habitats have to house the entire colony in a single large mound above ground. Alternatively, because the seasonally flooded habitats support abundant stands of annual sorghum grass, such a dense source of food material in these areas may allow the termites to sustain a large colony with a high population. Unlike large mobile vertebrates, a termite colony of any size is presumably limited in its foraging range to a circle with the radius of a typical worker termite's daily travel. Only if such a circle encompasses sufficient food resources to sustain a lot of termites can large colonies be maintained. In the sparse grasslands of the semi-arid savannas perhaps only small *Amitermes* mounds are possible.

YUGI ISAGI

On well-drained soils south of the Mitchell River in Queensland *Amitermes laurensis* builds small dome mounds no taller than a metre or so—tiny compared to the mature meridional mounds built by the same species in flooded areas. Although dismembered for the sake of science, this mound should be able to repair itself.

DESPITE THE MANY UNCERTAINTIES, there is clear evidence that the large magnetic mounds of both *Amitermes* species are an adaptation to seasonally flooded tropical plains. But there are many of these habitats throughout the tropics, so why are magnetic mounds found only in Australia? Perhaps the answer to this question lies in the instruction set used to create these mounds—coiled up in the termites' DNA. Perhaps it is the genetics of these termites that is distinctive rather than the environments in which they live. A given *Amitermes* population will build mounds that have a more-or-less fixed growth pattern and, if damaged, will be repaired to the same shape—a feat achieved by blind workers within their life span of a brief few years and just a fraction of the mound's existence. Clearly these insects do not work from an intellectual blueprint in their heads but presumably create mounds by following a series of fixed responses to a complex set of cues, and these responses are presumed to be encoded in their DNA. So examining the DNA in termites may tell us something about the mounds they build and it may also be possible to tease out the evolutionary relationships between the different

YUGI ISAGI

A field of *Amitermes meridionalis* mounds south of Darwin near Litchfield National Park showing their remarkably uniform shape and orientation.

Amitermes mound-builders. With this in mind a collaborative project was set up between Charles Darwin University in Australia and Hiroshima University in Japan to collect and analyse DNA from hundreds of *Amitermes* termite colonies across northern Australia.

The results of this survey show that in *Amitermes laurensis* there is not a simple genetic split between magnetic mound-builders and dome mound-builders; rather there are many branches of the 'family tree' that contain both dome and magnetic genotypes. This suggests that in this species the strange magnetic-mound 'body shape' has evolved several times from the close dome-type relative as an adaptation to seasonally flooded areas. If this interpretation is correct then magnetic mounds have a long evolutionary history in northern Australia. In this context it must be borne in mind that for the last tens of millions of years the Gulf of Carpentaria was in fact a great freshwater lake. Is it possible that vast seasonally flooded plains around 'Lake Carpentaria' were like the great plains that gave rise to the modern Horse: an extensive habitat that kick-started the evolution of those animals that could effectively exploit it, in this case magnetic mound-building termites?

Is it also possible that the reason magnetic mounds are endemic to northern Australia is related to the environment, but in a more exotic way than we thought? For example, it has been shown that *Amitermes meridionalis* termites are influenced by the direction of the Earth's magnetic field when they repair their mounds. Building a meridional mound may require the termites to follow an inherited magnetic cue to precisely orient the structures, which in turn would require a magnetic field direction that does not vary too much from one decade to the next—so that daughter mounds can still benefit from the magnetic bearing that they inherit from their parents. It turns out that northern Australia is one of the few parts of the world that has had a stable magnetic field direction over recent centuries.

We are just scratching the surface in understanding the radically unfamiliar 'bodies' of these Australian termite colonies and speculation abounds once you start thinking of the termite mound as an extended body for the colony, the shape of which is more likely to change in response to environmental challenges than the body shape of individual termites. Accept this and you will never think about termites in the same way again. □

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D. PARKER & E. PARKER-COTE/AUSCAPE

Platypuses and other native wildlife are often inadvertently killed in fish and yabby traps.

How often do we think about by-catch in the rivers of our own backyards?

TRAPPED!

BY TOM GRANT & MICK LOWRY

MATT DROPPED THE TWO yabby traps off the back of the ute onto the riverbank. He and his daughter Ellen then got to work baiting them with some old meat that the Kelpie had left behind. Nice and smelly! Just the thing to attract yabbies. They anticipated a good feed for lunch the next day. After Matt had thrown the traps into the water and hidden the recovery lines, they hung around for a bit, to make sure nobody had seen them.

It was just after dark when the female Platypus slipped into the water from her nesting burrow. Her two unfurred young were snuggled in the tight ball of leaves she had woven in the nesting chamber. She was pretty hungry; this lactation business was hard work! As she entered the water, she sensed something moving. Her bill had picked up the electrical signals generated by muscle contraction—a yabby, and a good-sized one too! Edging closer she touched a soft mesh barrier, but quickly found a way through. By the time her breath was nearly gone, the yabby was hers. She headed back towards the surface but was stopped by more of the mesh. She was trapped!

MOST PEOPLE KNOW ABOUT THE problems of by-catch in our oceans. We have all seen the dolphin-friendly stickers on tuna cans, and perhaps have heard of the drowning of albatrosses when they take the baited hooks from long-line fishing vessels. But how often do we think about by-catch in the rivers of our own backyards? The inland (fresh) waters of eastern Australia have been heavily fished since European occupation. As a result, large numbers of non-target wildlife species, including Platypuses (*Ornithorhynchus anatinus*), Water-rats (*Hydromys chrysogaster*), turtles and diving birds, have been killed by professional and recreational fishers, especially in the early days of commercial fishing when nets with small mesh-sizes were used. These days, non-target species are still regularly drowned in illegally set nets and various types of traps, including the most commonly used 'opera house'-style traps.

To protect wildlife species, setting of traps to capture yabbies is currently banned in all public inland waters of Tasmania, Victoria and the ACT but yabby traps can still be used legally in Queensland. Despite also being illegal to use in any fresh waters in the eastern part of New South Wales, 'opera house'-style traps are still sold in many country stores, service stations, fishing-tackle shops and even in some large retail outlets. A resident of the Wyong area recently saw them in a department store for $3.80 each. He paid a bit more for one in a tackle shop four years previously, when he was assured by the salesperson that the nine-centimetre entrance rings would stop wildlife entering the trap. However, five Platypuses drowned when he set the trap in his local creek. "At today's price," he told us, "if you divide the cost of a trap by the number of Platypuses I drowned, then a Platypus life is worth just 76 cents!"

Platypuses are even occasionally caught by anglers using worms, flies or lures. Unfortunately many people, scared of being spurred, simply cut the line if they catch a Platypus, instead of handling it to remove the hook. But only males have spurs and all Platypuses can be held safely by grasping the end of their tail. A bag, jacket or some other thick material can be used to hold the animal down while the hook is removed. Letting an animal go with a hook or lure still embedded in its bill or body will most likely result in a slow death from starvation or infection.

In the various States of Australia, recreational and commercial freshwater fishers are currently permitted to use a variety of traps to capture a range of species, including eels (*Anguilla reinhardtii* and *A. australis*), yabbies (various species of freshwater crayfish) and the introduced Common Carp (*Cyprinus carpio*), now found in plague proportions in many streams and lakes of Victoria, New South Wales and southern Queensland. Unfortunately all freshwater fisheries involving the use of traps can drown protected wildlife caught incidentally. For example, 17 Platypus

BOB FARAGHER

Occasionally Platypuses are caught on the hooks of fishing lures, flies or baits. Lines attached to hooks can entangle animals and unremoved hooks can cause death by starvation or infection.

PETER MARSACK/LOCHMAN TRANSPARENCIES

Moving relatively clumsily over rocks, a Platypus is easy prey for a Fox or Dog. Platypuses are particularly subject to predation during droughts, as they move over shallow riffles from pool to pool.

skeletons were found in a single abandoned eel trap that had been illegally used in an inland river in Victoria. Realising the potential impact of trap-based fisheries on wildlife, NSW Fisheries undertook to investigate ways of either preventing wildlife species from entering traps, or providing a means for them to escape or remain alive in an air space if they do enter traps.

TRAPS USED IN THE COMMERCIAL eel fishery in New South Wales consist of a metal-rod frame (50 cm wide x 40 cm high x 90 cm long), with a single ten-centimetre one-way entrance or 'valve', through which eels (and non-target animals) can enter but cannot normally find their way out. Although these are legal to use in estuaries, impoundments and farm dams, where Platypuses only occasionally visit, they still result in some Platypus mortality. We decided to investigate how small the entrance to a trap has to be to

Platypus
Ornithorhynchus anatinus

Classification
Family Ornithorhynchidae.

Identification
Streamlined body with distinctive bill, webbed front feet and broad flat tail. Head–tail length 40–60 cm; body weight 700–2,500 g (up to 3,000 g in Tas.), marked sexual dimorphism (males larger than females). Upper body fur dark brown to reddish brown, underfur light brown to silver. Venomous spur (1.5 cm) on rear ankles of males.

Habitat and Distribution
Waterways in eastern Aust. from around Cooktown to Tas. (including King Island). Western slopes of Great Dividing Range from southern Qld to Vic. Probably extinct in SA, introduced to Kangaroo Island.

Biology
Mates Jul.–Sep., around 3 weeks to egg laying, incubation about 10 days, lactation 3.5–4 months. Litter size 1–3. Young leave nesting burrows late Jan.–Apr. at 75% adult size. Eats benthic invertebrates, including insect larvae, worms, small molluscs, freshwater shrimps and yabbies.

Status
Common over most of its range but some local populations vulnerable or threatened.

GUNTHER SCHMIDA

Introduced Common Carp are pests in many river and lake systems of Australia where Platypuses also occur.

prevent Platypuses from entering it.

With Bruce Pease and Trudy Walford (NSW Fisheries) we caught Platypuses and carried out a series of experiments by placing individuals inside semi-submerged traps, where they had access to a single opening of a specific size to make their escape. The results were astounding. Small female Platypuses could pass through an opening of six-centimetres-square and larger females and males through one of only seven centimetres! Consequently, the only way to reduce the incidental capture of Platypuses by eel-fishers was to continue restricting the use of eel traps to estuaries in New South Wales, so that Platypuses seldom come into contact with them. In farm dams and some artificial impoundments where licensed eel traps are used, these traps have to be fitted with an extension (called a cod end) that is fixed above the water so that any captured Platypuses or other air-breathing species can reach the air space and survive until released. In our studies, Platypuses placed in underwater eel traps with elevated cod ends had no difficulty finding the air spaces in these traps. Researchers often use quite similar traps, called fyke nets, to capture Platypuses in small streams (see "Metropolitan Monotremes", *Nature Aust.* Spring 1996).

LETTING NON-TARGET *species into a trap was OK, as long as they could subsequently escape.*

Although not specifically carried out in relation to yabby traps, the experiment with eel traps showed that the nine-centimetre rings often inserted into yabby traps, and reputed to keep wildlife species out, would not work for the Platypus. Consequently, NSW Fisheries banned these traps from all Platypus waters (mainly the area east of the Newell Highway between Tocumwal on the Murray River and Goondiwindi on the border of Queensland to the coast). Outside this area, nine-centimetre rings became mandatory in all traps used by commercial and recreational fishers to prevent the entry of other wildlife species, particularly turtles. While some smaller turtles may still drown in these modified traps, the younger ones apparently tend to be less adventurous and so are not as likely to enter the traps compared to the larger breeding adults, which readily enter to eat the bait. Unfortunately this regulation, in force since November 2003, has not been well publicised so that many people who already have traps do not realise that their use is illegal.

Carp can grow well in excess of ten

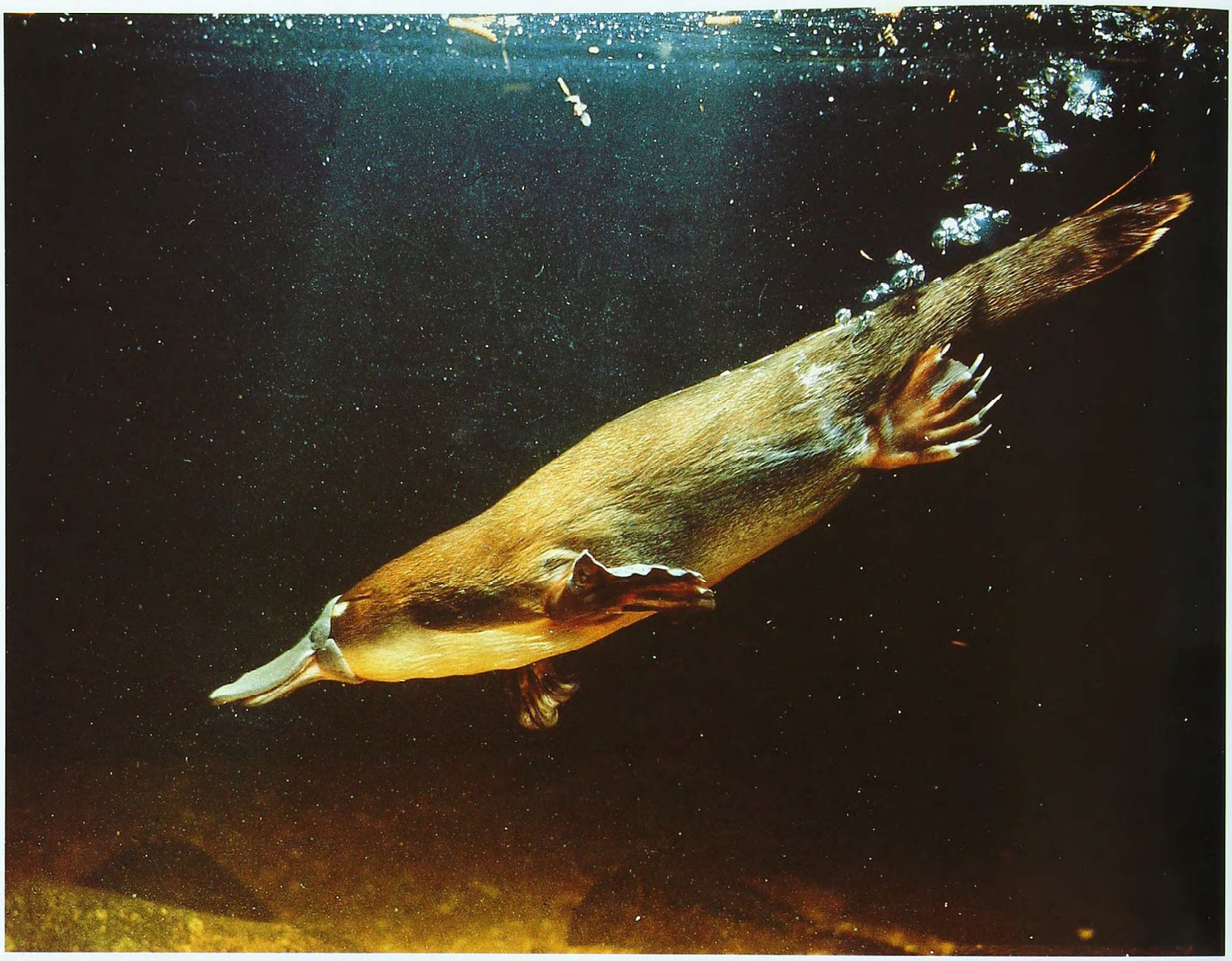
kilograms and so entrances to traps used to capture them need to be large, certainly much bigger than the 6–7-centimetre entrances through which Platypuses are able to pass. Our colleague Ken Graham (NSW Fisheries) suggested that perhaps letting non-target species into a trap was OK, as long as they could subsequently escape. So we experimented with modifying an existing drum trap—a drum-shaped frame (90 cm in diameter x 170 cm long) that lies under the water on its side, with flexible mesh stretched over it and an entrance funnel in one end. We added an escape hole in the top, but eight centimetres under this hole we suspended a metal grid platform. The design, originally adapted from a similar trap used in South Australia that apparently let Water-rats escape, aimed to exploit the natural tendency of air-breathing animals to move up and towards the surface. The idea was that,

PETER MARSACK/LOCHMAN TRANSPARENCIES

Fyke nets are used in Tasmania and Victoria to capture eels and have resulted in Platypus mortality. In this research net there is an airspace to permit trapped Platypuses to breathe.

BARBARA LOWRY

Mick Lowry removes a prototype carp trap from his mother's swimming pool where the experiments on turtles were carried out.



ROBIN SMITH

The bubbles coming from a diving Platypus led some early naturalists to believe that the species breathed through its back! Air trapped in the fur is actually being squeezed out by water pressure as the animal dives. The air retained in the fur acts as excellent body insulation.

once captured animals reached the top of the trap, they would move along until they passed between the platform and the roof, and then escape through the hole. Carp, on the other hand, tend to stay near the bottom of a trap, and even if they did find the escape route, they would probably be too big to negotiate it. So we commandeered Mick's mother's swimming pool (without chlorine of course) and tried the modified trap out on a group of Murray Turtles (*Emydura macquarii*). It worked, with 77 per cent of the turtles escaping from the trap within four hours.

But would it work on Platypuses? We assumed it would, as the work done on eel traps showed them to be real Houdini escape artists. But just to make sure, we tested the modified carp trap out in the field and were very surprised by the result. Neither of the two Platypuses tested on the first night were able to find the escape hole and had to be released!

WE COMMANDEERED *Mick's mother's swimming pool and tried the modified trap out on a group of Murray Turtles.*

So a couple of nights later we set up underwater video-surveillance equipment to try to understand the behaviour of a trapped Platypus. We put three Platypuses into the traps, and filmed each of them separately as they negotiated their way round inside. Only one managed to find the escape hole; the others had to be released. Active Platypuses can only hold their breath for about two to three minutes, although they can hold it for up to 11 minutes if wedged under a log or rock and not using much energy. Unexpectedly, the videotapes showed that the Platypuses did not immediately try to surface, but instead tried to find escape holes along the sides of the trap and on the bottom, seldom investigating the roof of the trap at all. They spent much of the time searching with their bills around the corners where the sides met the ends of the drum, particularly at the base of the entrance funnel. This seemed to be the clue for modifying the trap.

We tied back pieces of the mesh to provide a number of ten-centimetre triangular escape holes around the base of the entrance funnel of the trap. The

next night we put three Platypuses into the trap and they quickly found the new holes and escaped to freedom. By the end of our experiments, all 13 of the variously sized Platypuses that we trialled were able to make their escape.

ALTHOUGH THERE IS THE POTENTIAL for small carp to also escape through these holes, subsequent field trials have demonstrated that the modified carp trap is an effective means of capturing a broad size range of carp in small waterways. As our previous work indicates that non-target wildlife species can escape from these traps, we suggest that Landcare and Rivercare groups use this method to reduce large carp populations in areas where the presence of protected wildlife makes the use of other methods impractical.

When young Ellen pulled in the first trap she was delighted—there were half a dozen good-sized yabbies inside. She threw the remains of the bait into the river and the Kelpie playfully chased after it. However, when her Dad pulled out the second trap, the sight of a dark, limp furry shape in the bottom of the trap turned her joy to horror. Traps and wildlife can be a fatal combination. □

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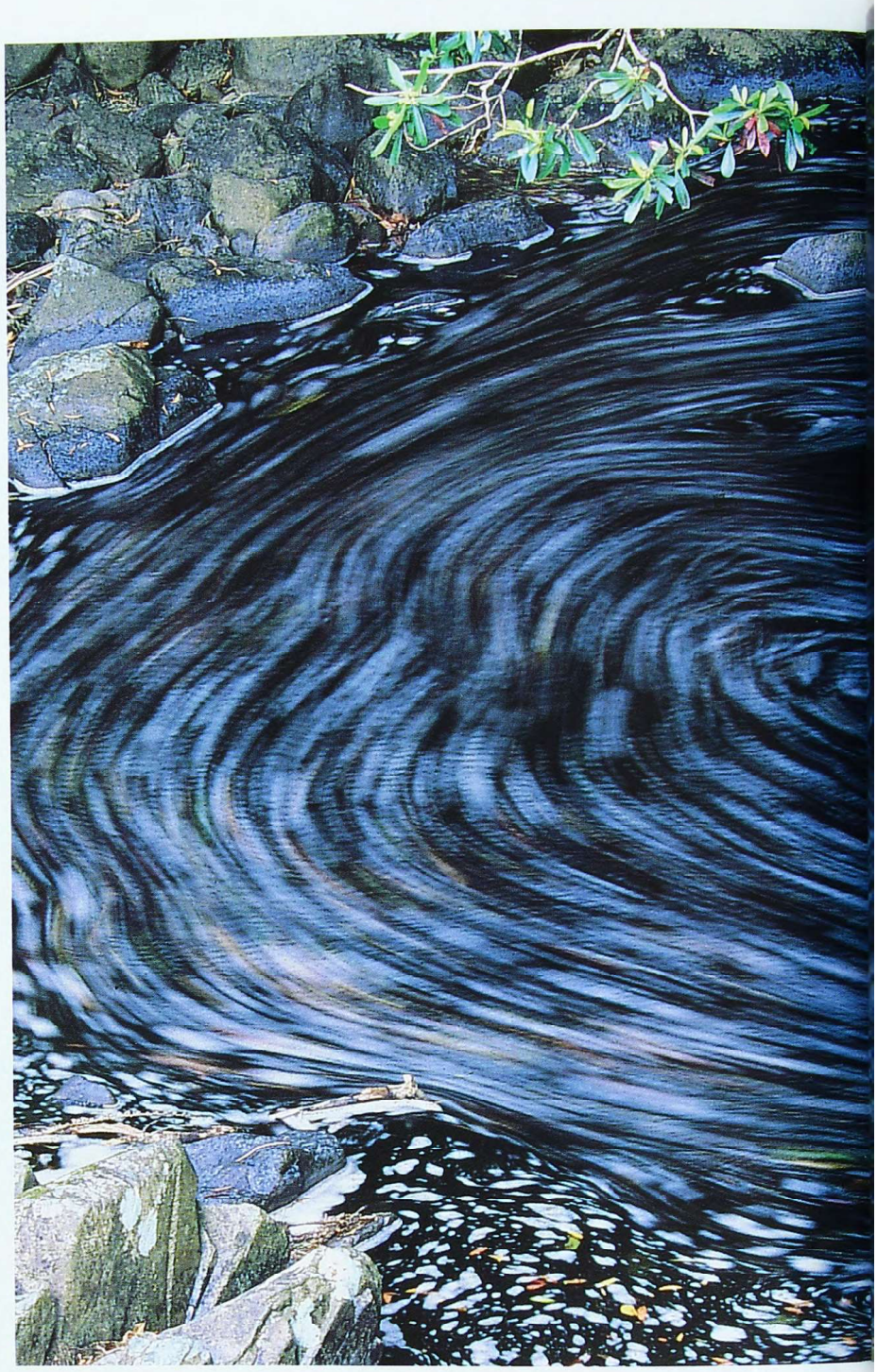
MICK LOWRY

A Murray Turtle escaping from the prototype trap, which retains captured carp but permits turtles and Platypuses to escape.



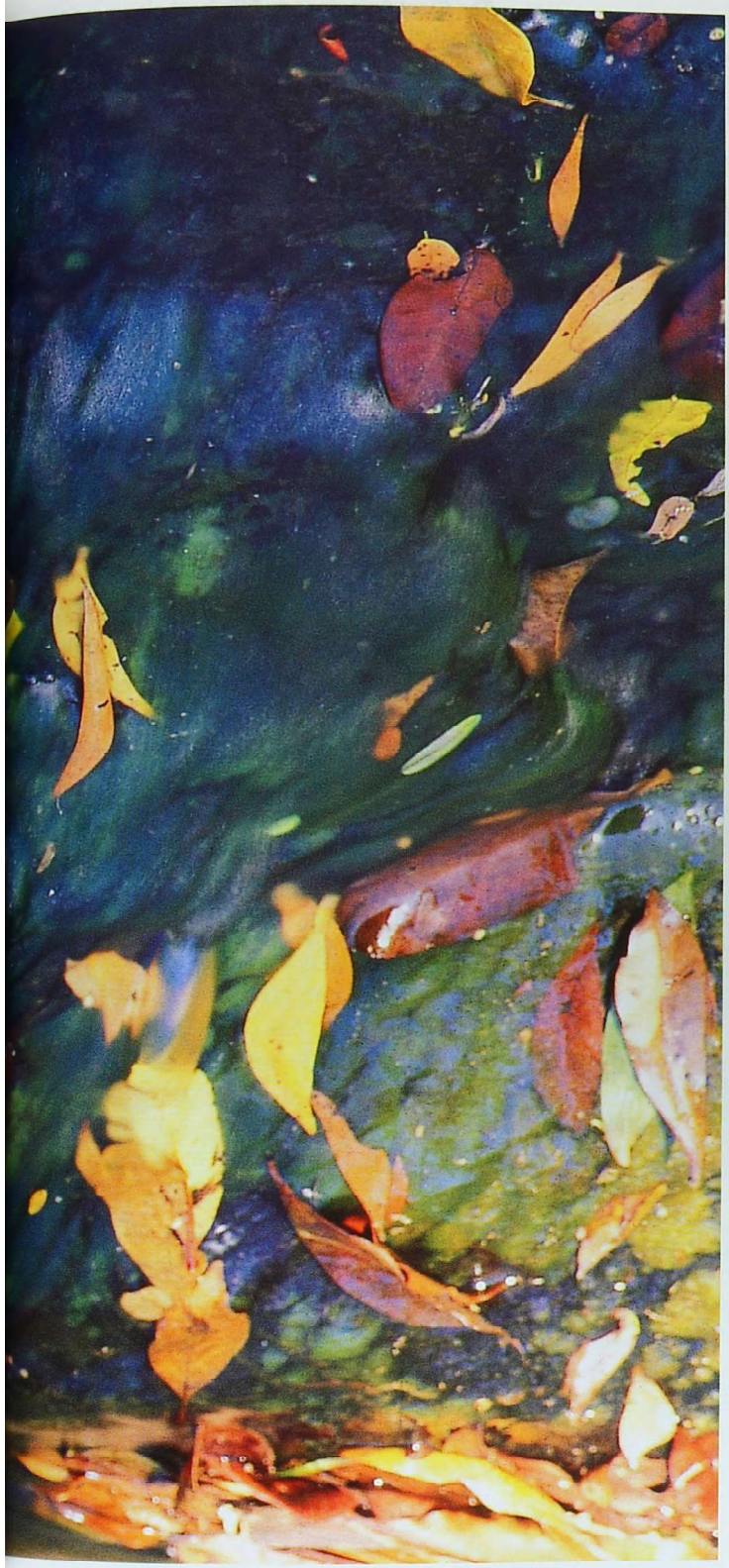
Foaming waters created by the leaching of nutrients and secondary compounds from rainforest leaves spiral in a current created by intake falls near Helenvale, northern Queensland.

Fresh fallen leaves drift by a sand bank in a stained stream in south-western Western Australia.

impressionist streams

BY ANDREW DENNIS

The reflection of a blue sky and moving water combine to turn a rock face covered in bright green algae into an opal-like surface, while leaves trapped in the algae provide a variety of colour highlights.



Water loaded with minerals leaves concentric rings in isolated rock pools off the Lynd River in northern Queensland.

Rocks carved by ages of flowing water create abstract sculptures in the Lynd River in the Einasleigh Uplands, northern Queensland.

Reptilian cows?

The daily agenda for Giant Anteaters is fairly simple; eat about 30,000 ants over eight hours and then sleep for 16 hours.

TUI DE ROY/ AUSCAPE

The Giant Anteater's middle front claws are so long that it must hobble along on its wrists.

IT'S A SCENE THAT COULD HAVE been taken from any one of countless horror films in which a giant monster creates havoc as people that appear to be the size of ants run around like ants. In this case, a Giant Anteater has just used one of its huge front claws to tear an opening in the side of an ant mound and it is licking, lapping and sucking up the residents. Feeding for only about ten seconds, it shuffles onto the next mound and the mayhem and carnage starts again while the survivors from the previous attack repair the damage.

It is unlikely that a giant Giant Anteater will join Godzilla or King Kong as one of cinema's towering icons. In fact, the Giant Anteater (*Myrmecophaga tridactyla*) is such an odd-looking mammal, it would not be out of place in a cartoon of imaginary animals. It is about the size of a German Shepherd, but has a bushy tail almost as long as its body. The hairs on the tail and underside are almost half a metre long. It has a head that looks like it was designed in a wind tunnel by car engineers: it is very streamlined with small eyes and ears, and tapers into a half metre-long snout, which is a tube of bone formed by the fusion of the upper and lower jaw. Its legs are short and it has a slow limping gait because the middle claws on its front feet are so long that it has to walk on its wrists with the claws curled out of the way.

Giant Anteaters do not have any teeth and cannot bite, as they can only open their mouths about two centimetres.

Inside the mouth is a 60-centimetre worm-like purple tongue with backward-pointing spines. It is coated with great wads of sticky, viscous saliva and can be flicked in and out at up to 150 times a minute, making it a writhing nightmare inside an ant mound. The muscles that move the tongue are so large that they are attached not only to the skull but also to the top of the breastbone. By creating a vacuum in their throat, the snout also becomes a vacuum cleaner that would not look out of place in "The Flintstones". The anteater does not produce acid in its stomach for digestion. Instead, it uses the ants as self-digesting parcels, relying on the formic acid the ants release as they are crushed inside the mouth and stomach. The anteater's long fur and rubbery skin do give it some protection against the biting jaws of soldier ants, which stream onto its body after their mound has been invaded, but by dipping only briefly into each mound, the anteater avoids a full-scale attack.

Living on ants is not a very nutritious diet, and Giant Anteaters are economical with the amount of energy they expend on maintaining a mammalian metabolism. At 32° C, they have the lowest temperature of any terrestrial placental mammal and a brain that is metabolically undemanding because it is the size of an olive. Only when the ambient temperature reaches 28° C do anteaters become active. Presumably, once the mammal engine is at operating temperature, they can think lofty anteater thoughts that in lower temperatures would have been unthinkable. The daily agenda for Giant Anteaters is fairly simple; eat about 30,000 ants over eight hours and then sleep for 16 hours. Individual anteaters will graze from hundreds of ant mounds a day and the size of their home range (anywhere from about 50 to 2,500 hectares) is a reflection of how far they have to walk to find enough ants for the day. When they are ready to rest, they lie down in the grass and use their tail as a blanket to keep them warm.

Giant Anteaters live in large parts of southern Central America and the northern and central parts of South

BY SIMON D. POLLARD

America, especially in the tropical forests, grasslands and highlands where ants are most abundant. In Brazil's Serra de Canastra National Park, Robert Young and his students from the Pontifical Catholic University of Minas Gerais have been studying the behaviour of this widely recognised, but little-known mammal. Giant Anteaters are almost blind and don't hear that well, but can sniff the air with the acuity of a bloodhound. Like a group of paparazzi following a slow-moving celebrity, Young and his team walk with Giant Anteaters by keeping quiet and downwind.

A popular myth in Brazil is that anteaters defend themselves by rearing up on their hind legs and slashing bear-like with their front claws or hugging the predator to death. Young has only seen anteaters run away from danger and suspects that their large bushy tail may be used as a head mimic to confuse anteater-eaters, like Jaguars and Pumas, which prefer to attack from the rear. When the anteater flees, it keeps its tail in the air, even when it pauses to raise its nose like a periscope to sniff the air. In this posture it is very difficult to tell which end is which.

Male and female Giant Anteaters look similar and, except when mating, both sexes are solitary and keep away from one another. Females are pregnant for 180 days and the baby is born looking like a miniature replica of its parents, complete with shaggy fur and sharp claws. It rides on its mother's back for about six to nine months and when it leaves this perch to walk alongside her, it is almost half her size. On the mother's back the baby anteater is perfectly camouflaged because the markings on its own fur blend in with those of its mother. Young found that raptors would also follow anteaters, with a special interest in the infants. A baby would be small enough to be taken as prey by a raptor and is likely to be a lot tastier than an adult, because it lives on milk, rather than ants, which apparently make anteater flesh very acidic.

After months of following anteaters, Young sees their slow-paced lifestyle as having the thermal constraints of a reptile and the grazing behaviour of a cow. As a fellow mammal, I have to wonder whether having a brain the size of an olive makes it easier to spend eight hours a day sucking ants up your snout. □

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FRANCOIS GOHIER/AUSCAPE

A baby Giant Anteater gets a ride on its mother's back.

This sporting life

Not everyone loves sport, but the history of its favoured sport probably tracks how a society grows.

BY RICHARD FULLAGAR & DONALD FORSYTH CRAIB

SPORTS SCIENTISTS THINK OF Olympic athletes as another species, and with good reason. Even if we were born in the pool and swam laps all day, Ian Thorpe would still have an edge over us. It's their combination of muscle mass, dedication, genes and even shoe size that makes the difference—only 0.1 per cent is attributable to the coach. But this doesn't stop us playing sport. Although most of us are in the shallow end of the swimming gene-pool, we still go flat chat in the parents vs. teachers freestyle, and we love to watch—especially Australian Rules Football (AFL) if born in Melbourne, Victoria.

AFL supposedly has its roots in a gentle version of rugby for cricketers and in an Aboriginal game, called Marngrook by the Gunditjmara people of western Victoria, in which players kicked a possum or kangaroo skin stuffed with charcoal and took high leaping marks. This tells us something about early Victorian and Aboriginal relations. And maybe also something about cricket—the first cricket tour from Australia to England was an Aboriginal team, nearly all Victorians, in 1867–1868.

Not everyone loves sport, but the history of its favoured sport probably tracks how a society grows. The Smithsonian Institution in Washington has recently held a wonderful exhibition on baseball, from the perspective of players, men, women, children, supporters, presidents, minority groups and more, each tracing elements of American economic and social history. For many people the paraphernalia and mementos associated with sport provide the best example of how simple objects, things like red socks, can become powerful symbols. But before the first pictures or writing, it is very difficult for archaeologists to identify a bat or a ball, let alone decipher the symbols.

How did different sports begin? Why are they so similar? Balls get tossed around in a lot of different games. Is sport just about being fit, a preparation for life's battles? The trouble is that sport is not easy to define. Even the OED definition seems a little non-specific: "an activity involving physical exertion and skill in which an individual or team competes against another or others". Is there any kind of activity that does *not* involve some degree of physical exertion? Is improving your PB not sport? And it hardly defines recreational fishing, often classified as the most popular 'sport' in Australia. Even with a more restrictive definition that incorporates explicit rules and symbols, most people play some kind of sport; it is probably part of being human.

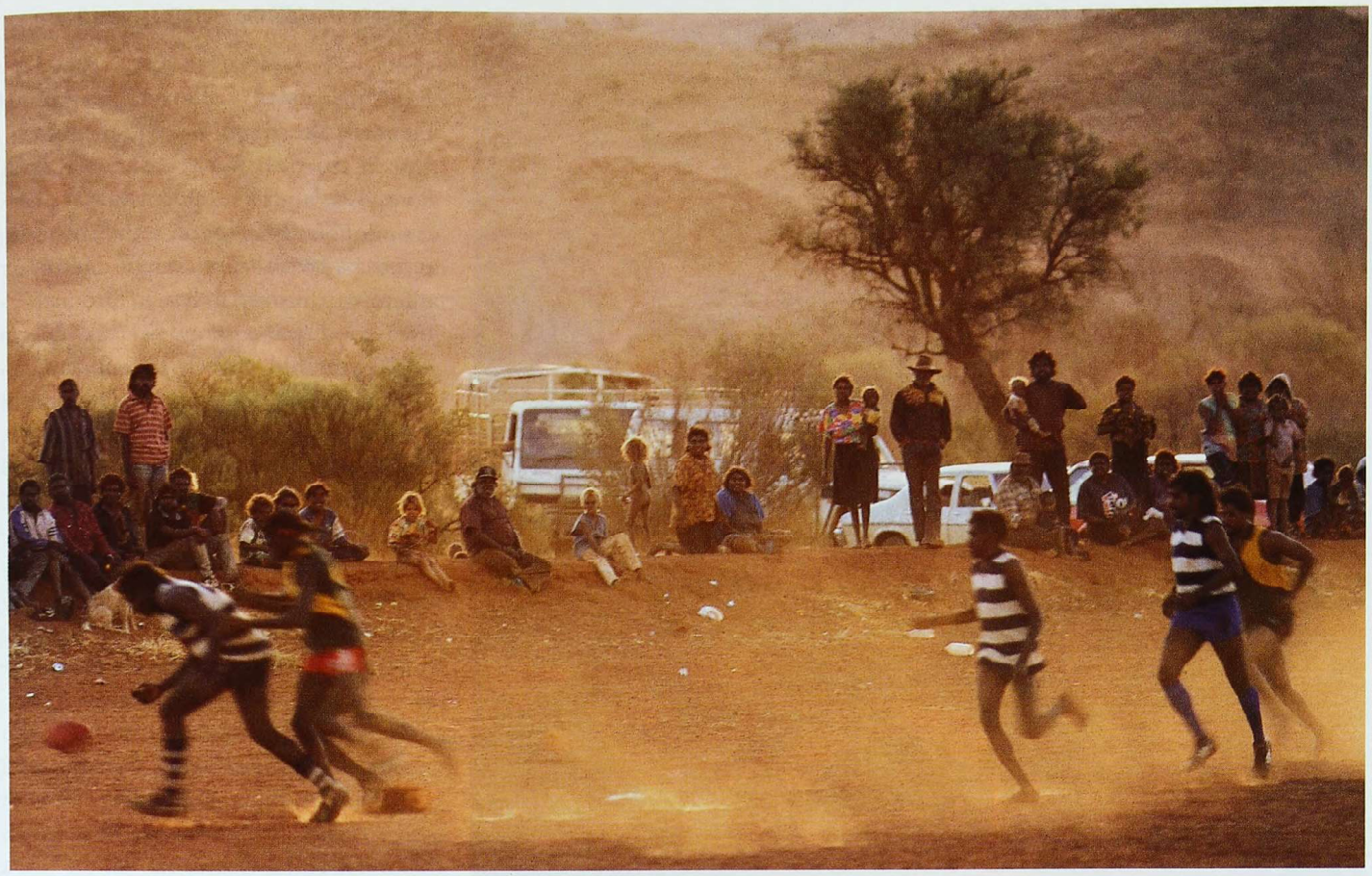
The earliest unequivocal evidence for sport only comes from the last five or ten thousand years.

No-one knows when jogging became a sport, but Dennis Bramble (Utah University) and Daniel Lieberman (Harvard University) propose that endurance running evolved by about two million years ago, when humans were competing with other scavengers on the African savanna. After first locating a carcass (perhaps by spotting circling vultures), humans had to get there to secure it, and they did so by jogging (slowly and steadily; we weren't built for speed). A ridge at the base of human skulls, relative size of legs to arms, peculiar joint structures and huge buttocks are all indicators of running early in human history, but the earliest unequivocal evidence for *sport* only comes from the last five or ten thousand years.

Some sports seem to be practice for war. For example, in early Mesopotamia (southern Iraq) combative sports like wrestling, boxing, archery and horse riding appear more than 1,000 years ago (along with swimming and acrobatics). A similar range of sports is reported in other early civilisations, and interestingly are often preceded by archaeological reference to more 'friendly' amusements, such as ninepins in Egypt, marbles in India, and soccer in China. Although ball games seem innocuous, some were deadly, especially the first to use rubber.

Rubber balls were first used 3,500 years ago by the Olmecs and successive Mesoamerican cultures in a form of basketball claimed to be the earliest team sport in history (see ***http://www.ballgame.org***). The Meso-americans used the sap of morning glory plants to fix or 'vulcanise' latex from rubber trees, long before Charles Goodyear used sulphur to do the same job. The rubber was then moulded around something firm and hollow (often a human skull) to give the balls much more bounce than a solid object. The balls ranged from 10 to 20 centimetres across and weighed 11–17 kilograms.

The game, called *pok-ta-pok* by the Mayans, was played on an I-shaped field with teams decked out in decorative and protective gear. The largest ball court still standing is 150 metres long at the Mayan-Toltec site of Chichén Itzá, Mexico. Two teams kept the ball mov-



STEWART ROPER/LOCHMAN TRANSPARENCIES

Australian Rules Football has its roots in the Aboriginal game of Marngrook.

ing without use of hands or feet or any sort of bat, and scored points when they drove the ball to one end or knocked it through a stone hoop on the side. Ball courts were sacred, richly decorated and built in honour of the gods. Cosmic symbolism and ritual played important roles in execution of the court construction, the game and even the losers! (Losers were often sacrificed.) Playing the game, however, was not the exclusive domain of any social class or rank—unlike the royal game of tennis.

Australian star Pat Cash called tennis "the McDonalds of sport—you go in, they make a quick buck out of you, and you're out" (*Independent* 4 July 1999), but it was not always so. Tennis was played for the fun of it (even with hard balls made of cork or hair), and was so popular in 13th-century France that nobles wanted to ban it, presumably to protect its status. Eventually vulcanisation changed the balls to rubber and a new game emerged.

The Canadian national game of lacrosse is thought to have originated in one of the eastern Algonquin tribes and was carried down the Saint Lawrence River to what is now the USA, before Europeans arrived. The French gave the game its name, because the webbing at the end of the stick reminded them of the bishop's crosier (staff) or cross. Participants used rackets with netted pouches at the top for catching, throwing and carrying the ball, and the objective (just like *pok-ta-pok*) was to score points, when you were not hammering your opponent.

How much has really changed in the modern era? Although the Olympic Games have come to stand for religious ideals, friendship and peace, in his popular book *The naked Olympics* (2004), Tony Perrottet questions the myth and suggests that the ancient games were the Woodstock of antiquity. A big party, but mostly for men only. Married women were not allowed in the stands—only young women and virgins. Facilities were very basic, and sports bars and prostitutes probably made more money than the organisers. The winning athletes though were set up for life. Sound like any sport you know?

Contact sports and team games can be fun, but there is something noble about individual pursuits—just swimming or jogging for the hell of it, unlike our ancestors two million years ago. And you have to love the idea that baby we were born to run. □

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Size matters

This is as big as any single flower on Earth gets.

DENSEY CLYNE

***Rafflesia arnoldii:* the world's largest flower.**

BY TIM ENTWISLE

THE WORLD'S BIGGEST FLOWER IS also the world's biggest free-loader. The aptly-named Corpse Flower (*Rafflesia*) has no leaves, no stem and no roots. In the time it takes a human baby to gestate, the Corpse Flower swells from a few parasitic threads weaving through the stem of the tropical vine *Tetrastigma*, to a flower bud the size and shape of a large cabbage. And then it opens.

Releasing a sickly aroma of decaying flesh into the jungle air of Sumatra, the ten-kilogram flower of *Rafflesia arnoldii*, the largest of the genus, unfurls to nearly a metre across. This is as big as any single flower on Earth gets, although there are other flower-like structures and collections of flowers that tower metres into the air (the flowering last year of the Titan Arum, *Amophophallus titanum*, at the Royal Botanic Gardens in Sydney drew attention to this massive compound flower). In a sense there is little to hold the Corpse Flower back. This parasite uses its free board and lodgings to create a gigantic fly attractant. When you produce a single flower sporadically, you need to make it a large one to attract the attention of passing pollinators. If the Corpse Flower had to grow its own leaves, and generate its own food and energy, things might be different.

But then again, the world's biggest plants are all 'free-living'. The most massive plant on Earth is a 2,000-tonne Giant Sequoia (*Sequoiadendron giganteum*) in eastern California, nicknamed General Sherman. It's 83 metres tall, and 24 metres in circumference at its base. Although like most vascular plants it undoubtedly relies on supportive relationships with root fungi and other micro-organisms, it has to produce its own food and energy. So too does a 4,000-year-old Sweet Chestnut (*Castanea sativa*) in Sicily, called 'The Tree of a Hundred Horses', which had a circumference of 58 metres in 1780 (and has since split into three). In Australia, there is a 10,000-year-old Huon Pine (*Lagarostrobos franklinii*) at Mount Read, in Tasmania, with a spread of over 2.5 hectares. There may well be parasitic fungi that occupy more space than some of these trees, but that's another story.

The world's tallest plants are also 'doing it for themselves', right up to a 112.7-metre-high Redwood (*Sequoia sempervirens*) in Humboldt Redwoods National Park, California. There are a few smaller trees, like the Western Australian Christmas Tree (*Nuytsia floribunda*) which reaches ten metres, that are partly parasitic on the roots of other plants, but record-breaking trees have to find their own way to tower above other vegetation and gain access to extra sunlight. What limits their size, in fact, is a plumbing problem: how do you get water from the ground to a leaf fluttering 100 metres above?

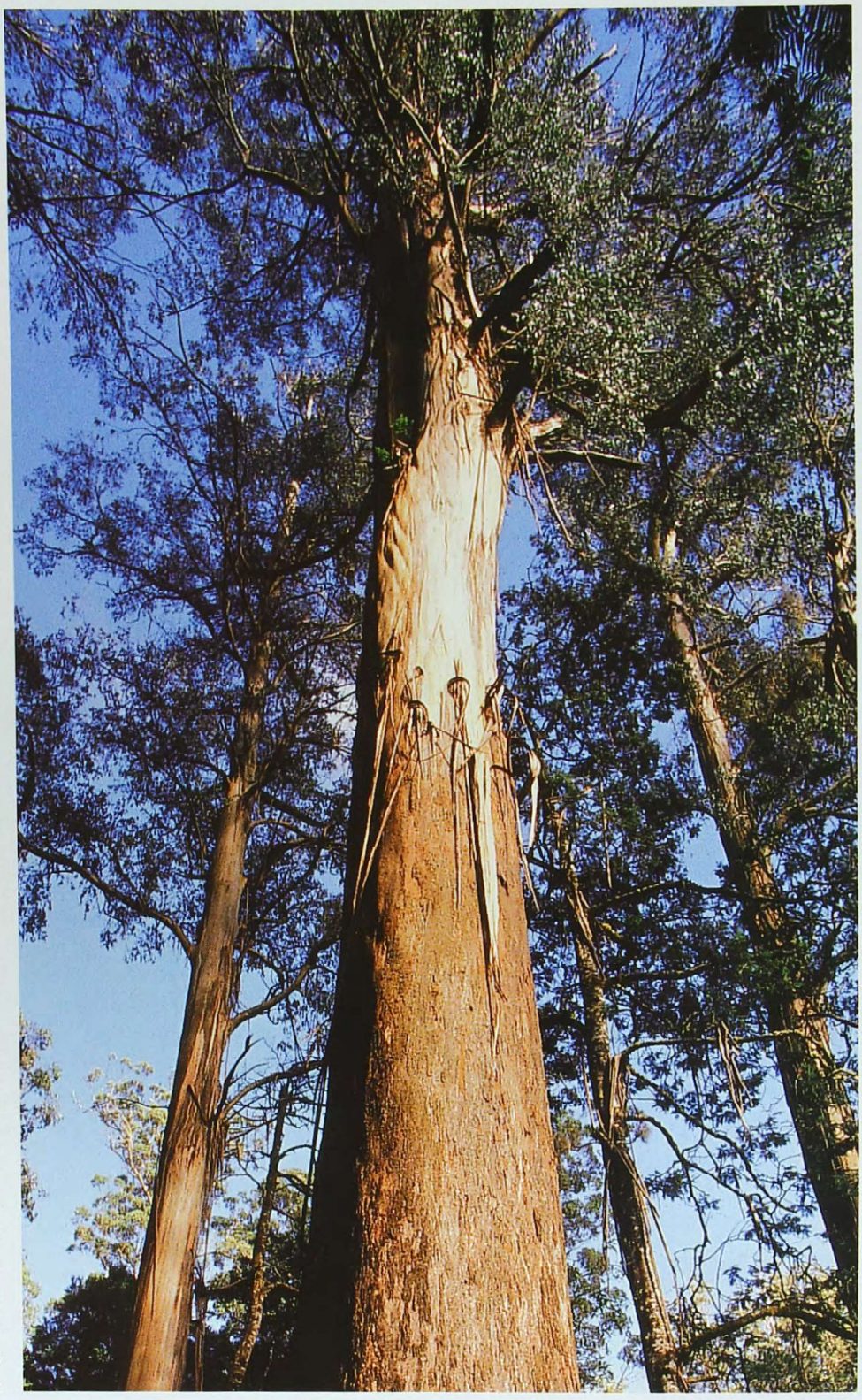
In 1905, Alfred J. Ewart, the first Professor of Botany at the University of Melbourne, erected scaffolding around some local garden trees so he could measure the water pressure in the upper branches. Ewart was frustrated by his measurements, and couldn't explain how water could move through the dead tissue of a tree trunk. A decade later the 'cohesion theory' was conceived, postulating a continuous chain of water from soil to air. As long as there are no bubbles breaking the chain, the surface tension and adhesion of water to solid surfaces mean that evaporation at the leaf surface can draw water all the way up through a plant.

This gravity-defying mechanism has a limit. Conifers such as the Californian Redwoods can regularly reach over 100 metres, but not much more (the tallest

conifer ever recorded was apparently a 126-metre Douglas Fir, *Pseudotsuga menziesii*). The tallest flowering plant, as distinct from a conifer, is our Mountain Ash (*Eucalyptus regnans*), a majestic sight when flanked by tree ferns along mountain roads in Victoria and Tasmania. Although there are claims of Mountain Ashes over 120 metres tall, the tallest ever accurately measured was 107 metres. Today the tallest living specimen is in the Styx Valley in Tasmania, at 99 metres, but the rapid growth of eucalypts means that others may top 100 metres in our lifetime. There are no records, or even brags, of any trees in the world over 150 metres tall.

The limits to tree growth have intrigued researchers since the time of Professor Ewart. Now, George Koch (Northern Arizona University) and his associates have decided to go right to the top for an answer. They recently climbed the world's tallest trees to measure water potential and photosynthesis in the highest branches, followed by more detailed analysis of leaves transported back to the laboratory. They found that gravity starts to win out against water cohesion at around 110 metres. The leaves most distant from the base of these gigantic Redwoods are under extreme water stress, and their small size and low photosynthetic rates may be due to the plant closing some of its breathing pores (stomata). This would not only retain precious water, but also slow down the rate of water transport through the plant, reducing the possibility of deadly air bubbles being formed—a break in the water chain would be permanent and mean death for a lofty limb. To keep such a tree alive the surrounding forest must remain intact so that moisture levels are high and the trees are buffered against storm damage. Unless the environment changes dramatically, Koch's team boldly predicts that we will never find a Redwood more than 130 metres tall.

But perhaps one of our Mountain Ashes has the potential to break this barrier. Koch is keen to visit Australia and find how Mountain Ashes reach such great heights so quickly. He suspects they may have a few tricks that the conifers don't have. Although Australia will never have the biggest flowers in the world—these are restricted to tropical jungles near the equator—if we manage Australia's old forests responsibly, we might one day be able to boast the tallest tree. □



ROBIN SMITH

Mountain Ash: the world's tallest flowering plant.

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reviews

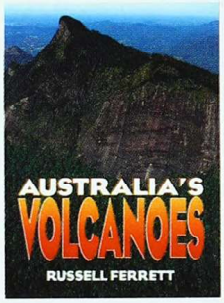
Bird Calls of the Greater Sydney Region: A Regional Field Guide. Vol. 5

Recorded and produced by Fred van Gessel. Professional Wildlife Sounds (64 Dorothy Ave, Woy Woy NSW 2256), 2002, $55 rrp + $8 postage.

THIS REGIONAL FIELD GUIDE IS VOLUME 5 IN THE AUSTRALIAN BIRD CALL Series. It consists of three CDs. Over 200 species of birds in the Greater Sydney Region are represented. Most of these are found in Sydney suburbia, with the exception of some rainforest birds. The introduction at the beginning of disc 1 gives some brief information on habitat and the extent of the physical area covered.

Those of you who remember the days of tape cassettes will appreciate these CDs. Now you have the facility to skip tracks, and to carry the CDs with you on birding trips. Another incredible plus is that you could copy a number of calls from a particular species to your MP3 player and take it with you into the field. Highly recommended for backyard birders.

—LEONÉ LEMMER
AUSTRALIAN MUSEUM



Australia's Volcanoes

By Russell Ferrett. Reed New Holland, Sydney, 2005, 160 pp. $29.95 rrp.

AUSTRALIA'S VOLCANOES IS A COMPACT ACCOUNT OF VOLCANIC FEATURES IN EVERY AUSTRALIAN State. The Introduction explains how Australia has experienced volcanism for 40 million years and shows the areas of volcanic rocks. Part 1 sets off on 'Formation of Volcanoes', Part 2 discusses 'Eruptions, Tephra, Lava and Rocks', Part 3 depicts 'Volcanic Landforms'. Then starts a tour of the States. Part 4 covers Queensland, Part 5 proceeds to New South Wales, Part 6 to Victoria, and Part 7 takes in South Australia, Tasmania, Western Australia and Heard Island. A useful glossary, some references and an index complete the survey.

The book is profuse with photographs by the author and a few other sources. Each part starts with a panoramic double spread and the strong visual impact is enhanced by colour maps and diagrams. The writing is direct, but a few concepts become oversimplified and lose accuracy. For example, a diagram labelled "Mineral compositions of common volcanic rocks" lists no minerals but only elements, and the Ebor volcano is said to lack plugs, domes or dykes, yet some occur and include the main plug for the volcano. All in all, however, the book is a *tour de force* for the layperson. While many of these features appear in other sources, this book brings everything together. Highly recommended to take along on travels.

—LIN SUTHERLAND
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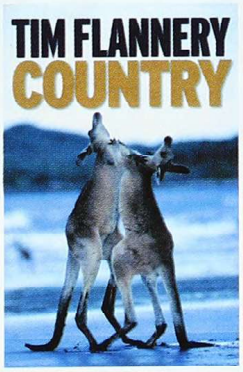

Country

By Tim Flannery. Text Publishing Company, Melbourne, Vic., 2004, 258 pp. $32.00 rrp.

COUNTRY READS LIKE A SCRAPBOOK FROM TIM FLANNERY'S MIND; A MONTAGE OF THOUGHTS, ideas, experiences and natural-history minuets pasted together around the central theme of being Australian. Tim explores his own relationship to the land through a series of personal recollections. These include a failed motorbike tour of the continent in his late teens, working as a palaeontologist's assistant during his undergraduate years, time spent at the Australian Museum as a young scientist, and various other endeavours. Invariably Tim's exploits have taken him away from the cities into the remotest outback and this is where Tim explores his own identity as an Australian.

It's not an easy journey for him; the landscape and the people tend to challenge any naive impressions Tim may have had. In particular some unpleasant experiences with Indigenous people and some even more revolting experiences with intolerant red-necks make confronting reading. The often-personal stories are juxtaposed with a series of natural-history portraits of various kangaroos whose superb adaptations to the Australian environment he strongly admires. For me, Tim's idiosyncratic personal journey is not as interesting as the fascinating profiles of the macropods that shine as rich and valuable vignettes throughout the book.

—PAUL WILLIS
ABC SCIENCE REPORTER

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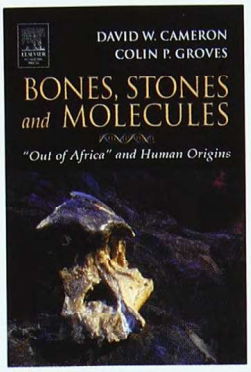


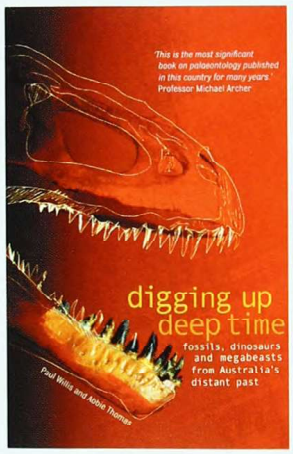
Bones, Stones and Molecules: "Out of Africa" and Human Origins

By David W. Cameron & Colin P. Groves. Elsevier Academic Press, 2004, 402 pp. $60.50 rrp.

THE RECENT, SOMETIMES CRANKY, BUT VERY PUBLIC DEBATE OVER THE LATEST ADDITION to our genus, *Homo floresiensis*, has once again thrust palaeoanthropology into the limelight and demonstrates the widespread public appeal of this discipline. The record for human evolution, encompassing data from bones (palaeontology), stones (archaeology) and molecules (molecular biology), unravels one of the most intriguing stories for all of humanity, that is the story of how we became 'us'. This book brings a refreshing (and antipodean) and engaging perspective of human origins from the work of two of Australia's most prolific palaeoanthropologists.

Trying to come to grips with the complexity of human origins (and proto-human extinctions) is no easy task. Although heavy-going in some sections, the book remains accessible to both the professional and the layperson, taking considerable care to explain difficult concepts. By meticulously reviewing the enormous wealth of material available to palaeoanthropologists, Cameron and Groves present a strong case that many proto-human species preceded anatomically modern humans, who originated in Africa in the late Pleistocene. However, this is only the last part of the story. The book brings to life a range of other topics such as the origin of primates, the radiation of apes and their subsequent demise during the Miocene, the emergence of our earliest ancestors, their struggle for survival in the African savanna, and the successive exodus of species of *Homo* from that continent. For those readers interested in the evolutionary story of our origins, and the evolution of our primate cousins, *Bones, stones and molecules* is an essential addition to your library.

—MICHAEL WESTAWAY
WILLANDRA LAKES WORLD HERITAGE AREA



Digging up Deep Time: Fossils, Dinosaurs and Megabeasts from Australia's Distant Past

By Paul Willis & Abbie Thomas. ABC Books, Sydney, 2005, 294 pp. $34.95 rrp.

IT IS PLEASING TO SEE A BOOK ON PALAEONTOLOGY WRITTEN IN AUSTRALIA, BASED ON Australian examples. This is no text book and doesn't claim to be comprehensive in any way. Rather, it is a travelogue through geological time, biased towards vertebrate fossils since that is what the authors have most experience with. It visits various sites in Australia detailing what the fossils and sediments tell us about life and times of long ago in a manner that is easy to read and can be understood by both fossil enthusiasts and the interested layperson. It recounts many interesting tales and anecdotes of fossil-collecting undertaken either by Paul or a range of well-known Australian palaeontologists.

Paul Willis is a palaeontologist and science media presenter. He has visited most of the sites in the book and so has had the experience to give credibility to the palaeontology. Abbie Thomas is a science writer. Together they make this book a worthwhile addition to the palaeontological literature of Australia.

—ROBERT JONES
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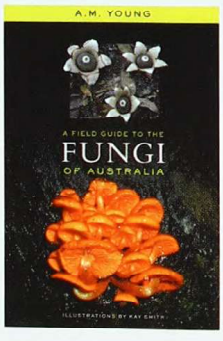

A Field Guide to the Fungi of Australia

By A.M. Young. UNSW Press, Sydney, NSW, 2004, 240 pp. $29.95 rrp.

THIS IS AN EXCELLENT GUIDE TO AUSTRALIAN FUNGI. ALTHOUGH PRIMARILY A FIELD GUIDE, IT also has many other useful sections, such as the introductory chapters dealing with the definition of fungi, their current classification, how to collect and preserve them, odd facts (like luminescence in some species), whether you can eat certain species and whether it is wise to experiment (the 'try-and-die' method of finding edible species!).

The book estimates there to be up to 2,500 species of Australian macrofungi, 60 per cent of which are unknown/undescribed. As only 200 species are covered, it stands to reason that the majority of Australian fungi will not be found in this book. Still, using the keys provided, readers should be able to identify the more obvious or frequently encountered fungi down to at least genus level.

The species accounts are listed under their scientific name, followed by a common name if they have one, a description of the fruiting body, spores, habitat, distribution and a photograph or illustration. Symbols are also used to indicate suspicious, toxic or extremely toxic species.

I have already successfully used it on a couple of occasions and certainly think it would be a useful book for any naturalist's or gourmand's library!

—MARTYN ROBINSON
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SOCIETY PAGE

Get involved! Across Australia there is a network of active societies, large and small, local and national, that exist to further the cause of the subject that you hold dear. Whether your special interest is conservation, birds, science, national parks, bushwalking or a particular group of animals, there's a society for you.

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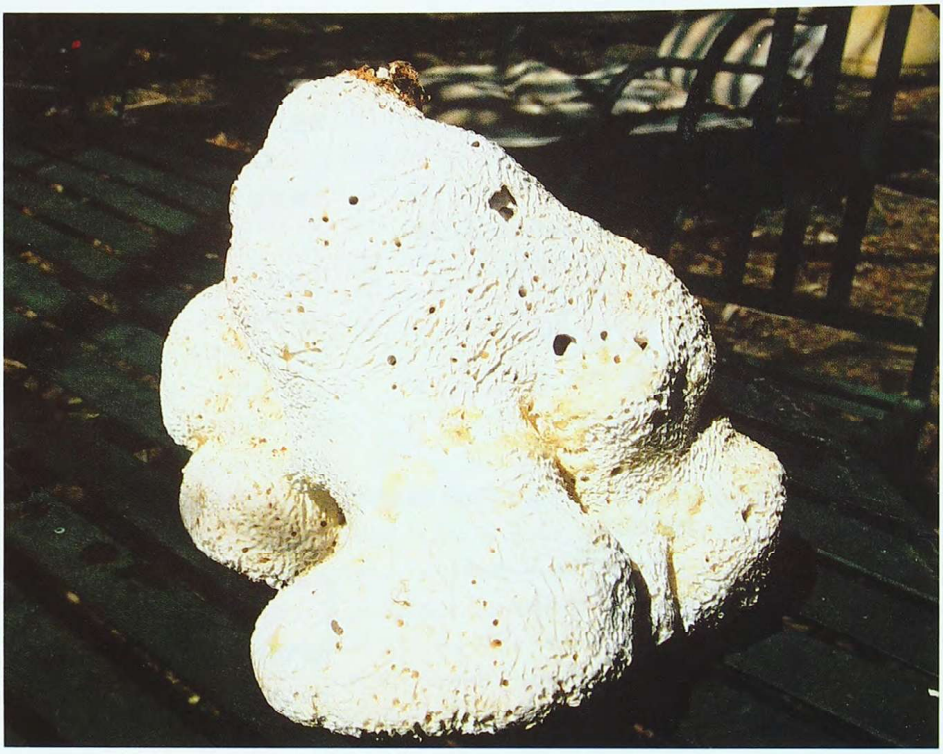

COURTESY JACK ARDEN

Punk rock? This fungal fruiting body weighed around 14 kilograms.

Humongous Fungus

Q: *Can you identify this fungus for me? It weighed about 14 kilograms, and I found it attached about nine metres up a tree in the bed of the Nile River, Queensland, by a three-centimetre-thick stalk (attachment point visible in the photo at the top).*

—Jack Arden
Charleville, Qld

A: From the photo, this looks like the fruiting body of a Punk Fungus (*Laetiporus portentosus*). The specific epithet '*portentosus*' means monstrous, and this fungus can certainly get to a large size (as much as 70 centimetres across). The hoof-shaped fruiting bodies typically form high up on the trunks of eucalypts (often stringybarks, but also River Red Gum and other species). The fungus grows in the heartwood of the tree, causing a brown cubical rot. Sometimes much of the centre of the tree can be hollowed out by the rot (which attacks only the dead heart wood, not the living sapwood). When dry, the texture of the fruiting body is quite light, and Aboriginal people used the fungus to carry fire. Once lit, the fungus just smoulders away, but when you blow on the burning part it glows red and can be used to ignite grass. When the fruiting body falls from the tree, it is often eaten out by beetle larvae, which tunnel in the flesh of the fungus, leaving it resembling soggy polystyrene when lying on the forest floor.

There are a few other fungi that form large fruiting bodies, but these are usually shiny and/or brown on top (*Ganoderma*), or have thinner fruiting bodies, not so hoof-shaped as in the Punk.

—Tom May
Royal Botanic Gardens
Melbourne

Odd-looking Currawong

Q: *The accompanying photo shows an abnormally coloured bird, obviously currawong, but with plumage suggestive of Australian Magpie. Can you explain what is going on here?*

—Sue Hamonet
Hunter Bird Observers Club
New Lambton, NSW

A: The mystery bird is an unusually coloured Pied Currawong (*Strepera graculina*). The russet breast (shown in another photo) resembles that of an immature Pied Butcherbird (*Cracticus nigrogularis*) and the back presents some suggestion of an Australian Magpie (*Gymnorhina tibicen*), however the white patches on the wing and rump, pale eye and currawong-like bill support the identification. This bird is also in the company of two other Pied Currawongs, apparently an adult and an immature. The pale gape of the piebald

Pied Currawong (on the right) with a twist.

bird indicates that it, too, is young. Plumage oddities such as this are much more frequent in Magpies than in currawongs. They occur naturally at low frequencies and are not indications of interbreeding between species.

—Walter E. Boles
Australian Museum

Turtle or Tortoise?

Q: *What is the difference between a turtle and a tortoise?*

—Wendy Reid
Centennial Park, NSW

A: One of the most confusing tangle of common names is that for turtles, tortoises and terrapins (order Testudines). In Australia, at least until recently, turtles that lived in fresh water were called 'tortoises', and turtles that lived in the sea were called 'turtles'. However, these days Australians tend to call all turtles 'turtles', whether they live in fresh water or the sea.

In the UK and the USA, large turtles that live on dry land are called 'tortoises', and turtles that live in the sea are called 'turtles' in the USA but 'sea turtles' in the UK, although the 'sea' part is dropped in individual species names. Turtles that live in fresh water are called 'terrapins' in the UK, but 'turtles' in the USA. The USA's only brackish water species, however, is called a 'terrapin'—the Diamondback Terrapin.

Common names often vary within and between countries, although there have been attempts for some groups (particularly birds and mammals) to standardise them. That is why, at least for scientific and legal purposes, the binomial Latin name is preferred.

—G.H.

Answers to Quiz in Nature Strips (page 18)

1. *Sn*
2. *Russia*
3. *Feathers*
4. *Carapace*
5. *Blue*
6. *Yes*
7. *Nine kilometres*
8. *Your mother*
9. *A black hole*
10. *To cool themselves*

AUSTRALIAN MUSEUM

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 *Where river meets sea*. Autumn's Pic Teaser was aquatic Black Worms (*Lombriculus variegatus*).

Back to nature

Never, in our entire history, have we spent so little time in physical contact with the natural world.

EVER THOUGHT MUCH ABOUT the popular catchphrase "Getting back to nature"? Advocates of the idea assume that we have moved away from nature, and that getting back to it is a good thing. Why? What is 'nature'? Are humans part of it? The dominant attitude in modern society is that humans are *beyond* nature, *outside* of nature, *above* nature, or *better* than nature. That said, it doesn't take a genius to work out that nature makes us feel good (think of your last beach holiday). Interestingly, scientists are coming to the conclusion that humans may be dependent on nature not only for material needs (food, water, shelter) but also for psychological, emotional and spiritual needs.

But in the last few hundred years we have gone to extraordinary lengths to disengage ourselves from nature. This is mostly due to the massive shift of people from rural areas into cities. Here, contact with nature is often only available through parks, pot plants and pets. Never, in our entire history, have we spent so little time in physical contact with the natural world.

The famous biologist Edward O. Wilson (Harvard University) once wrote that, for a species that evolved in-touch and in-tune with nature for 99 per cent of its history, to be completely removed from it in such a short time (evolutionarily speaking) is remarkable. The rapidity with which our new, human-constructed environment has developed has outpaced our ability to adapt to it, despite bringing an enormous range of benefits. But are we still 'naked apes' with part of our being intrinsically tied to the natural world?

Wilson attempted to unravel this riddle with his 'Biophilia Hypothesis'. Biophilia asserts that humans have an innate attraction for other living things likely to maximise health and wellbeing. This is due to our evolutionary history where there was an advantage in knowing about the natural world. Without such knowledge, we would have died of hunger, cold, thirst or some combination of all three.

Why do people spend time and money caring for an animal that has no other function apart from companionship? You can't eat them and they don't work.

Good evidence for Biophilia comes in the form of pets. The figures are quite astounding and they are on the increase worldwide. In Australia, at least 60 per cent of households own at least one pet. Why do people spend sometimes-ridiculous amounts of time and money caring for an animal that has no other function apart from companionship? You can't eat them and they don't work; in fact pets consume time, resources and energy! And why do we have this overwhelming urge to feed wildlife wherever we encounter it? National park authorities find it is an almost impossible task preventing tourists from feeding wildlife. Wildlife-feeding not only occurs in national parks, but also in the suburbs. The recent nationwide WildWatch Australia survey (by the ABC's Natural History Unit) found that more than 40 per cent of households feed local wildlife in their backyard at least once a week!

Yet, there is still a lack of understanding in the general public, governments and institutions, not to mention the scientific community, about the significance of the human connectedness with nature. Despite this, evidence for the health benefits that come from our contact with nature continues to grow.

Like in legends where heroes struggle against the 'untameable' forces of nature, we are still wrestling with Mother Nature. Although the character of the contest has changed and the battle is often fought on a molecular level (genetic engineering), we are still trying to win. All the while, the race to consume what remains of the Earth's natural resources has not slowed. In fables, old men describe the tenacity, the ferocity and the strength of nature. Considering the extent to which humans now dominate the Earth, it seems it is our own nature that will prove most difficult to overcome. □

FURTHER READING

ABC Natural History Unit, 2004. WildWatch Australia. ***http://www.abc.net.au/wildwatch/default.htm***

Wilson, E.O., 1984. Biophilia. *Harvard University Press: Cambridge, Massachusetts.*

BY CECILY MALLER

CECILY MALLER IS PART OF THE NICHE (NATURE IN COMMUNITY, HEALTH & ENVIRONMENT) RESEARCH GROUP IN THE SCHOOL OF HEALTH & SOCIAL DEVELOPMENT AT DEAKIN UNIVERSITY, MELBOURNE. SHE IS CURRENTLY RESEARCHING HER PH.D. ON THE INFLUENCE OF 'HANDS-ON' CONTACT WITH NATURE ON THE MENTAL HEALTH AND WELLBEING OF CHILDREN.

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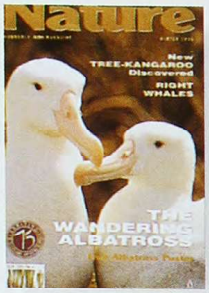

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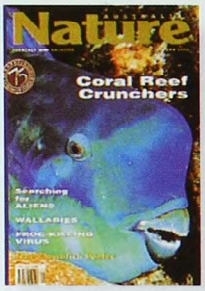

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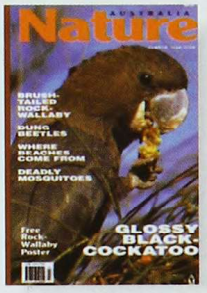

26/7

26/8

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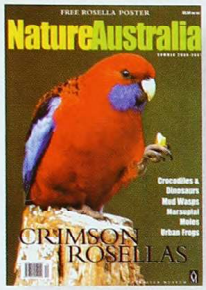

26/11

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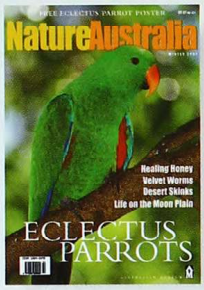

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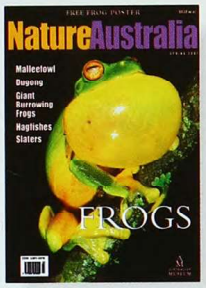
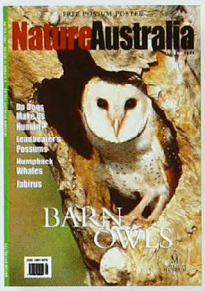


27/2

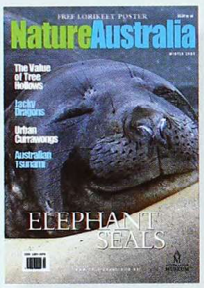


27/4

27/5

27/6

27/7

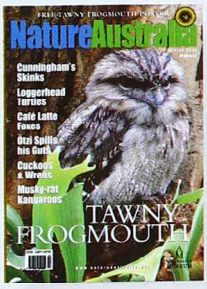


27/9

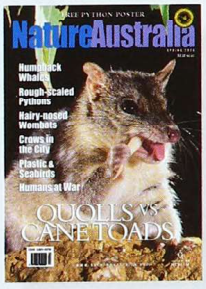
27/10

27/11

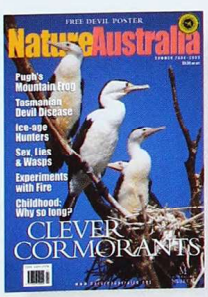
27/12



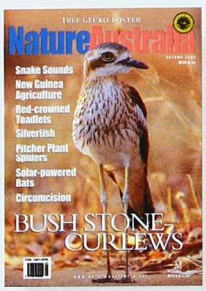
28/1



28/2



28/3



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