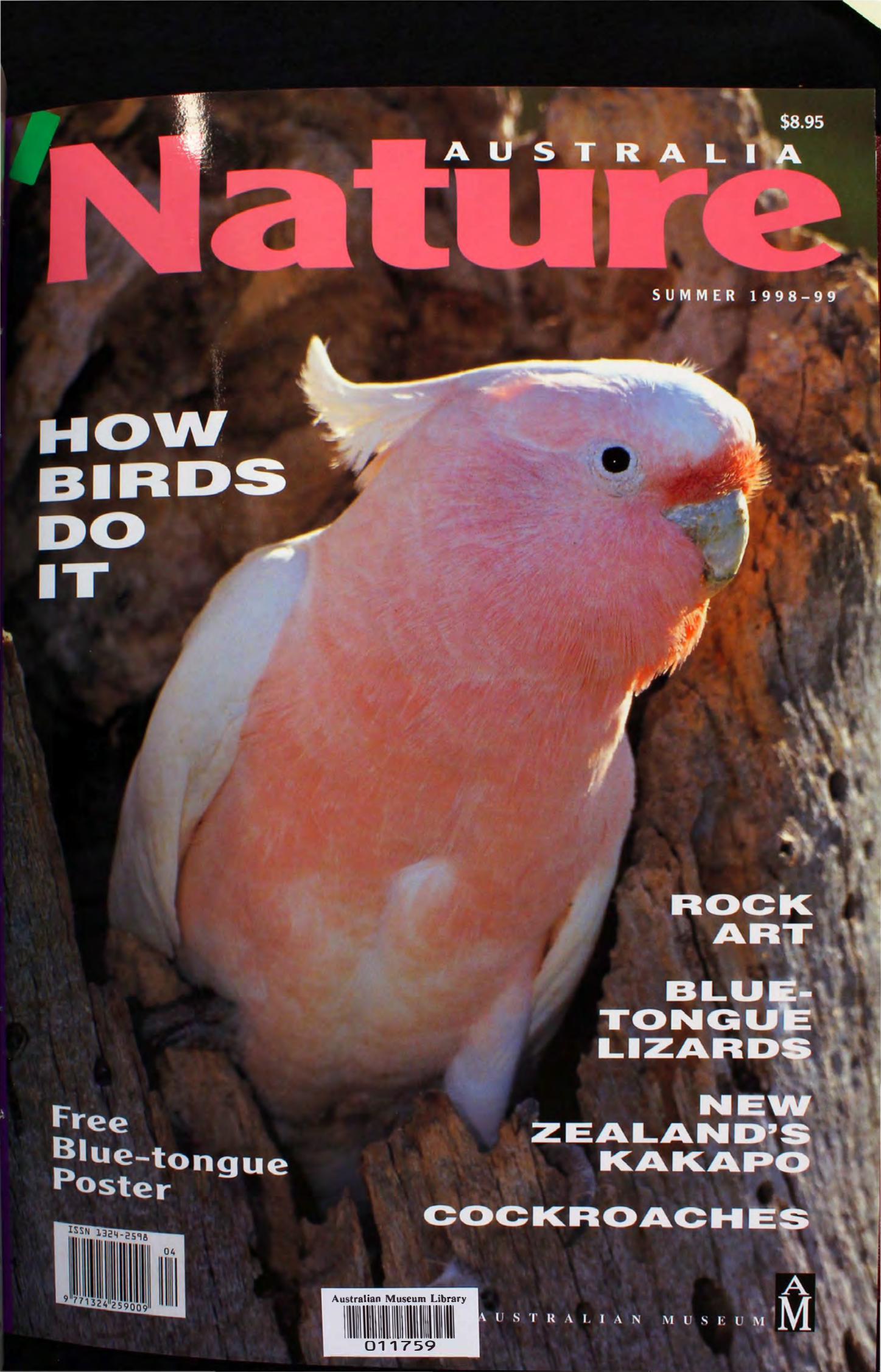
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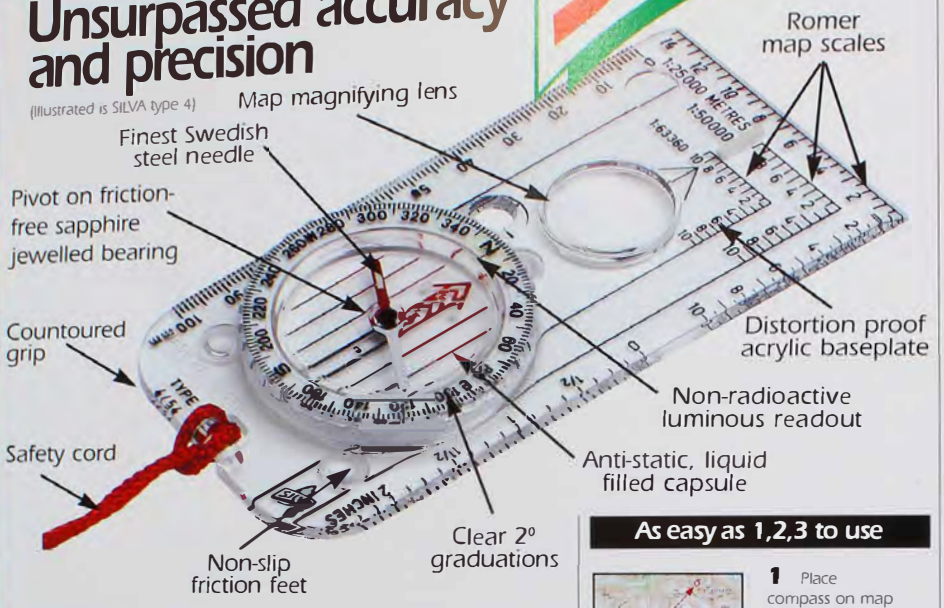

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Up Front

For most of us living in the city it's a joy to encounter wildlife, and among the more commonly sighted reptiles are blue-tongued lizards.

KEN GRIFFITHS

It's great to see a big fat blue-tongue basking in the sun in an urban backyard. Blue-tongues occur just about everywhere in Australia and there are a number of different species. In his article on "Backyard Blue-tongues", Glenn Shea highlights the point that, despite their seeming ubiquity, very little is actually known about the ecology of blue-tongues in the wild, and all may not necessarily be well with them. Is their individual longevity masking a declining population?

Another common sight around backyards is birds, but, as familiar as they are, what do we really know about them? In "Why Kissing is for the Birds", for example, we see what female choice can do to males. It would seem that, in the early evolutionary history of birds, the intermittent organ (or penis) was lost in several independent lineages, resulting in the vast majority of species functioning quite nicely without one. One of the oddest and rarest of birds is the Kakapo, New Zealand's flightless parrot. It is left over from a time when New Zealand had many more ground-dwelling birds that filled niches normally occupied by herbivorous mammals. Careful study of the Kakapo's breeding behaviour is leading to a slow increase in its numbers and providing hope for the survival of this paradoxical parrot.

For those of you who like a good mystery, Paul Taçon sheds a little more light on the enigmatic 'Bradshaw' paintings of the Kimberley region. Who is responsible for them and what do they mean?

In our regular features we have sensitive plants that try to disappear, rock-wallabies with a penchant for lush backyards, the wonderful world of cockroaches, and elephants that dog-paddled their way to Australia.

—Jennifer Saunders

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Front Cover
Male Major Mitchell's Cockatoos (*Cacatua leadbeateri*), like 97 per cent of all bird species, do not have a penis. Is this because the females prefer it that way? Photo by John Cooper.

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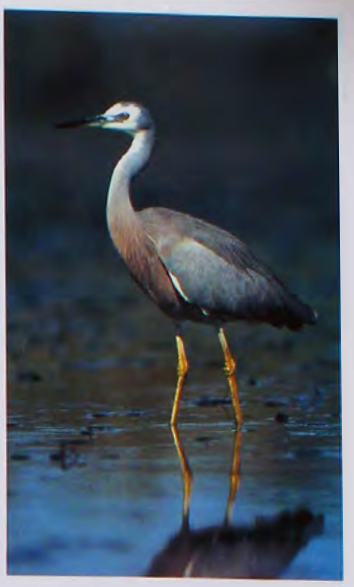

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The forum for readers to air their views about their concerns, past articles and interesting personal events.

The Huntsman

We have a huntsman in the
house who comes out
every night,
Hoping to catch a moth or
two from the bright and
shining light.
You are fast asleep when
nature calls and you
have to get out of bed
To make your way to the
bathroom, very careful
of where you tread.

And there he is on the wall
staring straight at you,
Watching every movement
you may or may not do.
You go about your business
keeping a fair distance
away,
Making sure he doesn't
come closer or move
from where he lay.

You return to your warm
and inviting room,
With the spider safely in
the bathroom—you
presume,
But he is in fact making his
way across the bath-
room floor
To find a new home, behind
my bedroom door.

—Katie Harris
Cedar Creek, Qld

More Stingless Bees

I found the article on stingless bees by Tim Heard (*Nature Aust.* Spring 1996) fascinating. I look forward to the day when native bee honey is readily available to consumers.

In the article, Tim mentions that most of the 14 or so native stingless bees occur in the tropical north, the remaining two being found in subtropical eastern Australia.

Prior to moving to Queensland I spent almost five years working in arid central Australia. While there, I frequently observed native bees, mostly in the gorges and creeks that flow from the central ranges. The local Aborigines also speak of stingless bees and relish 'sugar bag' as a food source. They relate tales of tying long strands of spider web to a bee so it can be followed to its hive. Can you tell me what the central Australian species would be?

Also, the relationship between *Eucalyptus torelliana* and stingless bees in northern Queensland is extraordinary. I have heard reports that outside its natural range, *E. torelliana* may be a problem for stingless bees. Can you shed any light on this and possibly provide a further reference?

—John Clarke
Yeppoon, Qld

Honey from stingless bees is becoming increasingly available as the number of colonies in artificial hives increases and as we improve our techniques for extracting and storing the honey. We also hope that one day it will be as common as macadamia nuts. Utilisation of indigenous products can help to ensure their preservation.

The most common species of stingless bee in arid central Australia is Austroplebeia percincta *and is probably the species you observed there.*

Reports from Rockhampton state that Eucalyptus torelliana *resin can destroy hives of stingless bees (see an article by Mark Chamberlain in the Spring 1993 issue of* The Growing Idea, *the official newsletter of Greening Australia Queensland Inc.). The bees collect large quantities of the resin and seed from the*

ROBERT VALENTIC/NATURE FOCUS

Life with a Huntsman spider in the house is never dull.

Do White-faced Herons talk to one another?

A.D. TROUNSON/NATURE FOCUS

gumnuts for their nest construction. The resin has a low melting point and, in hot weather, large quantities of stored resin can collapse, blocking the colony entrance. This may be a local problem because it does not occur in southern Queensland. It would be interesting to know if anyone is aware of this phenomenon in other tropical areas of Australia and particularly within the native range of the plant.

—Tim Heard (CSIRO Entomology) & Anne Dollin (Australian Native Bee Research Centre)

Freedom of Speech

When our Autumn 1998 edition of *Nature Australia* turned up last week and I saw those two or three correspondents getting stuck into Mike Archer over Thylacines and wombats, I took the trouble to check back issues to see what all the hoo-ha was about, not remembering anything particularly controversial myself. I won't comment on either subject as such, except to say it's been traditional to allow professors certain latitudes and remissions for their mental aberrations. Scientists in general should also be allowed some degree of latitude when they dare to enter the preserves of politics, since politicians have long denigrated sciences with the ultimate put down by voting with their feet and acting as though the cosmos, and the sciences that attempt to explain it, have not yet been invented.

—Des Petersen
Dalby, Qld

Kiwi Bitter?

When Chinese Gooseberries or Kiwi Fruits (*Actinidia chinensis*) are abundantly available I may eat several a day. I have noticed after a week of such abundance and indulgence a curious taste phenomenon or parageusia. Other food items, consumed many hours or even a day after the last Kiwi Fruit, acquire an unpleasant, bitter aftertaste, which is apparently subjective. It takes more than a day for the effects to clear, and a week or more of eating Kiwi Fruits for the effects, presumably cumulative, to first appear. The phenomenon is absent with an empty mouth, and seems to apply particularly to sweet or strongly tasting items. Any suggestions, or other similar experiences?

—John Bradshaw
Monash University, Vic.

Bird Talk

I have just read the Nature Strips item on "Raven Roosts" (*Nature Aust.* Spring 1997) and would like to relay a similar experience I have had—not so much with ravens but with the White-faced Heron (*Egretta novaehollandiae*). (I understand that herons also roost together at night.)

Years ago I had a fish pond in my yard and stocked it with half a dozen or so goldfish. Months and months went by and the fish grew and became very 'friendly', swimming near the surface and always looking for food. One day a White-faced Heron passed by (after not having seen one for years) and quickly took advantage of my uncovered fish pond. The heron gobbled down two or three fish before I realised what it was doing. I chased it off again and again, and soon decided that a cover would be the only safeguard against our new pond visitor. Anyhow, the next morning I walked out to the pond only to notice four herons perched on my rooftop—all, no doubt, looking for a quick easy feed.

After this experience I would have to say that, if herons and birds in general can't 'talk' to one another, then they certainly can relay the meaning of free food. While I could not say if the original heron was in the group and had in fact shown the others the way, or whether it had given the other birds intimate details of my fish pond's location, I feel sure there is some sort of communication going on.

—T.W. Richards
Kingston, Qld

Tsunami Hype

As much as I loved the picture of Michael Archer's 'one-in-600-year wave' about to dump a million tonnes of water onto what appears to be a prize home in the Gold Coast hinterland (*Nature Aust.* Winter 1998), I can't quite suppress the harmless pedant that lives within.

My criticism is not with the picture but with the idea that tsunamis can "tower above

the surface of the ocean". Indeed, if tsunamis did tower, there would no doubt be more warning. Satellites would clearly pick up the freak wave patterns as the tsunami moves across the ocean surface at a speed of hundreds of kilometres per hour, giving our prize home-winners a couple of hours to Getaway in their prize Range Rover.

Perhaps unfortunately, the energy contained in a tsunami is not put into a whole lot of height as it moves across the ocean surface. Rather, its energy is expressed in the extremely fast movement of the huge amount of water, usually of a long wavelength and low amplitude. It is only when this massive momentum hits shallow water, and the rotational path of the water molecules causes them to bunch up (because of friction at the water–substrate interface), that the wave slows down, and the energy is transferred into wave height. Thus they only really tower when they hit shallow water . . . and expensive real estate.

—Eric Vanderduys
Wynnum, Qld

More on Aborigines and Ticks

In response to Michael Westaway's letter and Stephen Doggett's reply regarding the acquisition by Aboriginal Australians of immunity to the Australian Paralysis Tick, there are many animal species, Australian native and exotic, that are able to mount quick and effective immune responses to the toxin produced and released by the tick. The antisera available commercially to counter the effects of the toxin are produced by gradually exposing Horses and domestic Dogs to increasing numbers of ticks, allowing them the opportunity to mount increasing immune responses to the foreign proteins. When they have mounted a response that is effective against the neurotoxin produced by a large burden of ticks, their circulating plasma has high concentrations of antibodies and it can be harvested as anti-tick serum. As Horses and Dogs are exotic to Australia and have had very short evolutionary exposures to this neurotoxin, it appears that the ability to mount quick and effective immune responses is widespread in mammals at least, and perhaps this or similar toxins are encountered in other continents.

The most important factor in mounting an effective immune response is the gradual exposure to the toxin. An animal with no previous exposure is at great risk of suffering from the paralytic and other pathological actions of the toxin, and this includes native Australian animals: brushtail possums with large *Ixodes* ticks have died showing signs typical of exposure to the neurotoxin; other brushtail possums and Emus have been successfully treated with antiserum when showing signs of paralysis associated with heavy tick loads. This risk becomes important when captive or hand-reared native animals (which will be naive to the toxin) are released in areas where adult Paralysis Ticks may be present.

These two factors—apparent widespread abilities to mount effective immune responses, and the susceptibility of native Australian animals—indicate that it would very likely be unproductive to look for a specific gene(s) in Aboriginal Australians that confers resistance to the neurotoxin.

—Derek Spielman
Territory Wildlife Park, NT

Lyrebird Lyrics

I greatly enjoyed Sydney Curtis' article on lyrebirds (*Nature Aust.* Winter 1998). Coincidentally, as I read it, a Superb Lyrebird was in full performance just outside my window.

Our house is an inadvertent 'hide'. From various rooms we look onto the territories of five lyrebirds, watching them sing, dance, court, mate, and rip the garden into shreds from early winter until late spring. (We have about two acres of garden, closely planted and heavily mulched; if you have ever watched chooks rip up a garden, then multiply this by ten and you've some idea of the devastation lyrebirds can create—those claws are strong and dedicated.)

Lyrebirds here appear not only to learn their songs from other lyrebirds, but to increase the complexity of their songs as they get older.

When I began spying on lyrebirds about 25 years ago, an extraordinary songster was already in residence. His 'music' was magnificent. Sadly he left me with exaggerated expectations; no other lyrebird has come anywhere near to his performance. He not only imitated sounds, but wove them into patterns, something no other lyrebird here has even appeared to have attempted.

After his death, and the death of most of the other older birds at much the same time (coincidental with a sudden build-up of feral Cats and Foxes), we had several years of extremely paltry imitations. Presumably the younger birds lacked musical mentors.

The range of birds mimicked, however, has been steadily increasing (and the depth and resonance of their calls too), and possibly the musician's genes may live on. I suspect that his song was learnt at least in part from older birds and that, without guidance, our youngsters won't ever achieve his glory.

In regard to lyrebirds imitating 'human' sounds, I have only heard two 'human imitations' that I'm sure about, both from the bird I just described.

We were running the tractor up near his territory when something seemed to go wrong with the engine. The beat seemed to be doubling, or missing. We turned the engine off, but the engine noise continued—it was the lyrebird, not quite in sync.

The other instance was one of those moments you remember with so much awe that it is hard to believe it happened. I was sitting on the grass, singing my own badly remembered version of the last movement of Beethoven's 9th, when the lyrebird joined in. He took the melody and repeated it, then changed it and melded it with his own.

No, I had not been eating interesting mushrooms or other herbage. I never heard the engine noise nor Beethoven's 9th incorporated in his song again.

As I write this I can see the lyrebird we refer to as Fishtail. Although Fishtail displays to female lyrebirds, he also displays to his reflection in the living-room window—frustrating when his image disappears as he passes the door.

We too have heard the birds tapping one vine or branch against another. But the lyrebirds here also make use of the clicking sound as they dance on the metal gate and the wooden backs of our garden chairs. The most effective 'instrument' however is the long metal pipe leading to our hydraulic ram. It reverberates beautifully and you can hear it some distance off.

One more thing. Several autumns ago I left a giant yellow marrow out in the garden. A lyrebird leapt on it one morning, presumably to dance on it. It immediately began to roll downhill. We were treated to a version of lyrebird barrel-rolling, as the bird attempted to keep its balance.

Later that morning I replaced the marrow. Ten minutes later the lyrebird jumped on it again, and over the next few weeks repeatedly seemed to enjoy balancing on it as it rolled down the hill, yelling and wing-flapping as it went. I've never been sure whether to ascribe it to a new form of territorial display, lyrebird insanity, or just playing around.

Three weeks later the bower birds and currawongs ate the marrow. That ended the lyrebird's performance, although for a time it attempted to fool around with flower pots.

—Jackie French
Braidwood, NSW

NATURE AUSTRALIA **welcomes letters for publication and requests that they be limited to 250 words and typed if possible. Please supply a daytime telephone number and type or print your name and address clearly on the letter. The best letter in this issue will receive a signed copy of Tim Flannery's latest book *Throwim way leg*. The winner this issue is T.W. Richards.**

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Nature Strips

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GEORGINA HICKEY

Red is for Hunger

Newborn chicks are demanding little creatures. They squawk incessantly, creating bedlam as they jostle and beg for food. When faced with a nestful of squabbling chicks, how does a parent bird decide which to feed first? The answer, it seems, comes straight from the chick's mouth.

Rebecca Kilner from the University of Cambridge has discovered that, although Canary (*Serinus canaria*) chicks have pink mouths, when they start to beg the mouth lining flushes a deep red. By photographing the gaping mouths of chicks at different intervals from feeding, Kilner found that the hungrier the chick, the more intensely coloured was its mouth.

When the parent bird 'sees red' it responds by eagerly feeding the chick. Kilner tested this by artificially colouring the inside of Canary chicks' mouths with cochineal and found chicks with redder mouths were fed more. Interestingly, when all nestlings had their mouth colour enhanced, the parent bird simply worked harder to feed the malcontent young.

If chicks can score extra food from their parents, what prevents them from cheating the system and remaining red-mouthed all the time? Kilner believes the rapid changes to mouth colour are the result of blood rushing to the area and may be physiologically prevented if the gut is full. Redirecting blood away from the stomach may slow down digestion and would be too costly for a well-fed chick. Consequently, the red flush provides an honest signal of how hungry each Canary chick is and helps parents allocate food during the riotous calamity of feeding time.

But what about birds with different-coloured gapes? Could blood also enhance the colour of a yellow or orange mouth? In a more recent study, Kilner and Nick Davies (also from the University of Cambridge) surveyed 31 British bird species and found that honest signals of hunger occur only in chicks with red gapes, and only in those birds whose parents feed them by regurgitation (such as finches and ravens). The chicks of other species, whose parents feed them with food carried in their bills, do not show change in mouth colour, even those whose gape is red. The relationship between honest colour-change signals and being fed by regurgitation remains a mystery.

—K.H.

Monkeys Aim for the Gap

Monkeys are not traditionally regarded as the tidiest of animals. They generally leave a trail of half-eaten fruits, broken vegetation and faeces behind them as they crash through the forest. But it now seems there is, in fact, some method in the monkeys' mess, particularly when it comes to toilet habits.

Kellen Gilbert, now at Southeastern Louisiana University in the United States, followed groups of Red Howl-

BILL BELSON/LOCHMAN TRANSPARENCIES

The Welcome Swallow (*Hirundo neoxena*): do hungry chicks show their true colours?

ing Monkeys (*Alouatta seniculus*) through the Amazonian forests, noting where individuals defecated and how much vegetation was hit on the way down. In order to accurately measure defecation, Gilbert stood directly underneath the monkeys, often gaining a closer than comfortable insight into the behaviour she was observing.

Gilbert found that the monkeys tended to defecate over gaps in the forest. They were much less likely to defecate over foliage between 10 and 25 metres high—the area in which the monkeys typically forage. And defecation sites had much less foliage than random sites or areas where the monkeys did other things like sleeping, eating or travelling.

Keeping a clean house makes good sense. It reduces the risk of passing parasites on to other members of the group and keeps everyone healthy and clean. Except for the dedicated researcher beneath!

—D.C.

Hissing Snakes Full of Hot Air

Rattlesnakes (*Crotalus* spp.) really let you know when they don't like you. They puff themselves up, hiss their displeasure and provide an ominous rattling sound with their tail.

Making oneself as big as possible is a common reaction to danger in many species—from Dogs and Cats to snakes and frogs. The rattlesnake's rattle is another highly developed threat strategy. But what of the snake's hiss? In popular mythology, the hiss is a clear signal of sinister intent. But do rattlesnakes really use hissing, as well as rattling, to ward off potential enemies?

To investigate, Clare Kinney, George Abishahin and Bruce Young of Lafayette College in Pennsylvania studied the defensive behaviour of two species of rattlesnake: the Eastern and Western Diamondback Rattlesnakes (*C. adamanteus* and *C. atrox*). They found that the rattling sound was loud and continued until the snake began to relax—sometimes for more than 15 minutes. Hisses, in comparison, were much quieter and only occurred when the snake was initially startled. Hissing coincided with the rapid intake of air that the snake requires to puff itself up during a threat. Once the snake reached its peak size, the hissing stopped.

So it seems the snake's hiss is like an involuntary gasp of horror. Far from being a signal of ill intent, hissing in rattlesnakes is just a side effect of the snake inflating its size.

—D.C.

JOHN CANCALOSI/AUSCAPE

Hissing in the Western Diamondback Rattlesnake: signal of sinister intent, or simply incidental?

Whales' Tongue Trick

A thick insulating fat layer over much of the body helps baleen whales survive in cold polar waters. However, these massive creatures are certainly no blubber mouths. So how, with such large oral cavities necessary for filter feeding, do they prevent heat loss from their mouths?

The answer, according to zoologists John Heyning (Natural History Museum of Los Angeles County) and James Mead (National Museum of Natural History, Washington), lies in the structure of the tongue. The researchers discovered, during dissections of two dead Gray Whale (*Eschrichtius robustus*) calves, a complex arrangement of blood vessels within the tongue designed to restrict heat loss.

Located throughout the large oral organ are many countercurrent heat exchan-

JEFF FOOTT/AUSCAPE

How does the Gray Whale prevent heat loss from its mouth?

ge 'units', each consisting of an artery surrounded by a dense network of veins. These are arranged so that cooled blood returning from the tongue's surface is carried through veins from the front of the organ to the back. The arterial blood, warmed by its passage from within the body, heats up the cold venous blood as the vessels pass close to each other.

A proliferation or branching out of the arterial system at the base of the tongue enhances the whole system by slowing the blood flow to provide more opportunity for heat exchange and by increasing the arterial surface area over which heat exchange can occur.

Like other baleen whales, Gray Whales feed mostly on the abundant invertebrates available in the polar regions during summer. Unrestricted heat loss from the enormous tongue would make this impossible. The tongue needs to remain mobile and agile to control water flow over the baleen plates during filter feeding, so blubber would be too restrictive. The countercurrent system is a far better solution and, as Heyning and Mead speculate, probably the one employed by all baleen whales.

—K.McG.

Firefly Femmes Fatales

Female fireflies in the genus *Photuris* are the 'femmes fatales' of the insect world. By mimicking the sexual response flashes of another genus of fireflies (*Photinus*) they lure the hapless *Photinus* males within reach, and promptly devour them.

But *Photuris* females gain more than just nutrients from these ill-gotten meals. As Thomas Eisner and colleagues from Cornell University in New York have recently discovered, they also gain protection from predators.

Photinus fireflies produce a defensive steroid chemical called lucibufagin (LBG).

COURTESY THOMAS EISNER

Female *Photuris* fireflies gain more than just nutrients from their male *Photinus* prey.

When disturbed, the fireflies exude droplets of LBG-tainted blood, which jumping spiders (*Phidippus* spp.) find repellent. *Photuris* females, however, are unable to synthesise LBG themselves and so must steal it from elsewhere.

Experiments in which female *Photuris* were offered to hungry jumping spiders showed that fireflies that had not eaten LBG (either as an artificial supplement or as a male *Photinus*) were immediately attacked, but those that had consumed LBG were spared. The more LBG they had eaten, the more repellent they were to jumping spiders.

The researchers believe that LBG, whether stolen or homemade, also protects fireflies from thrushes, and probably ants and other invertebrates as well.

—P.R.

Lizard's Liquid Lunch

Most lizards opt for lunch with a crunch—flies, beetles, spiders and other arthropods, even the processed remains of another lizard's lunch. But on the tiny island of Nitge, one of the Balearic Islands off the coast of Spain, the lizards there prefer to sip on nectar.

In the first known record of lizard pollination, Valentín Pérez-Mellado (University of Salamanca) and José L. Casas (University of Alicante) report how the Balearic Lizard (*Podarcis lilfordi*) is a key pollinator for the local sea fern *Crithmum maritimum*.

Lizards had previously been observed climbing over the ferns from dawn until dusk, spending all day licking nectar and pollen from the flowers, and so the researchers suspected they may play a role in pollination. To prove it, though, they had to run a series of exclusion experiments in which some ferns, but not others, were fenced off from the lizards.

COURTESY VALENTÍN PÉREZ-MELLADO

In the first known record of lizard pollination, the Balearic Lizard sups on nectar from a sea fern.

Plants that were made available to the lizards were found to have between 14 and 75 per cent viable seeds, compared with only five to ten per cent for the plants that lizards couldn't reach.

The plants that were fenced off from lizards may have been pollinated by wind and insects, suggesting that lizards are the significant, but not sole, pollinators. The sea fern, on the other hand, is vital to the lizards, whose stomach contents reveal that nectar and pollen are their only food source during midsummer.

Nectar sipping is a luxury few lizards can afford, because the sweet temptation often leaves them exposed to predators. But on Nitge Island, an unusual lack of predators has allowed the lucky lizards to drink to their hearts' content.

—A.T.

Cheating Choughs

A cooperative approach to breeding is quite common in birds but few take it quite as far as White-winged Choughs (*Corcorax melanorhamphos*). These natives of eastern Australian forests live in groups of up to 20, often related, individuals. Only one pair will produce offspring but all members of the group take part in building a cup-shaped mud nest, up to 30 centimetres across, and help forage for the young. Without this level of teamwork, White-winged Choughs are unable to reproduce.

The support, however, is not always as devoted as it might at first seem, according to Australian National University ecologists Christopher

ROGER BROWN/NATURE FOCUS

When other adults aren't around to watch, White-winged Choughs may gobble food intended for the nestlings.

Boland, Robert Hein-sohn and Andrew Cockburn.

Choughs take about four years to mature. When they begin foraging, they are not particularly efficient and have enough trouble meeting their own energy requirements, let alone the demands of perpetually hungry nestlings. And so, the researchers observed, some helpers routinely consume food meant for the group's offspring.

They are, however, sneaky about it. Boland and his colleagues witnessed young 'cheats' (typically two-year-olds) carrying food to the nest and even dangling it into the gaping mouths of nestlings before swallowing it down themselves. This only ever happened if there weren't other birds around to watch them. Cheating ceased when supplementary food was provided and foragers had no problems finding food.

Interestingly, the researchers also observed that the young tricksters displayed a greater tendency to preen nestlings, almost as if they were trying to make up for their deceptive ways.

—K.McG.

Oily Birds

A distraught young woman gingerly grips a grease-soaked bird. Its small dark eyes blend into the rich blackness of the crude oil coating. The tragic environmental cost of an oil spill is immediately recognisable. Valiant wildlife rescue efforts following environmental disasters may help to salvage our conscience, but for some species it appears to be the only thing we are saving.

For more than ten years, researchers in Britain have studied the survival rates of ringed Guillemots (*Uria aalge*) following rehabilitation from oiling. Chris Wernham and colleagues, from the British Trust for Ornithology, measured a large discrepancy in the average life span of Guillemots in natural populations compared with those released after rehabilitation. Wild healthy adults were found dead an average of 599 days after ringing, while rehabilitated birds lasted only seven days after release. Only about one per cent of rehabilitated Guillemots survived their first year after release.

Brian Sharp, a former US Fish and Wildlife Service biologist from Oregon, has studied similar seabird populations in North America where he found the average life span of rehabilitated Guillemots after release to be 9.6 days.

Rehabilitating oiled birds is labour-intensive, expensive and has a very low success rate for some species.

Rehabilitating oiled birds is labour-intensive, expensive and has, as we now know, a very low success rate for some species. Although the number of birds being released is increasing with improved techniques, many individuals do not live to

breed again. So why do volunteers slave to save oiled birds that won't help their populations recover?

For many people, rescuing oiled birds and mammals is a matter of animal welfare, not conservation. Washing birds with warm detergent and providing them with nutritious slurries may temporarily reduce the suffering for individual birds; but, importantly, it also makes the volunteers feel that they are at least doing something to compensate for the mess that our species has caused.

Theoretically the most effective way to reduce the environmental cost of oil spills is to stop them from happening in the first place. Prevention, as they say, is better than cure. But the world will never be ideal, and oil spills are likely to continue. In the grim yet inevitable event of another oil spill disaster, we need to understand why some bird species do not fare as well as others after rehabilitation. For this, a more rigorous and comparative approach to collecting information during the rehabilitation process must be adopted.

—B.D.

Stuffed Wasps

Faced with the problem of how to ensure that food meant for wasp larvae isn't gorged by idle male nest mates, hard-working females have come up with a pragmatic solution: females surround hungry males and stuff them headfirst into the nearest empty nest cell.

Aggression within colonies of social insects is well documented, but Philip Starks and Emily Poe (Cornell University in New York) only recently observed this unusual behaviour in nests of the paperwasp *Polistes dominulus* with the aid of 26 hours of video footage.

They found that male-stuffing, which can take two forms, occurs when female foragers return to the colony bearing food for the larvae and encounter males wishing to consume their hard-earned resources. (Males generally hang around the nest for a few weeks after emerging as adults, without engaging in any of the usual nest maintenance activities, before leaving the colony to mate.)

During 'initial stuffing', a female bites and threatens to sting the male until he is overcome, then forces him headfirst into a nearby cell from which he later escapes when the females' attentions are otherwise engaged. 'Repeated stuffing' occurs after the male's head and thorax are already inside the cell; the female continues the attack on the male's protruding abdomen, ensuring he remains stuffed for much longer before escape.

In short, say the researchers, stuffing ensures that food is preferentially channelled to the needy larvae, which, in wasp societies, are likely to be more closely related to females than females are to males. So limiting food to adult males may maximise the fitness pay-off for female workers.

—R.S.

Insect Pearls

Pink Ground Pearls (*Eumargarodes laingi*) put on their hottest pink and surface every spring, hoping to attract the opposite sex. It's an evolutionary throwback to a time when there were males in the species. Today the Pink Ground Pearl, a tiny (two to five millimetres long) wingless bug related to the scale insects, reproduces without sex (called parthenogenesis), depositing hundreds of eggs in white frothy fairy-floss masses about a metre below the soil surface.

After the eggs hatch, the nymphs (all female) wander through the soil, seeking plant roots to which they will

DENSEY CLYNE

Some female paper wasps punish idle males by stuffing them headfirst into a cell.

attach and remain for the rest of their lives. To protect themselves against desiccation and attack from natural predators, such as wireworms and other soil-dwelling beetles, they create a luminescent pearl-like capsule or cyst as impenetrable as a tank and with only a 'peephole' big enough for a retractable, hair-like feeding tube. The cyst enables them to survive long periods of drought without food. As the ground pearls grow, they increase in size, changing from beige to bright pink just before the adults mature. Up to 10,000 of these 'pearls' may be found clinging to the roots of one plant.

One peculiar feature of these insects is that, every day from October through to December, the pink adults emerge briefly at the soil surface. This is always between 10 and 11 am. We still do not know what they do at the surface, or whether the individuals come to the surface just once or more often, before returning below ground to lay their eggs.

The absence of males and reproduction by parthenogenesis are also oddities. Parthenogenesis allows a population to increase rapidly, as all the energy of the population is focused on egg-laying females and not on 'unproductive' males. This works well while conditions remain stable, but does not allow the dissemination of useful mutations as does sexual reproduction.

Just as puzzling is where the species originated. It was discovered in 1932 in a Sugarcane field at Bundaberg, Queensland, but is now known from Sarina on the mid-Queensland coast down to Sydney; and not only in Sugercane fields, but also in turf grass on golfing and bowling greens. Although it was first recorded in Australia, it was also found on wild grasses in North America around the same time, causing speculation that it is native to that continent since Sugercane is a cultivated, introduced crop.

Peter Allsopp, an entomologist from the Bureau of Sugar Experiment Stations in Bundaberg, is studying the behaviour and biology of this tiny insect in the hope of finding a way to combat it in Sugarcane fields. So far, insecticides have proven ineffective, so cultural controls such as bare-fallowing fields, or growing other crops such as melons in rotation, are being looked at to break the insect's one-year life cycle. Sugarcane varieties are also being tested to determine why some are more resistant to attack than others.

—Lisa Halvorsen
University of Vermont, USA

Pretty in pink? Not according to Sugarcane growers, whose crops are eaten by Pink Ground Pearls.

COURTESY PETER ALLSOPP

Hot and Cold Dino Debate

The battle continues to rage about whether dinosaurs were warm- or cold-blooded (see *Nature Aust.* Summer 1996–97). This time 'cold-blooded' evidence comes from the so-called 'feathered' dinosaur unearth-

Crocodiles share a bellows-like lung with theropod dinosaurs: another nail in the coffin for hot-blooded dinosaurs?

JOE SHEMESH/NATURE FOCUS

ed in China in 1996 (see *Nature Aust.* Spring 1997).

John Ruben (Oregon State University) and colleagues observed that the fossilised *Sinosauropteryx*, an early Cretaceous theropod (the group popularly supposed to have given rise to birds), seemed to contain an outline of the dinosaur's innards—unusual enough as soft tissues are not normally preserved in fossils.

More exciting for the researchers was the observation that the innards seemed to exhibit the same compartmentalisation of organs found in modern crocodiles—but not birds—in which an airtight diaphragm separates the lungs and heart from the intestines and other organs. When the diaphragm is drawn down, it creates negative pressure in the thoracic cavity, forcing air into the bellows-like lung. Birds, in contrast, do not need a diaphragm for breathing. They have a highly modified, flow-through form of lung, which allows for high levels of gas exchange required for powered flight. Ruben and colleagues argue that the dinosaur's bellows style of lung would not have been able to provide the gas exchange rates typical of active endotherms.

In a double whammy to accepted dino theories, they also argue that there is unlikely to have been a direct transition between the crocodile-style lung and the bird lung, because the transitional animal would have had a life-threatening hole in its diaphragm. Based on this evidence, it seems that, while there is probably a relationship between dinosaurs and birds, it may not be a linear one as is popularly supposed.

—R.S.

Rodent Paint Bombs

Don't be fooled by these brightly coloured jelly-beans—they may actually be rat poo! It appears that a family of rodents left evidence of their gourmet taste in a suburban home in Brisbane.

The connoisseurs are thought to have been Black Rats (*Rattus rattus*), an introduced species common to most urban areas around coastal Australia. Simple fare of grains and greens was apparently far too pedestrian for these particular rodents, which appear to have dined out on a truly multicoloured experience. After some sleuthing by Greg Czechura from the Queensland Museum, a partially nibbled palette of watercolour paints was found to be the source of their cheery scats.

COURTESY GARY CRANITCH/QUEENSLAND MUSEUM

Most of the faecal pellets were quite uniformly coloured, indicating that the rodents ate different coloured sections of the paint at separate sittings. If more than one rat was responsible, they would have squirrelled the paint sections away and eaten them on their own.

The next time you find evidence of ratty friends in your childrens' paintbox, consider points of taste and see if you can discover the favoured culinary colour of the rodent world.

—B.D.

Shell Shock?

A Leopard may not be able to change its spots, but some snails can, as malacologists studying colour and shell patterns in *Puperita* recently discovered.

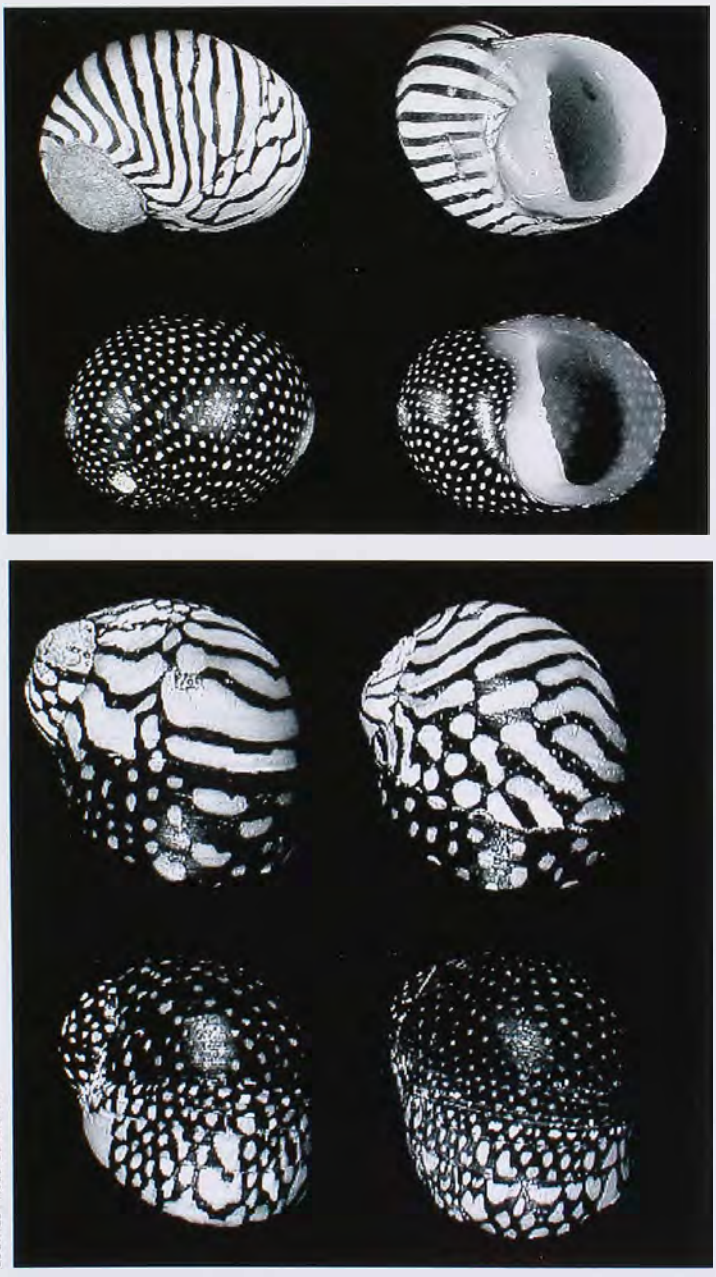
The Zebra Nerite (*Puperita pupa*) has a white shell with black stripes and is normally found in high-saline rock pools, while the Melancholy Nerite (*P. tristis*) is black with white spots and is found in low-saline pools. On a routine field trip to Jingle Beach in Jamaica, Ross Gundersen (University of Wisconsin) and Russell Minton (University of Alabama) came across an odd-looking shell that looked like the Zebra Nerite but whose black stripes had started to split and cross, producing a netted effect. These were found in pools at the high-tide mark, where the salinity varied from fresh to super saline depending on rainy or sunny weather. Could this netted shell be an intermediate form of the two *Puperita* species? Could the two species in fact be just one species with different shell patterns depending on the local conditions?

To see whether salinity influenced the shell pattern, Gundersen and Minton decided to conduct a simple field experiment. They found a pool containing Melancholy Nerites, and another one about five metres away containing net-patterned Zebra Nerites. They swapped over 20 of the snails from each of the pools and came back in three months time to see if any changes in shell pattern had occurred. Sure enough, the area of new growth in the transplanted shells had the colour and pattern of the other type that normally lived there. The netted Zebra Nerites had an area of white-spotted black at the edges, and the Melancholy Nerites had a band of netted white.

Next the researchers collected some typical striped Zebra Nerites and put them into the test pool with the Melancholy Nerites. Again when they returned, nine months later this time, they found that the area of new growth had the Melancholy Nerite pattern of black with white spots. These simple experiments support the idea that salinity may affect the pattern and colour of shell growth. Whether this is a widespread or just a local phenomenon, and whether or not other factors also affect the colour and pattern of the shells, remain unknown.

In a final run of experiments, Gundersen and Minton looked at the DNA fingerprints of the two snail species. They found them to be identical and strongly suspect that the Melancholy and Zebra Nerites are really just one snail masquerading as two under varying conditions of salinity.

—G.H.



COURTESY ROSS GUNDERSEN

Half Zebra–half Melancholy: nerite snails can change the pattern of their shell.

Some Lizards Like it Both Ways

Most reptile species lay eggs, while others produce live young. Rarely, it seems, do they do both, or even exhibit anything in between. An extraordinary discovery, about a rather ordinary lizard, might help explain why.

Sarah Smith and Rick Shine from the University of Sydney found that the common Three-toed Skink (*Saiphos equalis*), while wholly unremarkable to look at, has some quite remarkable reproductive characteristics. Not only does it have different breeding strategies at opposite ends of its distribution, but one of these appears to be intermediate between egg laying and live bearing. Lizards from the northern highlands of New South Wales are live bearing, producing almost fully formed young inside a membranous sac. In contrast, lizards living in Sydney produce weakly shelled eggs with poorly

Quick Quiz

1. In Peregrine Falcons, which is the bigger sex: the male or female?

2. Which well-known virus is most similar to the recently discovered Australian bat lyssavirus?

3. What is the name of the imaginary line that separates the Oriental and Australasian zoogeographical regions?

4. Exactly where, on an insect, would you find an ommatidium?

5. Name the Australian wildlife photographer who developed a revolutionary camera lens that has been used in such movies as "Titanic", "Mouse Hunt", "Men in Black" and "Jurassic Park".

6. In which direction do stalacitites grow?

7. Do crocodiles 'cry' (i.e. shed tears)?

8. What do phycologists study?

9. How many toes do most frogs have on each front foot?

10. What is the new name for the Royal Australasian Ornithologists Union?

(Answers in Q&A)

H. EHMANN

Three-toed Skinks from the northern end of their distribution produce nearly fully formed young inside a membranous sac. Those from the south opt for a different strategy.

developed embryos. These embryos are more advanced than those in typical lizard eggs, and usually hatch into baby lizards in less than six days (compared to 35 days for other egg-laying skinks in the area).

Smith and Shine suspect that such reproductive halfway houses are uncommon because they don't fully offer the benefits associated with either of the extreme modes of reproduction, and yet may incur both sets of costs. A detailed comparison of the costs and benefits of a 'typical' versus intermediate reproductive strategy in the Three-toed Skink should help shed light on the evolution of live bearing in reptiles.

—S.R.

Sexy Sparrows

Like humans (whose grain they eat) House Sparrows (*Passer domesticus*) have made their way from Africa onto just about every landmass in the world. We tend to take them for granted and see them as the ultimate LBJs or 'little brown jobs' of the bird world. However, like the peacock's train, the male sparrow's chestnut, beige and black plumage contains all sorts of information that females can use to assess his suitability as a father.

Male House Sparrows have a black patch or 'bib' on their chest, which varies enormously in size between individuals. Males with bigger bibs are preferred by females and tend to win fights with other males. But why don't all males simply grow a larger bib and gain these advantages? The hormone testosterone is known to increase the sex traits of many male animals, but this had never been shown for plumage traits. Could it be the key to the sparrow's bib?

As part of my PhD research, I implanted some caged sparrows with capsules containing powdered testosterone (similar to the steroids used by body builders), and compared these birds to an untreated group. The testosterone-implanted birds were definitely 'sexier': their bib increased in size, they sang more, they displayed at a higher rate, and vigorously defended their food and nest boxes. Even their bill changed colour to the jet black characteristic of a breeding bird. However, compared to the untreated 'wimps', they also suffered from higher stress hormones (corticosterones), which decreased their immune response (measured by counting the number of antibodies produced when injected with blood from a sheep), reducing the likelihood that they would survive.

In the wild, it is likely that only very fit birds, which can afford the physiological consequences, will boost their testosterone levels and signal at the highest rate. Females thus choose males that advertise their ability to pay the high price of sexiness.

—Sasha Norris
University of Oxford, UK

BRIAN CHUDLEIGH/NATURE FOCUS

Male House Sparrows wear their black badge of honour at a price.

Danielle Clode, Beck Dawson, Karina Holden, Karen McGhee, Phillippa Rowlands, Stephen Richards, Rachell Sullivan and Abbie Thomas are regular contributors to Nature Strips.

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In our warm, moist climate, roaches and Homo sapiens *are inseparable yet insufferable bedfellows.*

THINGS THAT GO CRUNCH IN THE NIGHT

BY STEVE VAN DYCK

WHEN OUR SCROFulous forefathers dragged their leg-irons down the gangplanks to the shores of Sydney Cove, they were probably too preoccupied with spitting curses on the First Fleet's inescapable supplies of salted mutton and cockroaches to notice the potential of the surrounding real estate for relaxation and weekend water sports. Ironically their immediate concerns were well founded, because here we are, over 200 years later, and our land is daily picked and pounded by almost as many sheep as there are cockroaches sucking colonial goose fat from our barby plates by night.

In respect of the cockroaches, despite all our efforts, we are no closer to their extermination today than our children were to the eradication of poverty by 1990. History is emphatic on the cockroach question. In our warm, moist climate, roaches and *Homo sapiens* are inseparable yet insufferable bedfellows, with the cockies unwilling to differentiate between penthouse, poorhouse, and fish heads in the Cat's dish.

Cockroaches have been around since the Carboniferous (300 million years ago), so the intimate relationship with humans goes back way before present international boundaries, to times of mammoths, beetle brows, and serious body odour. Cave men probably had too many things on their expanding minds to be preoccupied with the finer details of personal hygiene and household sanitation. With wheels and internal combustion engines waiting to be invented, cockies probably got a toe-hold among fragrant bone-heaps accumulating at the back of the cave, and everything got a bit out of control from then on.

As late as 1908, ships sailing to San Francisco from voyages around the Horn were manned by sailors who wore gloves to protect their fingernails from being gnawed down to the quick by the hordes of cockroaches that infested the hulls. To help eradicate cockroaches on war vessels, sailors in the Japanese navy used to be awarded one day of shore leave for every bottle or bag containing 300 cockroaches (or, alternatively, one rat).

Appalled by the lack of cockroach control in hospitals, H. Frings recalled a 1948 tour around a childrens' ward with a pest control man. They noted healthy populations of roaches crawling around on infants inside incubators. On one of these small patients some of the insects were ". . . actually feeding on a little bit of caked milk at the corners of its mouth".

The mere mention of the world 'cockroach' is enough to turn most people inside-out with revulsion. The thought of one of those greasy little kernels of filth actually scurrying across one's sleeping face could throw many of us beyond the grip of sanity.

Almost every year in our house these rancid insects announce the opening of the cockie season with an electric fire-

KATHIE ATKINSON

The American Cockroach—an all too familiar face.

works spectacular that could rival the Queen's coronation. It might come via the oscillating fan or the more infrequently used electric can-opener. The power goes on, the motor starts to warm up, and then some crunching and grinding begins. To a nutty then more overpowering toasty aroma, brown gauzy wings are the first to shoot out of the air vents. Then as everything picks up speed, their armoury of droppings, like machine-gun bullets, starts blasting out at everything around the room. And finally, in a blaze of glorious incineration, all the remaining organics fuse in a cloud of stinky smoke and sparks. At least we found out where they were hiding during the winter.

Every country is quick to shuffle the blame when it comes to the question of original cockie ownership, and it is said that the English call their roach the German Cockroach, the east Germans call theirs the Russian Cockroach, the west Germans call theirs the French Cockroach and, if a German isn't sure, he calls it an English Cockroach. We in Australia have around 430 native species, one of which is a user-friendly, tortoise-slow, mouse-sized burrower (*Macropanesthia rhinoceros*) that, at 30 grams, rates as the biggest cockroach in the world. But none of our native species produces domestic nightmares. These instead are brought on by a tacky introduced line-up of five or six species hailing relatively recently from South-East Asia and Europe.

To deal with them, some of us spend shattered nights in jungle-camouflage pyjamas lurking around the kitchen with torch in one hand and an arsenal of swats, aerosols, thongs and vats of boiling water in the other. Most people, however, see the blur of scurrying wings and stripy shoulders that suddenly breaks camp the moment the light goes on as representing not only an embarrassment, but a battle well and truly lost. Even the invisible smear left behind by the wettex on the kitchen bench is enough to keep them plump. And, when they are busiest during the summer, they can still last a month without food!

It seems that one way to achieve some control on the domestic front comes from an initial pyrethrum knockdown to kill 95 per cent of the army, followed by a baiting program incorporating hydroprene (an insect growth regulator) to inhibit future breeding. Make household food and scraps less available, and tempt creepy visitors into oiled glass jar traps using stale beer or sherry. Some people spread bay leaves or fresh cucumber ends through cupboards as an extra deterrent.

To the present day, many scientists claim that the disease-carrying potential of cockroaches has been over-rated. The other side of the cockie-coin, however, presented by Louis Roth and Edwin Willis in 1957, has horrific implications and should only be read by pest exterminators and the very stout-hearted. In this study, cockroaches are claimed to be capable of carrying and transmitting the virus that causes poliomyelitis, bacteria such as *Streptococcus, Clostridium, Staphylococcus*, protozoa such as *Entamoeba*, and even tape worms and round worms.

As if the smell (which cannot be destroyed with cooking), the mess, the cunning, the dreadful sticky juice they vomit up when merely flicked, and their tough constitution weren't enough to fray our nocturnal nerves, the fact that cockies quickly fly from saucy sewer to our kitchen cutlery, and pass on whatever infective muck they are carrying on their legs or in their gut, is sufficient cause to treat them not with complacency, but as a common enemy.

Nevertheless, enemy or not, the cockie can be used to advantage, and, if you wish to impress your guests with an original and inexpensive pâté, try this not-so-famous 19th-century recipe appreciated by gentlemen in London: "A succulent dish is made from cockroaches simmered in vinegar all morning and then dried in the sun. The insects, freed of heads and intestines, are then boiled together with butter, farina, pepper and salt to make a paste which is spread on buttered bread." A challenge for Ian Parmenter to combine with a full-bodied Australian red, but one guaranteed to roll his eyes back and send him into a backward pike after the first crunch. Bliss! ■

DOMESTIC COCKROACHES

Classification
Order Blattodea, 4,000 named spp. worldwide, 428 Aust. spp., 10 introduced. Most common cosmopolitan pest species introduced to Aust. include: Brownbanded Cockroach *Supella longipalpa* (southern half of Aust.), American Cockroach *Periplaneta americana* (mostly northern two-thirds of Aust.), Australian Cockroach *P. australasiae* (northen half of Aust.), Brown Cockroach *P. brunnea* (Qld and NT), Smoky Brown Cockroach *P. fuliginosa* (Melbourne, Sydney spreading north), German Cockroach *Blattella germanica* (Aust.-wide). (Geographic vernaculars apply to the country where the cockroach was first described, not necessarily from where the roach originated.)

Identification
Brownbanded Cockroach: adult up to 17 mm, uniform yellowish brown, lighter band running across back. American Cockroach: up to 45 mm, uniform glossy mahogany brown with smudged pale yellow head-shield and no wing stripes. Australian Cockroach: up to 40 mm, uniform mahogany brown with strikingly well-defined yellow head-shield and wing stripes. Brown Cockroach: up to 35 mm, uniform deep nut-brown with pale anchor-shape on head-shield; no additional lighter markings. German Cockroach: up to 12 mm, uniform light brown (almost see-through) with two dark brown longitudinal stripes on head-shield. Smoky Brown Cockroach: up to 40 mm, uniform deep nut-brown without additional lighter markings.

Distribution
Worldwide in houses, restaurants, warehouses, sewers, septic tanks, trains, latrines, hospitals, markets, pipes.

Food
Practically anything from oil smears, paper, soap, carrion and flowers to faeces. Roth and Willis report medical experiments where researchers fed sputum, pus and decaying refuse to laboratory cockroaches. They (the roaches) were reported to "feed voraciously" on a meal of tuberculosis sputum.

Reproduction
Eggs laid in a hard egg capsule (ootheca) often carried around by female for a few days before depositing it in a concealed spot. Capsules contain 12–40 eggs. In Australian Cockroach eggs hatch in about 53 days (17 in German Cockroach). Nymphs undergo about 7 moults before becoming winged adults. Adults breed repeatedly during a life span from around 18 months (Australian Cockroach) to 9–10 months (German Cockroach).

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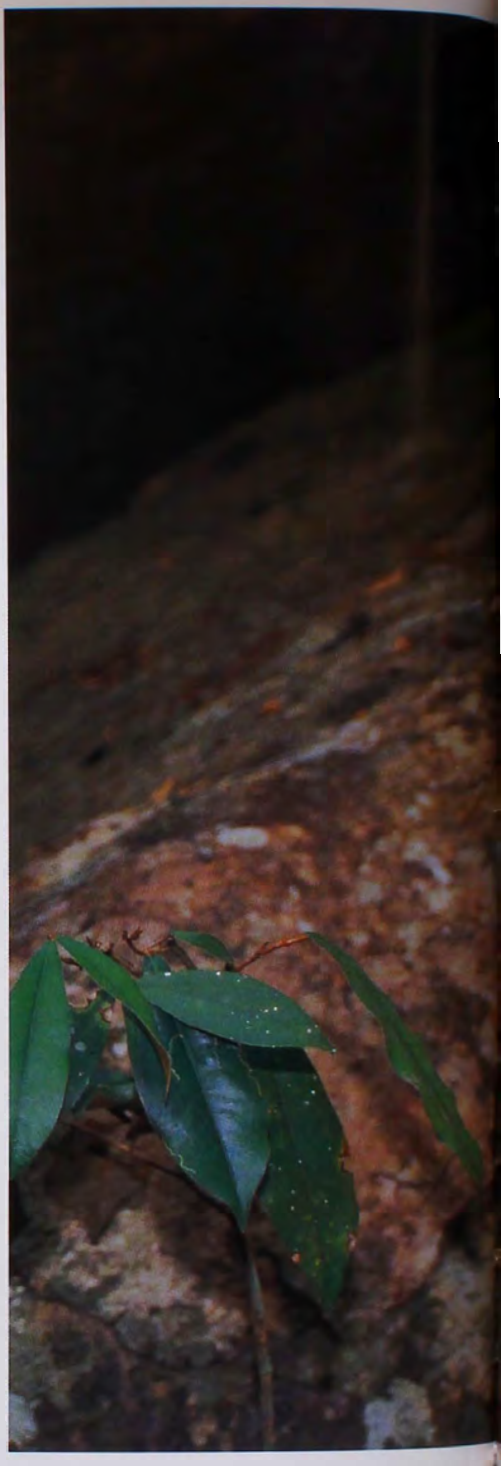
Dr Steve Van Dyck is a Curator of Vertebrates at the Queensland Museum where he has worked since 1975.

Lawns hardly ever need mowing, having been nipped into neatness by furry rainforest gardeners with soft brown eyes.

PROSERPINE ROCK-WALLABY

BY PAULA WINKEL



THERE IS A SOUND IN NORTHern Queensland rainforests that is in danger of fading away. It's not the peaceful noise of rustling leaves in the canopy, nor is it the night-time serenade of insects and frogs, nor the squabbling squawks of the birds and bats. The sound is much more subtle, and if you strain your ears to listen during a lull in the noise of the rainforest, you may hear the faint thuds of a macropod hopping and foraging on the rainforest floor. This is the Proserpine Rock-wallaby (*Petrogale persephone*), an endangered marsupial that, unlike other rock-wallaby species, is an exclusive rainforest dweller. It is only found in several patches of rock-filled rainforest located in the Proserpine/Whitsunday region of northern Queensland.

A combination of three factors has put the Proserpine Rock-wallaby onto the endangered species list. These are old age, competition and progress. By old age, I mean that the Proserpine Rock-wallaby is the oldest extant species of its genus in Australia. This fact, coupled with the knowledge that Australia's rainforests have been shrinking in size for thousands of years, has led to the belief that the Proserpine Rock-wallaby is a remnant population of a once much more widely distributed species. Some researchers also believe that a 'younger' species of Petrogale—the smaller Unadorned Rock-wallaby (*P. inornata*), which can make use of both open woodland and rainforest habits and has a distribution that partially overlaps and totally surrounds that of the Proserpine Rock-wallaby—may be out-competing its larger relation for both food and shelter sites where both species come into contact. A Proserpine Rock-wallaby weighs 4.1–8.8 kilograms, has an average home range of 21 hectares and, depending on the number of shelter sites available, will share a boulder-filled colony site with a number of other Proserpine Rock-wallabies. On the other hand, the Unadorned Rock-wallaby, which weighs only 3.1–5.6 kilograms and has a much smaller home range, can have at least double the number of individuals living in the same-sized colony site, effectively stopping the Proserpine Rock-wallabies from using the area.

It may seem that the future is a little grim for the ancient Proserpine Rock-wallaby, but unlike 'old dogs', Proserpine Rock-wallabies can learn new tricks.

Progress in its various forms, however, is the greatest problem for Proserpine Rock-wallabies. Due to the rock-wallaby's limited distribution, habitat destruction is a very real threat, and each hectare lost is a tragedy. Patches of rainforest habitat have become totally isolated from each other, and areas within the rainforest are being cleared for housing and development projects. Busy roads running throughout the rainforest have caused many road deaths of this endangered species. Constant harassment and hunting by feral and domestic Dogs are also a major problem for these shy, gentle creatures.

It may seem that the future is a little grim for the ancient Proserpine Rock-wallaby, besieged on all sides by the progress of humanity, competition from other species and the march of time, but unlike 'old dogs', Proserpine Rock-wallabies can learn new tricks (and so too can the locals). Where the push of humans into the rainforest is not so great, and Dogs are few and far between, the Proserpine Rock-wallaby has been quietly introducing itself to some of the local residents. With the proliferation of lush-

PAULA WINKEL

ly vegetated gardens around the homes that have cropped up in their habitat, these rock-wallabies, along with Red-legged Pademelons (*Thylogale stigmatica*), have learnt to make use of the new resource in their midst. On top of the normal rock-wallaby fare of rainforest fruits, leaves, grass and fungi, a tropical garden to a Proserpine Rock-wallaby is like a delicatessen, where it can go shopping for all sorts of delectable food stuffs (from hibiscus flowers and balsams, to a sampling from the vegetable patch). Some of the rainforest gardens can look like scaled-down imitations of Alcatraz, where wire netting surrounds prized plants that can't handle the occasional and intensive free pruning services, but on the up side, their lawns hardly ever need mowing, having been nipped into neatness by furry rainforest gardeners with soft brown eyes.

Through information and education programs run by the Queensland Department of the Environment and the Whitsunday shire council, the local human population is also beginning to understand a bit more about one of their 'oldest' residents. In addition, the number of tragic road deaths for these animals is being reduced through the use of special roadside reflectors that throw up a barrier of light along the side of the road when a vehicle drives past at night. Rock-wallabies (and other rainforest creatures) baulk at the light, which prevents them from crossing the road in front of the car. With a little understanding on the part of humanity (like driving slowly through the rainforest, making sure that Dogs can't roam, and minimising the amount of rainforest that inevitably has to be cleared), Proserpine Rock-wallabies and humans can live in relative harmony with each other. A little understanding can go a long way to making sure that the thump of hopping feet over rocks under the rainforest canopy is a sound not only remembered by the trees. ■

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Paula Winkel is currently completing a Masters thesis on the ecology and management of the Proserpine Rock-wallaby at James Cook University of North Queensland, Townsville.

Just as there are animals such as limpets that move slowly, so too are there plants that can move with speed.

PLANTS WITH SENSITIVITY

BY TIM LOW

PERHAPS THE MOST OBVIous difference between animals and plants is that most animals move about a lot, whereas plants stay still. Plants do in fact move upwards and outwards as part of the process of growth, but at speeds so slow they are imperceptible to our eyes.

There are exceptions, of course, and just as there are animals such as limpets that move slowly, so too are there plants that can move with speed. Obvious examples are the many plants with pods that suddenly contract upon drying, hurling their seeds afar. More unusual and much more spectacular are those plants with sensitive leaves.

The most remarkable of these is the Common Sensitive Plant (*Mimosa pudica*) of Latin America. A small tangled plant with reddish stems and pink flower heads, it grows along the Queensland coast as a prolific weed of roadsides, crops and pastures. If you touch its pinnate (feather-like) leaves, they fold and droop. Keep annoying this plant and the nearby leaves collapse as well until the whole plant dissolves before your eyes, leaving behind only a few slender stems and disguised stacks of leaflets.

Common Sensitive Plant has for hundreds of years attracted the fancy of botanists. In a major review in 1979, G. Robin cited more than 80 scientific studies dealing with the phenomenon, and many more have been conducted since then. The plant has been investigated partly out of curiosity, but also because it may help elucidate the methods of movement in plants, which usually proceeds more slowly. As Paul Bert put it in 1870 "the Sensitive plant is, so to speak, as a warm blooded animal among cold blooded ones".

Over the centuries botanists have submitted this plant to all manner of indignities. It has been poked, prodded, burnt, cut, gassed, X-rayed, and clamped down with electrodes. The tests have shown that Common Sensitive Plant responds to just about anything—to shaking of the whole plant, localised pressure, sharp temperature change, changes in barometric pressure, light, X-rays, burning, cutting, and application of such vapours as ether, chloroform, ammonia and formaldehyde.

Many studies have confirmed that the leaves droop by losing water in the base of the stalk (pulvinus). Potassium ions

PHOTOS: TIM LOW

Common Sensitive Plant often comes to the attention of travellers in northern Queensland because it thrives along roadsides. Before touching (below left), and after (below right).

migrate across cell walls and the water follows. The leaves retrieve their position after the disturbance stops, but slowly, taking 40 to 60 minutes.

The main reason for behaving like this is probably to avoid being eaten—when the leaves fold and droop they appear to vanish among the tough prickly stems. At night, the folding of the leaves (a habit shared with many other legumes) presumably slows water loss. As well, scientists have suggested that, by folding up during rain, the leaves minimise leaching of nutrients, but experiments do not confirm this.

Three kinds of sensitive plant have entered Australia: Common Sensitive Plant, Mimosa Bush (*M. pigra*) and Giant Sensitive Plant (*M. invisa*). Giant Sensitive Plant, a noxious weed in northern Queensland, was probably imported accidentally as a seed contaminant, but the other two may well have been brought in deliberately as curiosities. If so, the evolution of moving leaves has proved an excellent means of long-distance dispersal—these weeds were introduced to a number of countries as novelties, with regrettable consequences. Mimosa Bush has gone on to become one of Australia's worst weeds, by invading more than 8,000 hectares of the Top End, including wetlands at the edge of Kakadu.

Few people know this, but Australia also has native sensitive plants. In the tropics and subtropics there are five species of *Neptunia*, one of which, the Native Sensitive Plant (*N. gracilis*), extends south into northern New South Wales. A dainty little plant with yellow flower heads, its leaflets fold inwards when prodded, although not as completely as Common Sensitive Plant.

Australia has other plants that move in interesting ways. The trigger plants (*Stylidium* species) and duck orchids (*Calaena* species) have flower columns that swing forward when touched, ensuring visiting insects are painted in pollen. Like the sensitive plants, they remind us that sudden motion is not the exclusive domain of the animal kingdom. ■

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Tim Low is a Brisbane-based environmental consultant and author who is particularly interested in plants.

Keep annoying this plant and the nearby leaves collapse as well until the whole plant dissolves before your eyes, leaving behind only a few slender stems and disguised stacks of leaflets.

Odd though it may sound, male birds may have lost their penises over evolutionary time simply because females preferred it that way.

WHY KISSING IS FOR THE BIRDS

BY JAMES BRISKIE

WHEN YOUR PARENTS TOLD you about the birds and the bees they only got it partly right. This is because the males of most bird species (97 per cent) do not sport a penis or intromittent organ like that found in bees and other insects or in mammals like ourselves. Instead, male birds inseminate females using what ornithologists affectionately term the 'cloacal kiss', an acrobatic feat in which the male balances on the back of the female, twists his tail under the female's tail, and then presses the lips of his cloacal vent against the corresponding parts of his mate to transfer a small droplet of sperm. The female then draws the droplet of semen into her reproductive tract where it is used to fertilise her egg or eggs. The whole sequence can take as little as a second or two.

Why do birds copulate in such an odd manner when males of most other animals with internal fertilisation take the seemingly more efficient route of using a penis to transfer sperm directly into the female reproductive tract? The reason certainly is not because of some constraint on the ability of a penis to evolve in birds. In fact, at one time all species of birds probably possessed a penis but it subsequently was lost as modern birds evolved from their well-endowed reptilian ancestors. It even appears that the penis was lost not once but in at least three different lineages in the early history of birds. What emasculatory twist of evolution could have repeatedly favoured the loss of something so intuitively useful? The answer has eluded ornithologists for decades, but a recent comparative study of the presence or absence of intromittent organs in birds suggests an intriguing possibility. Odd though it may sound, male birds may have lost their penises over evolutionary time simply because females preferred it that way.

THE RATIONALE FOR THIS 'FEMALE choice' hypothesis lies in the fact that a penis is not absolutely necessary to transfer sperm successfully. This is clearly evident by the ability of most male birds to copulate without one. If a penis is not necessary for transferring sperm, then why should a male want a penis with all its attendant construction and maintenance costs? What good is a penis? One rather untantalising possibility and perhaps the key to the entire problem is that the penises of male animals may have evolved as a tool to allow them to force copulations on (or 'rape') unwilling females. Why males should sometimes want to force copulations upon females stems from the basic differences between the sexes in the level of effort invested in the production of young.

BARRY SILKSTONE/NATURE FOCUS

Like most birds, the male Princess Parrot (*Polytelis alexandrae*) has done away with a penis and transfers his sperm to the female using the 'cloacal kiss' method.

In general, females tend to invest much more in producing eggs and offspring than males do in producing sperm. This has led to different strategies between the sexes when it comes to selecting a mate. Because of the greater investment, females are expected to be choosy about partners, while males can best increase their evolutionary success by maximising the number of females they inseminate. Where females look for quality in a mate, males look for quantity. If this male strategy is not possible through cooperation with females, then natural selection in some situations could favour males that copulate by force. Females, for many reasons, are better off being able to choose their mates and so should favour a situation in which they have greater control over copulations. The cloacal kiss of birds does just this: females must cooperate during a cloacal kiss, otherwise a male bird lacking a penis is out of luck. In other words, a male bird cannot force sperm into a female if he has nothing to force it with.

This raises the question as to how a female preference for males without a penis could evolve if it is advantageous for males to have one. The answer may lie in the unique ability of female birds to easily 'abort' an embryo that has been fertilised through a forced copulation simply by abandoning that egg. Such a strategy is possible because birds ovulate and fertilise just one egg at a time, and so all a female loses by abandoning

an egg is a day or two of investment in that egg. This is not the case in most mammals and reptiles with long periods of gestation or in which large batches of eggs are ovulated and fertilised all at once—there a female would lose a huge investment in time and energy by abandoning the eggs or young. And here lies the crux of the argument: if females always desert eggs sired by males who force copulations, then there is no longer any evolutionary advantage to the male in performing this behaviour. Natural selection should then favour the loss of the penis in males because it no longer results in any advantages through forced copulation but is still energetically expensive to grow, maintain and keep free from disease.

Although most species of birds produce individual eggs at relatively little cost, it is true that there are some birds that put a huge investment into each egg. Eggs that are very large relative to the female's body size are the most costly. Kiwis, waterfowl, tinamous and cracids (two groups of South American birds), and the Emu and Ostrich are some examples. In these species, it may not pay females ever to desert such a large investment, even if an egg was forcibly fertilised by a male that a female did not particularly fancy as a father for her offspring. And it is because these females are unwilling to abort or abandon such costly eggs that selection would favour the retention of a penis in males that would allow them to force copulations. In support of this hypothesis, the three per cent of species with relatively large and costly eggs are also the same ones in which the males still retain a penis. Species with small and energetically cheap eggs are generally the ones in which the penis has been lost over evolutionary time.

Are there any alternative explanations for the loss of the penis in birds? Previ-

Why has the male Emu retained his penis?

ous hypotheses have generally focussed on why a few species have retained a penis, rather than why it has been lost in the majority of birds. For example, suggestions have been made that some species retain a penis to ensure proper coupling (particularly for species that copulate on water, or are big and have trouble maintaining balance while mounting), or to ensure paternity when a male helps with incubating the eggs. This latter hypothesis would seem to apply to species like the Emu and tinamous, in which the male does much of

PETER REESE/KEY-LIGHT IMAGE LIBRARY

Female kiwis put such enormous investment into the production of their egg that they are not prepared to abandon it regardless of its paternity.

KATHIE ATKINSON

Without a penis, this male Masked Booby (*Sula dactylatra*) has no choice but to go through an elaborate mating ritual in order to obtain the female's cooperation.

KATHIE ATKINSON

JOHN COOPER/NATURE FOCUS

Like most bird species, female Banded Stilts (*Cladorhynchus leucocephalus*) produce eggs with relatively little cost to the individual.

JOHN CANCALOSI/AUSCAPE

All male waterfowl, like the Mute Swan (*Cygnus olor*), possess a penis. The male and female Mute Swan pair for life and both parents incubate the eggs and tend the cygnets.

the incubating, but it cannot account for the retention of a penis in cracids, screamers and waterfowl with their female-only incubation. One popular idea is that the loss of a penis may even reduce the costs of flight. However, this explanation seems unlikely as most species of birds with a penis are quite adept at flying (like waterfowl) and a penis has not reappeared in most flightless species (such as flightless rails). Bats also seem to have little difficulty carrying the extra burden.

Much work still needs to be done to fully understand why most birds lack a penis, but it appears that none of these other hypotheses is supported by the data as well as the female-choice hypothesis.

If the female-choice hypothesis turns out to be true, does it mean that males in other animals have also evolved a penis

as a way to control female fertility? Although there are a number of other ways in which females could regain control (say by spontaneous abortion or infanticide of offspring sired by forced matings), none seems as cheap and effective as that open to female birds. In the evolutionary conflict between males and females over control of fertility, it seems that, in birds at least, females have won. The birds and bees will never be the same again. ■

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At the time of writing Dr James Briskie was a Lecturer in the Zoology Department at Oxford University. He has since moved to the University of Canterbury in New Zealand to continue his studies on the evolution of reproductive behaviour in birds. His work on bird penises was done in collaboration with Dr Robert Montgomerie of Queen's University in Kingston, Canada.

BIRD PENISES

What Birds Have Them?

Penises or intromittent organs are found in 246 species of modern birds, including the Ostrich (*Struthio camelus*), rheas, cassowaries, Emu (*Dromaius novaehollandiae*), kiwis, tinamous, cracids, screamers, and all waterfowl. The vasa parrots (*Coracopsis* spp.) of Madagascar also possess a 'cloacal protrusion' that is intromittent but differs anatomically from the penis found in the other groups. The remaining 97 per cent of bird species (approximately 9,000 species) lack a penis.

What Do They Look Like?

Unlike most mammals, the digestive, urinary and reproductive systems of birds empty into a common cavity called the cloaca, which in turn empties to the outside through a single vent. Intromittent organs in birds (for those that have them) form from an outpocketing of the ventral wall of the cloaca. When flaccid, the organ lies entirely within the cloacal cavity and only when erect does it become everted through the vent and visible externally. Unlike mammals, erection occurs through the lymphatic rather than the circulatory system.

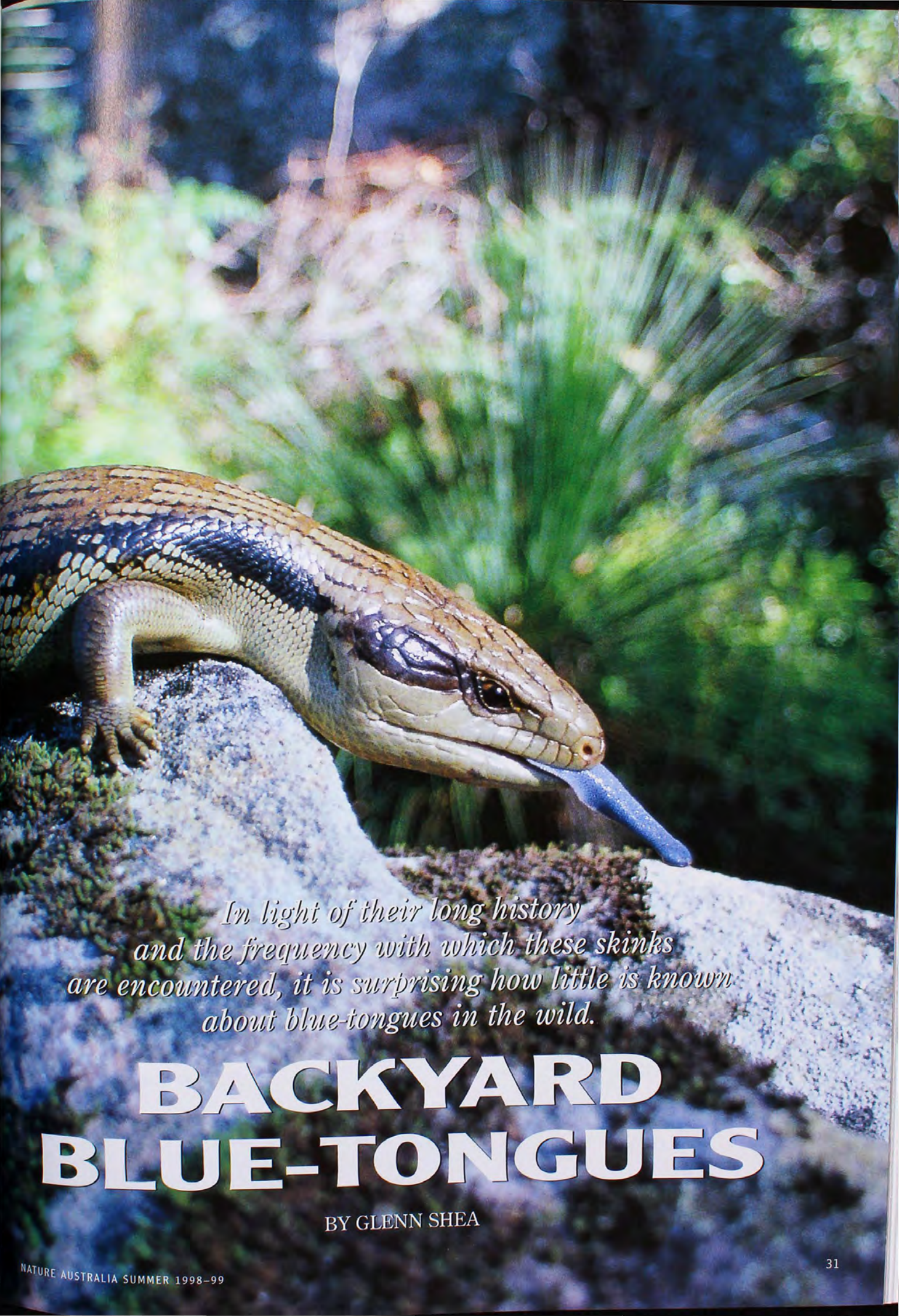
The buffalo weavers of Africa (*Bubalornis* spp.) also possess a stiff, phallus-like organ, located permanently outside the body cavity and anterior to the vent, but this structure does not transfer sperm and its function is unknown.

FERRERO-LABAT/AUSCAPE

Unlike 97 per cent of bird species, the male Ostrich is one of the few with a penis.

KATHIE ATKINSON

The Eastern Blue-tongue is the most common backyard blue-tongue in cities of south-eastern mainland Australia.



In light of their long history and the frequency with which these skinks are encountered, it is surprising how little is known about blue-tongues in the wild.

BACKYARD BLUE-TONGUES

BY GLENN SHEA

MOST AUSTRALIANS ARE familiar with blue-tongue lizards. After all, they are found over most of Australia, from sea level to the highest mountains, from coast to coast, and from rainforest to desert. At least one species is found in every Australian capital city. Over 3,000 publications worldwide, from strictly scientific monographs to popular books, have mentioned blue-tongues in some context. They are among the most popular pet reptiles in Australia, and were being exported for the pet trade as early as the 1880s. They are also food items and totem animals to various Aboriginal tribes.

Blue-tongues have been known to science for over two centuries. They were first reported by William Dampier from Shark Bay in August 1699, and first illustrated by John Webber, artist to Cook's final, fatal expedition, at Adventure Bay in Tasmania in January 1777. The first Australian reptile ever to receive a scientific name was a blue-tongue from the Sydney Region, sent to London in 1790 by John White, surgeon to the First Fleet, and described by the famous anatomist John Hunter.

In light of this long history and the frequency with which these skinks are encountered (even in suburban settings), it is surprising how little is known about blue-tongues in the wild. The ecology of only two species has been studied in detail, and these are the two most atypical blue-tongue species: the Shingleback (*Tiliqua rugosa*) and the Pygmy Blue-tongue (*T. adelaidensis*).

THERE ARE SEVEN SPECIES OF TRUE blue-tongue, all belonging to the genus *Tiliqua*. The Common or Eastern Blue-tongue (*T. scincoides*) is widespread in eastern Australia, and occurs in Brisbane, Sydney, Melbourne and Adelaide backyards. A distinct subspecies, the Northern Blue-tongue (*T. s. intermedia*), occurs across north-western Australia, from Cloncurry to Broome, including Darwin. The Blotched Blue-tongue (*T. nigrolutea*) replaces the Eastern Blue-tongue in the cooler parts of south-eastern Australia. In New South Wales, it is restricted to higher altitudes on the Great Dividing Range from the Blue Mountains south, while in Victoria and the extreme south-east of South Australia, it reaches the coast, coexisting with the Eastern Blue-tongue around Melbourne. It is the only species of *Tiliqua* in Tasmania, where it is found mostly in lowland areas. In the semi-arid mallee and heath habitats from central New South Wales and north-western Victoria, west to the lower west coast and including Perth, the Western Blue-tongue (*T. occipitalis*) replaces the Eastern Blue-tongue. In the spinifex deserts of northern Australia, this species is replaced by the Centralian Blue-tongue (*T. multifasciata*). Outside Australia, blue-tongues are represented by two species, with an unnamed subspecies of the Eastern Blue-tongue in the Tanimbar and Babar Islands in Indonesia, and the New Guinea Blue-tongue (*T. gigas*) in the lowlands of New Guinea and on surrounding islands.

These five species are generally similar in body form and size. The remaining two species are noticeably different. The Shingleback is a large, stump-tailed, slow-moving species with thick body scales and a very large head. The obvious differences between this species and the other blue-tongues led to it being placed in a different genus (variably spelled *Trachydosaurus* or *Trachysaurus*) by many biologists, although recent anatomical studies have provided evidence that it is simply a highly specialised blue-tongue, closely related to the other species. It is found in dry habi-

The blue tongue is thought to play a role in defence against predators. When threatened, blue-tongues (like this Blotched Blue-tongue) open their mouth wide and protrude the tongue, which contrasts in colour with the vivid pink of the mouth lining. The display is all bluff. The bite is non-venomous, although it may cause temporary bruising due to the strong jaw muscles.

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

The Northern Blue-tongue replaces the Eastern Blue-tongue in tropical northern Australia, from north-western Queensland west to the Kimberley. This heavily speckled individual is from the Kimberley region.

PAVEL GERMAN

A young New Guinea Blue-tongue, the only species of blue-tongue not found in Australia. Despite the specific name *gigas*, given to it in 1801 when only a few skink species were known to science, it is not the largest blue-tongue.

tats from the Great Dividing Range to the west coast in southern Australia, and can be found in the vicinity of Canberra (where it coexists with the Eastern and Blotched Blue-tongues), Adelaide (where it coexists with the Eastern and Western Blue-tongues) and Perth (where it coexists with the Western Blue-tongue only). The colouration, size and tail proportions of this species vary considerably throughout its range, and four subspecies are recognised. The relative abundance of this large lizard and its slow-moving, placid nature make it a well-known part of the Australian outback fauna, often seen (and sadly often killed) crossing roads, especially during the breeding season in spring. Reflecting this familiarity is the range of common names applied to the species in various parts of its distribution: Bobtail Goanna (or simply Bobtail or Bobby) in the west, Sleepy Lizard in South Australia, and Shingleback, Stumpy Tail, Bog-eye or Pinecone Lizard in the east.

The other atypical blue-tongue, the Pygmy Blue-tongue, is a remarkable species, physically adapted for living in vertical, narrow spider burrows. It is restricted to a small area of native grassland north of Adelaide. First named in 1864 from two specimens sent to Berlin by the German naturalist Richard Schomburgk, later to become director of

BLUE-TONGUED LIZARDS

Classification
Order Squamata; family Scincidae; genus *Tiliqua*; 7 spp.: Shingleback (*T. rugosa*), Blotched Blue-tongue (*T. nigrolutea*), Pygmy Blue-tongue (*T. adelaidensis*), Eastern Blue-tongue (*T. scincoides*, with the Northern Blue-tongue, *T. s. intermedia*, a distinct subspecies), Western Blue-tongue (*T. occipitalis*), Centralian Blue-tongue (*T. multifasciata*) and New Guinea Blue-tongue (*T. gigas*).

Identification
Large skinks with tails shorter than body length, limbs short and equal in length, 3rd and 4th toes equal in length, and several rows of scales over the temples. Tongue bright to dark blue in most spp.
Shingleback: body length (snout to vent) up to 34.1 cm, short stumpy tail, enlarged thickened bony scales on upper surface of body.
Blotched Blue-tongue: up to 36.8 cm, smaller scales and longer tail than Shingleback, generally dark with paler large blotches on upper surface of body.
Pygmy blue-tongue: much smaller (only up to 10.5 cm), small smooth scales, pink tongue, upper surface of body olive brown, either uniform or with a fine darker grey network.
Eastern Blue-tongue: up to 37.1 cm, alternating dark brown and silvery grey to yellowish bands, often a black streak over temples. Northern Blue-tongue subspecies: alternating orange and black markings along flanks and out of sequence with bands on back.
Western Blue-tongue: up to 32 cm, broad dark brown and cream bands.
Centralian Blue-tongue: up to 28.9 cm, narrow alternating orange and grey bands.
New Guinea Blue-tongue: up to 34.3 cm, similar to Eastern Blue-tongue but differs in having a longer tail and in several features of scalation.

Distribution and Habitat
Found in most parts of mainland Australia and Tasmania, and in most habitats, although less common in closed forests. Also found in lowland parts of New Guinea and eastern Indonesia.

Behaviour
Usually diurnal and ground-dwelling, active by day in sunny areas, sheltering by night in leaf litter and under large objects on ground. Relatively slow-moving and escape predators by bluff. When threatened, they inflate their lungs, causing body to swell; they turn towards the aggressor with open mouth, displaying contrasting blue tongue and pink mouth, and exhale, creating a hissing noise and causing body to deflate.

Reproduction
Viviparous (bear live young). Litter size varies from 1 to about 50, depending on species. Relative mass of litter is about 35% of maternal mass. Mating in spring, young born in summer to autumn after 3–5 months gestation. Mate fidelity in Shinglebacks; mating system of other species unknown.

Diet
Omnivorous, eating a variety of plant and animal materials, but especially fleshy leaves, flowers and fruits, large insects and snails.

Status
Most species currently common, although Pygmy Blue-tongue has a very restricted range and there are anecdotal reports that populations of Western Blue-tongue are declining.

the Adelaide Botanical Gardens, a further 18 individuals were found during the next century, although many of these were sent to museum collections in Berlin, Vienna and London. None was seen for over 30 years after 1959, despite intensive searches by experienced herpetologists, leading to fears that the species was extinct. Part of the difficulty in locating the species lay in the almost complete lack of knowledge of its ecology. Schomburgk had provided the comment "found in sandy, stony terrain" with the original specimens; a single individual from Dry Creek railway station just north of Adelaide was found under a stone; and two from Marion, a southern suburb of Adelaide, were found in burrows (emerging after hot tea was poured down the holes). But this was the limit of knowledge. It was not until October 1992 that the species was rediscovered, when a freshly dead individual was found in the stomach of a dead Eastern Brown Snake (*Pseudonaja textilis*) on the side of the road near Burra (see *Nature Aust.** Autumn 1994). Subsequent studies by Tim Milne, Mark Hutchinson and others at the South Australian Museum and Flinders University of South Australia have revealed that several populations survive at a few small sites in this region.

Closely related to these true blue-tongues are the slender blue-tongues of the genus *Cyclodomorphus*. This genus, which was formerly regarded as part of *Tiliqua*, includes nine species of medium to large, very slender, long-tailed skinks. Several of these species have only been recognised as distinct and formally named in the last three years. These recent studies have shown that one species, the Gill-necked Skink (*C. branchialis*), which was formerly considered to be widespread across arid Australia, is actually restricted to a small area near Geraldton, Western Australia, where it is under threat from agricultur-

*Previously *ANH*

al development. This finding emphasises the importance of modern taxonomic studies to conservation biology.

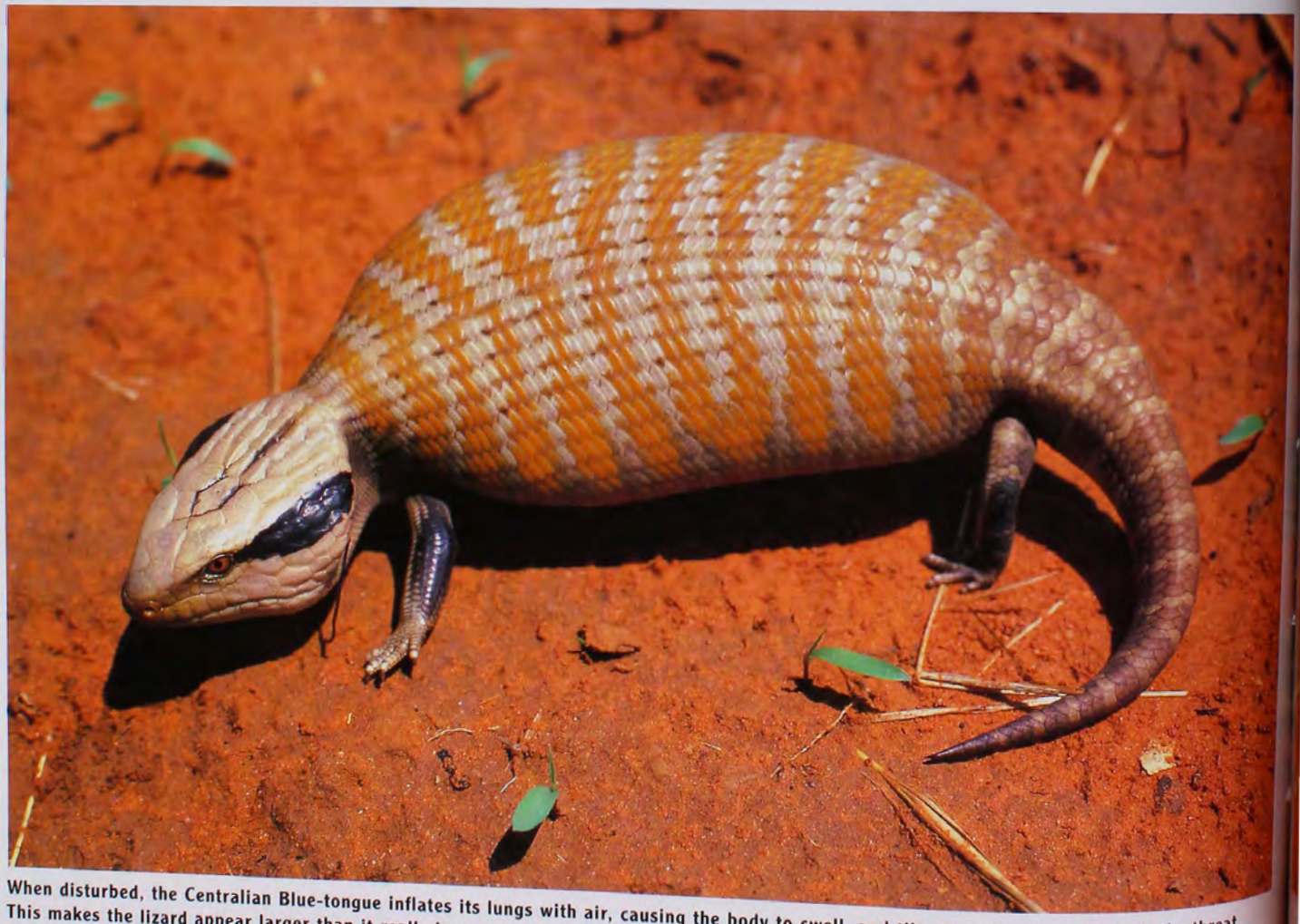
The first illustration of a blue-tongue lizard done by John Webber in 1777.

TOGETHER, THE BLUE-tongues and slender blue-tongues form a distinct evolutionary lineage of Australian skinks. Among the characteristic features of this lineage is the presence of enlarged teeth towards the back of the tooth row in both upper and lower jaws. All other skinks, by comparison, have teeth that are nearly even in size. Two small skink mandibles (lower jaws) from 15-million-year-old deposits at Riversleigh, north-western Queensland, have the same pattern of tooth enlargement and are in every other respect similar to jaws from small modern blue-tongues. They were recently described as a distinct fossil species, *Tiliqua pusilla*. The existence of typical blue-tongue dentition 15 million years ago indicates that the blue-tongue lineage is even older.

Despite the distinctive and consistent pattern of tooth enlargement in blue-tongues, there is a lot of variation in the shape of the teeth between species. The Blotched Blue-tongue, for example, has pointed, cone-shaped teeth, while those of the Eastern Blue-tongue are broadly rounded. In the Pink-tongue (*Cyclodomorphus gerrardii*), the largest tooth in each jaw is very much greater in diameter than the surrounding teeth, and provides a broad crushing surface. Such variation in tooth shape, unparalleled among other skinks, would suggest some fundamental differences in diet. Unfortunately, there is still little knowledge of the diet of blue-tongues. The Pink-tongue, a wet forest species from the east coast, seems to feed predominantly on snails, using the enlarged teeth to crush the shells. However the large blue-tongues, despite a range of tooth shapes, appear to be omnivores, feeding on a wide variety of animal and plant materials. There appears to be little selectivity in the diet. From the array of items found in blue-tongue stomach contents, they seem to swallow anything that is slow enough for them to catch, including inedible items such as small plastic toys. I even found a jewel beetle (family Buprestidae) in the stomach of a Shingleback, and jewel beetles are known to produce one of the most bitter chemical compounds known.

The variation in blue-tongue tooth shape is just one of their unusual features that are of unknown ecological or evolutionary significance. The blue tongue that gives the group its common name is another such feature. Although a number of lizards have a dark tongue, only blue-tongues have a bright blue organ. How the blue is produced has

The Western Blue-tongue inhabits semi-arid mulga scrub and mallee woodlands of southern Australia.



H. EHMANN

When disturbed, the Centralian Blue-tongue inflates its lungs with air, causing the body to swell, and tilts the raised body towards the threat. This makes the lizard appear larger than it really is.

J. CANN

The Blotched Blue-tongue has large litters of relatively small young.

never been studied. The function of the blue tongue also remains obscure, although it may be related to the threat display of most species, which involves opening the mouth widely to display the boldly contrasting blue tongue and pink mouth. However, not all blue-tongues have blue tongues. The Pygmy Blue-tongue has a pink tongue (although the lining and corners of the mouth are purplish), and the tongue of the Pink-tongue, as the name suggests, is pink in adults but blue in newborns.

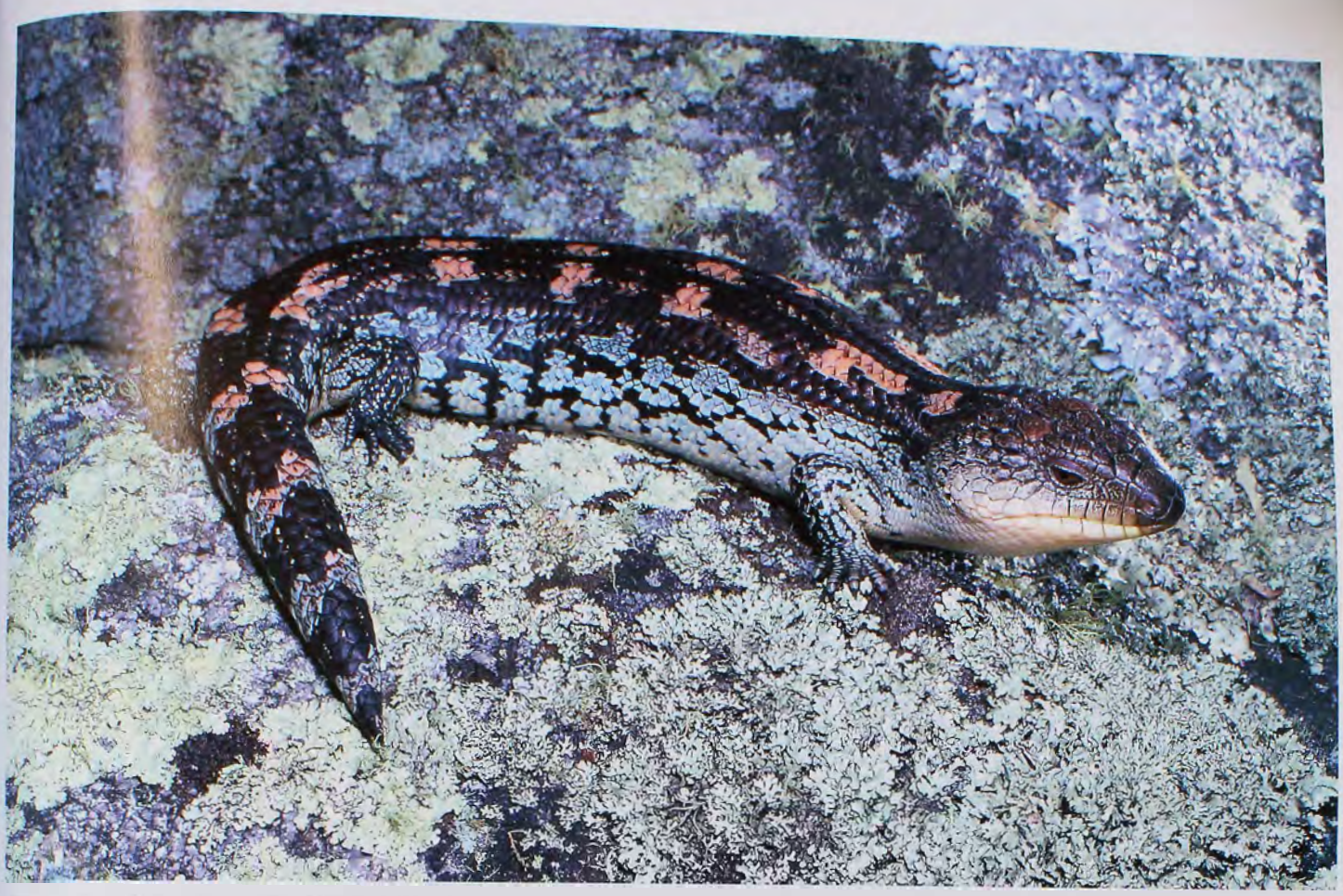
Blue-tongues are the largest members of the skink family (Scincidae). Most skinks, including the common garden varieties, are relatively small, with a snout-to-vent length of less than 20 centimetres. (Because most skinks readily lose their tail, they are measured in terms of body length.) Blue-tongues, with the exception of the Pygmy Blue-tongue, are much larger, with the Eastern and Northern Blue-tongues measuring over 37 centimetres. In contrast, only five other species of skinks worldwide (and there are about 1,000 skink species) have a maximum known snout–vent length greater than 25 centimetres, and two of these are closely related to the blue-tongues. Why have blue-tongues become so large? It may be related to their diet, as larger species in most lizard families eat a lot of plant material, but which came first? Is the large size an adaptation to an omnivorous diet, or did the diet follow from attaining large sizes?

Another unusual feature of blue-tongues is the large variation in litter size among the species, encompassing (if the blue-tongues and slender blue-tongues are treated as a single lineage) the entire range of variation in other skinks, and indeed in other lizards worldwide. Blue-tongues are viviparous; that is, they bear live young. Although there is some effect of maternal size on the number of young produced per litter, it does not explain all the variation. Shinglebacks have the smallest litters, between one and four young, but usually two, while a confirmed record of 53, and an unconfirmed record of 67, have been reported for the much smaller Pink-tongue. The Eastern Blue-tongue gives birth to 1–18 young, usually about 11, while other *Tiliqua* species lie between this species and the Shingleback in litter size. Inversely correlated with the number of young is the size of young at birth. Shinglebacks produce large young, while Pink-tongues produce small young. Despite this variation, the relative mass of the litter compared to the maternal mass is similar among blue-tongue species: about 35 per cent, a value similar to that found in other skinks.

There is no clear explanation for the variation in litter size within this small evolutionary lineage. One possibility is that large litters of small young reflect high mortality of offspring, while small litters of large young reflect high survivorship of offspring. Unfortunately, we have few data on mortality rates of young (or even adult) blue-tongues. A number of native and introduced birds and mammals have been recorded feeding on blue-tongues, including Wedge-

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Some blue-tongues, such as the Western Blue-tongue, have small litters of relatively large young.



PAVEL GERMAN

Although the colour pattern of the Blotched Blue-tongue is superficially different to other blue-tongues, the dark markings still align in transverse bands. The paler blotches are equivalent to the paler bands of other species, broken up by narrow dark stripes.

tailed Eagles (*Aquila audax*) and Brown Falcons (*Falco berigora*), large goannas, large venomous snakes, Black-headed Pythons (*Aspidites melanocephalus*), as well as introduced Cats and Dogs. Additionally, in modern times, road traffic, lawn mowers and snail baits add to mortality.

Despite this range of predators, and the number of dead blue-tongues seen on roads, numbers do not seem to be declining. However, observations on captive and semi-captive (backyard) individuals suggest that blue-tongues are potentially long-lived. There are several records of blue-tongues over 20 years old, and a few reliable records of life spans over 30 years. Even the smaller species have a long potential life span. Captive Sheoak Skinks (*Cyclodomorphus michaeli*) that I've kept in a terrarium at home have lived for over ten years—a remarkable feat for a skink with a snout–vent length less than 18 centimetres. However such a long life span can mask a declining population. Long-lived adults can survive in the absence of juvenile recruitment to the population, creating the impression of a healthy population. But when the adults finally die, populations can rapidly disappear.

Much of our knowledge of blue-tongue ecology is based on long-term studies by Mike Bull of Flinders University and his colleagues, mostly on the Shingleback, supplemented by numerous serendipitous observations published by amateur naturalists and reptile keepers on this and other species. Being large, slow-moving, common animals with complex colour patterns, blue-tongues are ideal subjects for ecological studies, as individuals are easy to identify, and transmitters or other tracing devices can be readily attached. (A transmitter attached to one of Mike's first radio-tracked animals created such local interest that the signal was tracked to a nearby hotel!) The Shingleback studies have revealed a complexity of social behaviour completely unexpected when the studies first commenced (see *Nature Aust.* Spring 1996). They showed that Shinglebacks exhibit long-term mate fidelity, with the same pairs reforming in successive years. Outside the breeding season, the pairs separate until the following year. Further, females are able to recognise their own young, at least for a short period after birth, but there is no evidence of any maternal behaviour.

Until there are comparable studies on the other blue-tongue species, it will remain uncertain as to whether these features are present throughout the genus, or are unique to the Shingleback. Such long-term studies on the biology of suburban blue-tongues, or those in bushland areas close to cities, would be easy and rewarding, and may help in conserving these prominent members of our urban wildlife. ■

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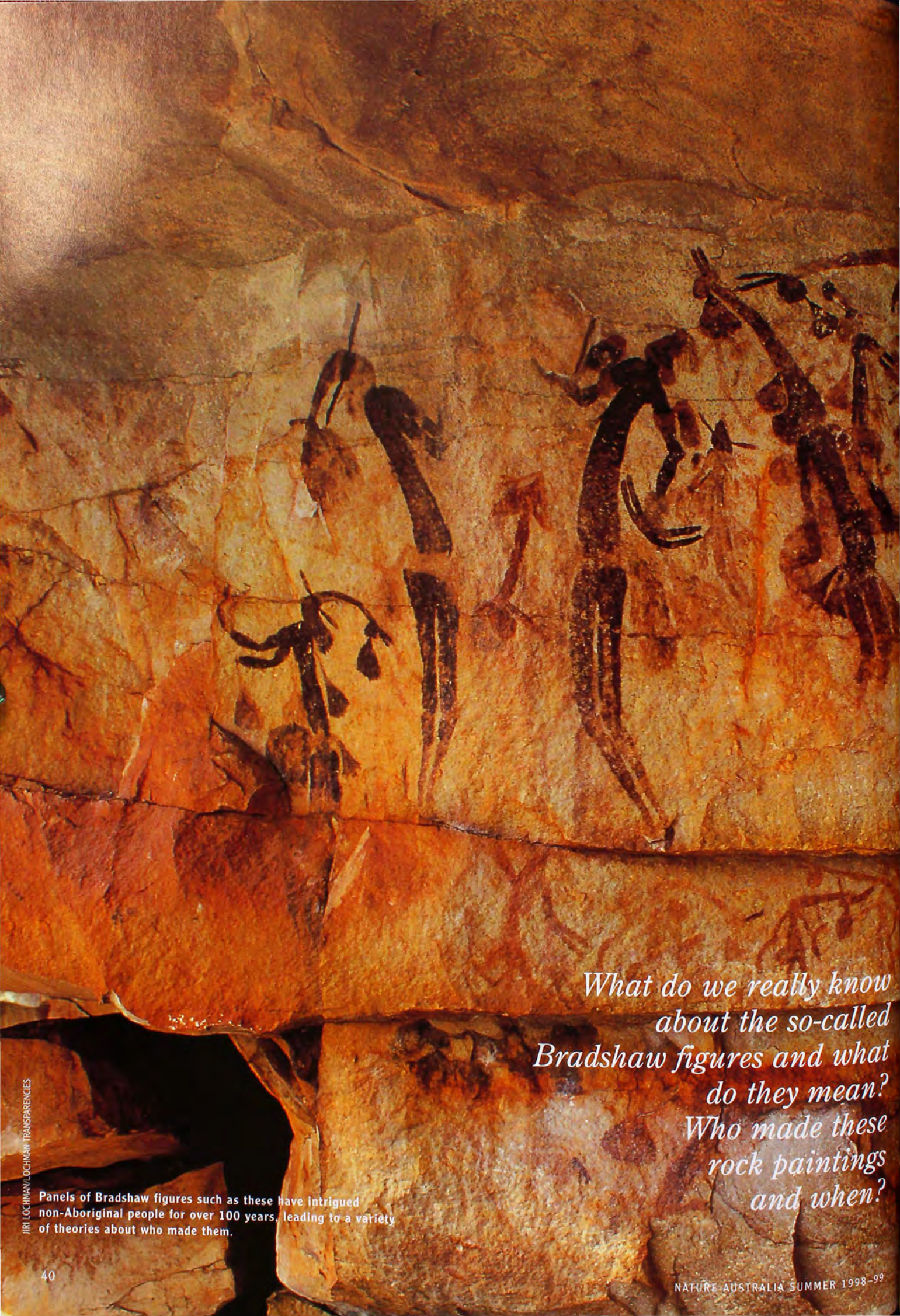
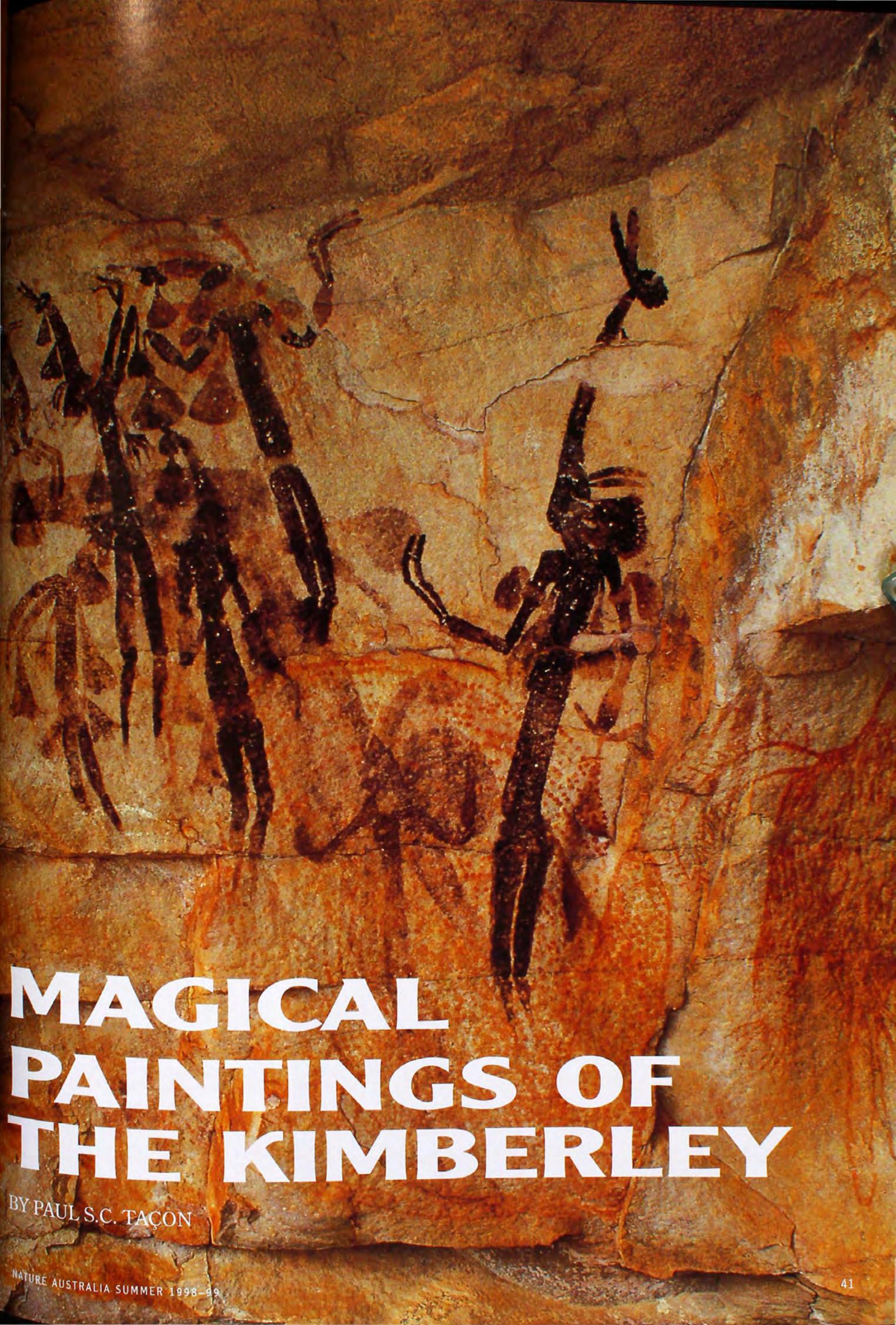
Dr Glenn Shea is a lecturer in the Faculty of Veterinary Science at the University of Sydney. His PhD was on systematics and reproduction of blue-tongue lizards, continuing an obsession that began in early childhood with his choice of pets.



What do we really know about the so-called Bradshaw figures and what do they mean? Who made these rock paintings and when?

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Panels of Bradshaw figures such as these have intrigued non-Aboriginal people for over 100 years, leading to a variety of theories about who made them.



MAGICAL PAINTINGS OF THE KIMBERLEY

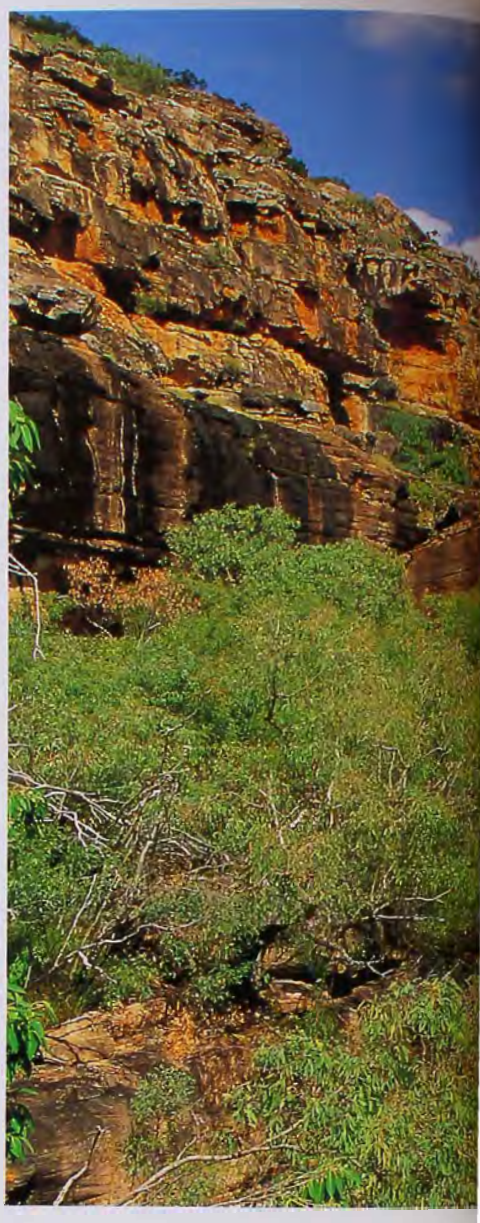
BY PAUL S.C. TAÇON

ONE OF THE MOST ENCHANTING forms of Australian rock art are the early 'Bradshaw' paintings found in rock shelters across the Kimberley region of Western Australia. With subtle grace and a refined elegance, these human figures seemingly float across rock shelter walls, rising above us, forcing our gaze upwards. A long-lost people, from another world, another time; they speak of a past that was different from the present yet one that still has relevance to us all. But although we may be able to connect with the power of their aesthetics—pleasing, curvaceous forms in tranquil poses that demand our attention—their symbolism and meaning are more difficult to grasp.

Many questions flood our minds as we step out from one of the hundreds of Kimberley rock shelters featuring these paintings, or as we read through the pages of one of the many books or articles devoted to the subject. For instance, what do we really know about the so-called Bradshaw figures and what do they mean? Who made these rock paintings and when? Are they still important for Indigenous people today? What relevance do they have in the modern world—a world thousands of years removed from the time of their creation? And will we ever crack the code that keeps us from their hidden meaning?

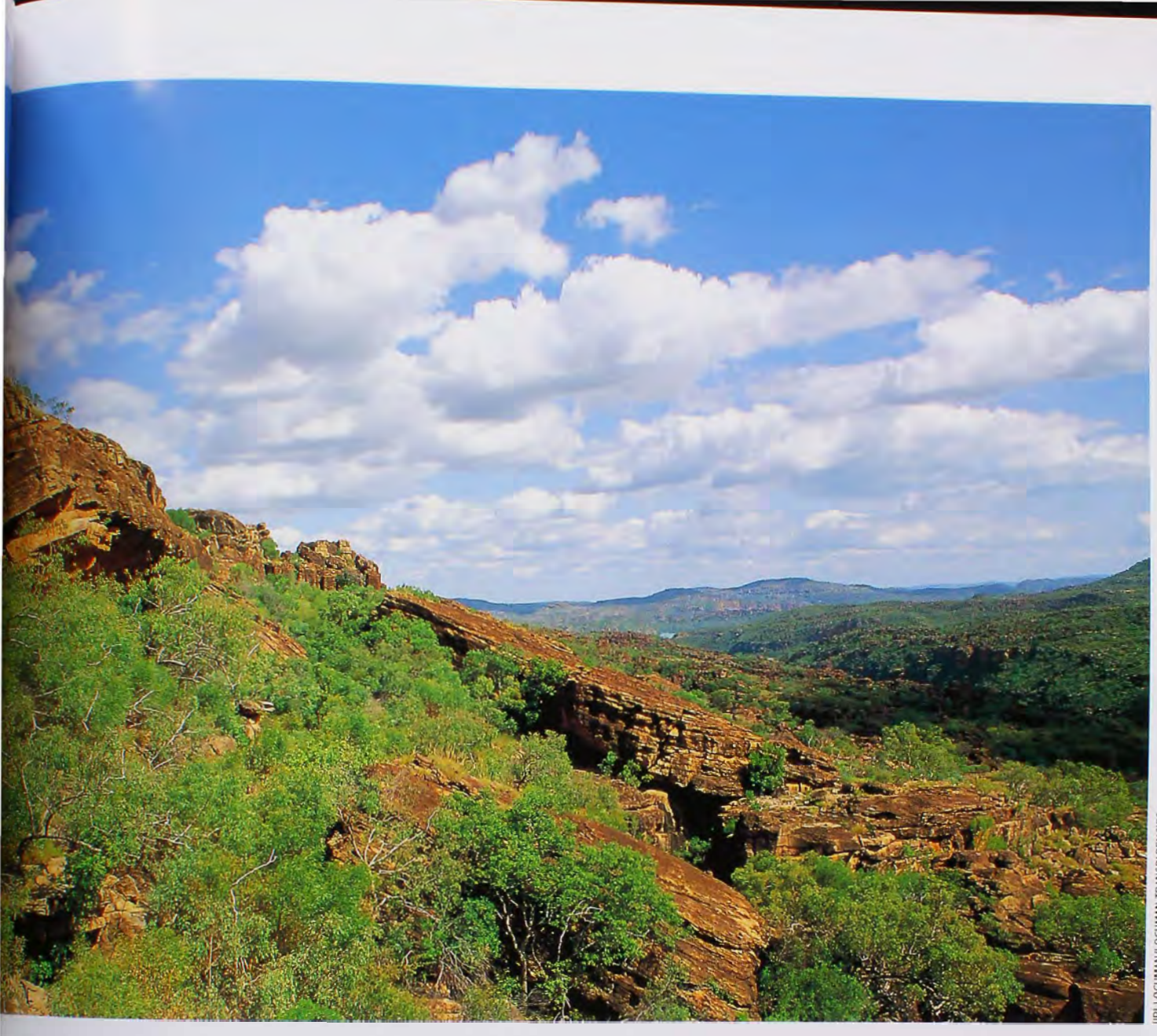
DAVID WELCH

This tasselled Bradshaw figure with a leaf or feather decoration poked into the upper arm bands is a good example of a painting depicting elaborate items of material culture that do not survive in archaeological deposits.



Cracking the code of meaning has long been the holy grail of rock art researchers. It is one of the big challenges that fuels debate, rivalling only the search for a precise age in terms of difficulty and importance. But any search for meaning always starts with good description—of form, style, subject matter, technique and so forth—along with the establishment of a relative chronology, or time chart, into which the rock art can be firmly placed. These provide the foundation and structure upon which a study of meaning must hinge. So, what are Bradshaw paintings and what do they look like?

CAPTAIN JOSEPH BRADSHAW, AFTER whom the paintings were named, was a pastoralist who visited the Kimberley region in the late 1800s and one of the first Europeans to take an interest in the area's rock art. He described the figures, noting their style and location. In particular, he remarked on their pronounced aquiline profiles, which were "quite different from those of any



JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Eroded escarpments and blocks of sandstone near the major river systems of the Kimberley are where many of the region's rock-art sites are found.

natives we encountered. Indeed, looking at some of the groups, one might almost think himself viewing the painted walls of an Egyptian temple."

Bradshaw human figures have muscular builds, prominent shoulders and curvaceous forms. Much care, dedication and skill would have been necessary to create such powerful, athletic, if not beautiful renditions of the human form. The figures are usually small, 30–50 centimetres long, but some reach life size. Commonly in rigid or static poses, they are a contrast to the comparable Dynamic (moving) figures of Arnhem Land, to the east. Sometimes the Bradshaws appear to float, glide, hover or fly—as if they are somehow suspended in air. Most are in a shade of red, often a deep mulberry colour, but others are white or yellow, in combination with red. Sometimes a possum-like animal is painted near the head of figures, as part of the picture.

Importantly, Bradshaw figures are invariably associated with material culture items—perishable objects that don't preserve well in the archaeological deposits of northern Australia. Boomerangs, barbed spears, armbands, belts, bags, strings, skirts, hats, headdresses, tasselled objects and other forms of elaborate body adornment are common. Much of the material culture appears to have ceremonial functions and most of the figures seem to be fully initiated males.

Because of where Bradshaw paintings lie in the sequence of overlapping styles, we know that they pre-date the much larger Wandjina Ancestral Beings and associated multi-coloured animal figures, but are younger than some other paintings and large panels of cupule (cup-shaped) engravings in the area. Although there is fairly broad agreement over the relative chronologies for Kimberley rock-art styles, their exact ages remain disputed. This is highlighted by the results of two new dating programs.

In the first study, conducted by renowned rock-art dating expert Alan Watchman (from James Cook University) and colleagues, chemical deposits containing oxalates, diatoms and algal remains were found overlying and within the Bradshaw paintings. Minute samples of these deposits were radiocarbon-dated, using an accelerator mass spectrometer (AMS), which counts the number of ^{14}C atoms present in the sample and estimates the time since death of the organic matter. The results give ages as early as 1,500 years and others exceeding 4,000 years, suggesting Bradshaw figures are not as old as some people think.

This is very different from the results of the second study, headed by Richard Roberts (La Trobe University). Roberts and his team used the recently developed 'optically stimulated luminescence' (OSL) technique to date the mud-wasp nests (from *Sceliphron* and *Abispa* spp.) that are sometimes found overlying and underlying the rock art. Optical dating provides a measure of time since quartz grains were last exposed to sunlight (see box). In mud-wasp nests quartz is hidden from light and accumulates radiation over time. It is this dose of radiation that is measured back in the lab. What Roberts and his team found is that one painted human figure, which

some people think may be a precursor of classic Bradshaw paintings, has a minimum age of 17,000, and possibly up to 25,000, years! Furthermore, they have backed up these old dates with an independent analysis of radium in the mud nest. The study, based on the rate of decay of radium, indicates the nest, and underlying painting, is at least 8,000 years old (the limit of the radium-based 'clock').

Because both studies are preliminary, and did not involve the same paintings, it is not surprising that the dates are very different. It will probably be some time before we have definitive results that establish exactly how old the various forms of human figure paintings are. All we can say for certain is that a lot more work needs to be done.

Knowing the precise age of the art would better enable us to determine who painted it—another area of great contention. For instance, writing in his journal in 1891, Captain Bradshaw boldly asserted "I do not attribute them to the presentations of the Black race", yet there is no evidence to suggest he ever discussed the matter with Aborigines.

Traditional Aborigines have always attributed these paintings to the old people or other beings (such as *Gwion Gwion*) who transformed in the Creation Period of the ancient past, and they regard the sites where the paintings are found as a valuable part of their heritage. Bradshaw figures may be very different from the more recent Wandjina paintings with which Kimberley Aboriginal people most readily identify, but prominent elders such as the late David Mowaljarlai and Paddy Neowarra contend Bradshaws still have much contemporary Indigenous importance. They argue few people took what they had to say about the art seriously, and that non-Aboriginal people have been bent upon emphasising a disconnection to the past rather than continuity and gradual change.

Captain Bradshaw began this process of disconnection in 1891, when he likened the paintings to Egyptian motifs. In the 1930s archaeologist Daniel S. Davidson further suggested a foreign influence in Bradshaw rock art, arguing that if they were not made by outsiders they must be Aboriginal depictions of foreign visitors. This has been repeated many times since, most prominently by televisions's "Bush Tucker Man", Les Hiddins, who has also explored the idea of other possible African connections. Some tourist operators incorporate these sorts of speculations into their commentaries, with suggestions of Egyptians, southern Africans or even Phoenicians washing up on the shores of the Kimberley coast, eager to paint their way across the land! Each year more and more bizarre theories sprout to explain the Kimberley region's enigmatic rock art with Eric Von Daniken, of "Chariots of the Gods" fame, even going so far as to ascribe an extraterrestrial influence to the Wandjina rock paintings! Most recently, rock-art researcher Grahame Walsh has argued Bradshaw paintings were made by an unknown race of people, very different from Australia's Indigenous groups. He even speculates they lived in towns, had light-coloured skin and were in no way related to the continent's Indigenous peoples because Bradshaw figures are for him far too elegant and refined to have been accomplished works of Aborigines. However, this view does not sit well with the dating results.

This idea is also at odds with other researchers who note strong connections with Arnhem Land and other parts of past and present northern Australia. For instance, Michael Barry just completed an Honours thesis at the University of Sydney that statistically supports

Classic Bradshaw figures often appear to be dancing, flying or floating, suggestive of ceremony or initiation.

GRAINS OF TRUTH?

The bedtime habits of 17th-century scientist Robert Boyle may well have raised the odd eyebrow among members of the Royal Society of London. He would snuggle up in bed with a diamond and bring it "to some king of Glimmering Light, by . . . holding it a good while upon a warm part of my Naked Body". This, it turns out, is the first recorded description of the phenomenon we now call 'luminescence'.

The emission of light, or luminescence, from a range of naturally occurring minerals (such as quartz, feldspar and zircon) has since been exploited as a method of dating the last time these minerals were heated to a red-hot temperature or exposed to sunlight. Throughout much of the world, luminescence methods have been used to date heated artefacts, such as pottery and prehistoric flint tools. It is also possible to work out how long artefacts have been buried by dating the dirt in which the artefacts were found. This is particularly useful in Australia because heated artefacts are rare.

The family of luminescence dating methods includes 'thermoluminescence' (TL) and 'optically stimulated luminescence' (OSL)—and, if Boyle's nocturnal activities seem bizarre, then he would surely be pleased to know that luminescence daters still do it in the dark! There are two good reasons for working in the dark. First, the light emitted by a mineral is usually far too faint to observe with the naked eye, but sensitive instruments (known as photomultipliers) can detect it in a darkened laboratory. Second, sunlight, and light from a lamp, will completely remove the luminescence dating signal from the mineral because the signal is very sensitive to light.

How does luminescence dating work? Think of sand grains resting on the ground surface. They get bathed in sunlight ('bleached') every day and become hidden from the sunlight only when they are buried under other grains. While exposed on the ground surface, the luminescence 'clock' remains fixed at time-zero, but the luminescence signal starts growing—that is, the clock starts ticking—once the grains are buried.

It is convenient to think of the luminescence signal as a form of stored energy. The grains receive this energy from the radioactive decay of chemical elements such as uranium and thorium, which are naturally present in very low concentrations in all soils and rock. Buried grains will store this energy in their crystal lattice and we can release, and measure, this energy in the laboratory. By knowing also the rate of energy supply from radioactive decay at each sampling point, we can then calculate the number of years that the grains have been buried.

To release the stored energy in the laboratory, we use heat (in TL dating) or light (in OSL dating). OSL dating is now the preferred method for dating the dirt surrounding buried artefacts because, if sunlight bleached the dating signal before the grains were buried, then the use of light in the laboratory will ensure that the same signal is measured. If heat is used, more energy would be released and, unless this extra energy is taken into account, the time since burial will be overestimated. But TL dating is still very useful for estimating the age of heated artefacts such as fired pottery and burnt stone tools. As these were heated in the past, it is appropriate to use heat to release the stored energy that has accumulated since the last heating event.

An exciting recent breakthrough made in OSL dating is our ability to date single grains of sand. This means that very small samples can now be dated, such as from mud-wasp nests found on top of, and sometimes under, Aboriginal rock art. Dating of individual grains also allows us to identify any 'rogue' grains that were not fully bleached before burial. These grains would still have had 'time on their clocks' and so would have been buried with an already appreciable 'built-in' age. This problem seems to have been responsible for the very old TL ages reported in 1996 for the archaeological site of Jinmium in the eastern Kimberley. By identifying only those grains that had been fully bleached before burial, OSL dating has since indicted that the age of Jinmium deposits are very much younger.

—Richard 'Bert' Roberts
Dept of Earth Sciences, La Trobe University

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

the proposition that Bradshaw paintings are most like the Dynamic figures of Arnhem Land and nothing at all like those of Africa, Asia, Europe or elsewhere. My own work in Arnhem Land, with Christopher Chippindale (Cambridge University) and others, has shown Dynamic figures date to the end of the Pleistocene (about 10,000 years ago) and that changes from the Dynamics to the very different recent X-ray paintings can easily be documented. Historian and archaeologist Darrell Lewis (North Australia Research Unit in Darwin) has remarked similarly on the relationship between the art of Arnhem Land and the Kimberley, contending for over a decade that the two were once part of a much larger cultural province that extended farther north, on what is now submerged land. And rock-art researcher David Welch has shown strong links between Bradshaw material culture and contemporary or historic items from the Kimberley, Arnhem Land and other parts of Australia. Indeed, he has documented a recent use of every type of artefact depicted in Bradshaw art, strongly suggesting the paintings reflect an Indigenous Australian way of life.

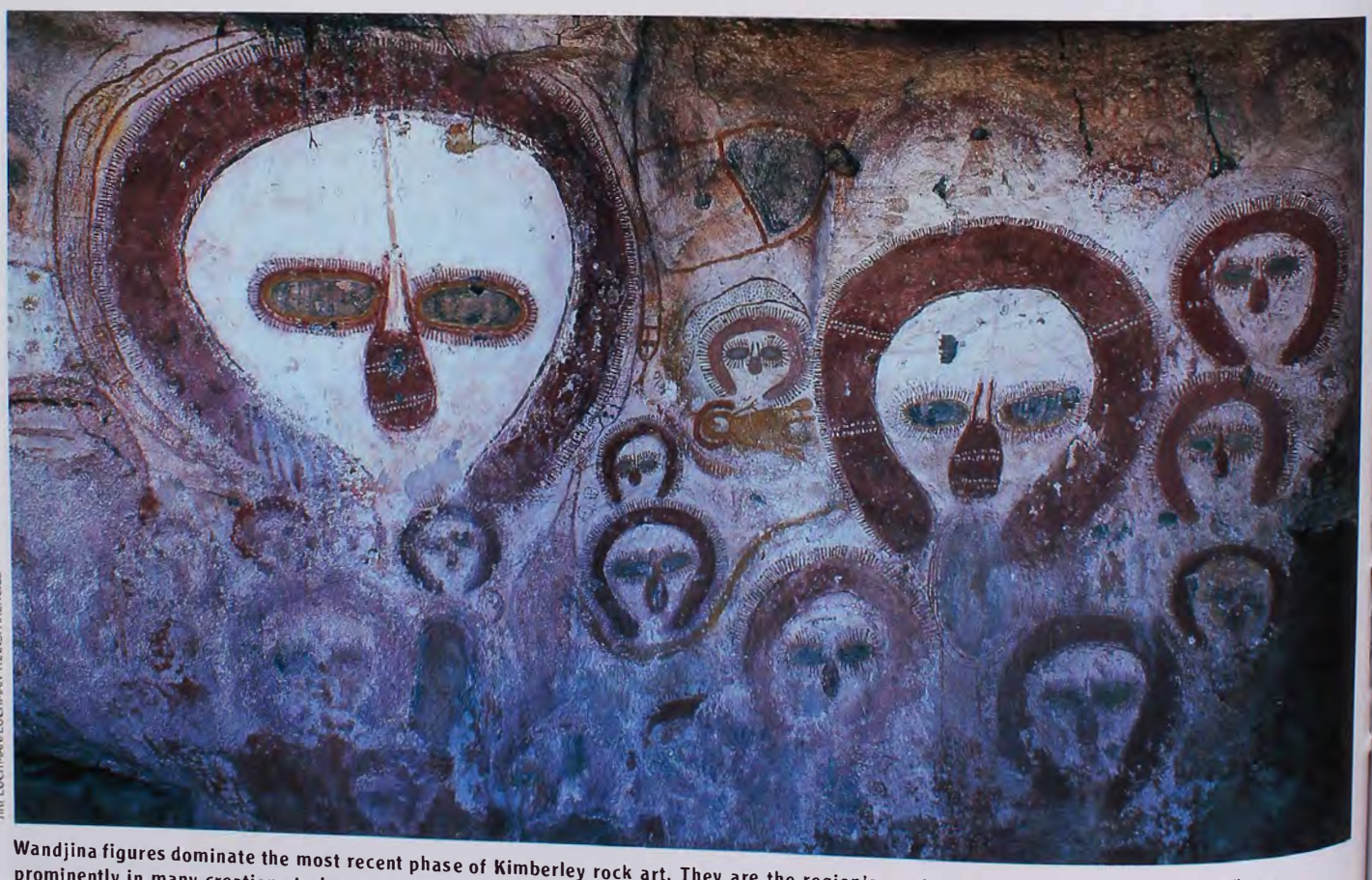
ALL IN ALL, CURRENT EVIDENCE SUGgests Bradshaw paintings were made by an Indigenous group of Australians, probably around the end of the Pleistocene, but possibly more recently. The people that made them had links with those of Arnhem Land but also differed from them. Contact may have taken the form of trade or travel, but a more likely scenario is that the two cultures once had common roots and were at one time part of a wide northern Australian cultural block of peoples, living similar ways of life in similar environments. At that time the climate was much drier and people would have ranged over wider distances to obtain the essentials of survival. It is also probable that many forms of art and ritual were practised by different members of the group—for instance, between the initiated and uninitiated, men and women, and so forth.

Among many groups of people, great art traditions associated with ritual and healing emerged during periods of profound stress.

The Bradshaw paintings—by virtue of their association with ceremonial attire, their focus on what appears to be initiated men, the floating/flying/hovering postures and what look like wing-like appendages on some of the figures—seem to have a very focused concern or meaning. I believe this had to do with medicine men, male initiations, healing, and other aspects of northern Australian religion. It also had to do with communicating Aboriginal 'Dreamtime' law and ritual. Finally, it is suggestive of the sort of art that often emerges in times of great environmental or socio-cultural change and stress.

For instance, among many groups of people, from the prehistoric Dorset Eskimo and Iroquoian First Peoples of North America to the San of southern Africa or the Europeans of the Middle Ages, great art traditions associated with ritual and healing emerged during periods of profound stress. The heightened production and use of symbolically meaningful material culture by these groups helped them to express and cope with the overwhelming threats and changes to their societies. The Bradshaw artists were likely engaging in similar behaviour during a period of intense change that eventually led to a very different art system with the Wandjinas dominating.

If nothing else, the Bradshaw paintings remind us of the therapeutic value of expressing oneself, both individually and culturally, in creative new ways during disturbing times. For this is one of the fundamental ways in which humans deal with confrontation positively; a survival mechanism that has differentiated us from other species for at least 50,000 years. ■



JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

Wandjina figures dominate the most recent phase of Kimberley rock art. They are the region's most powerful Ancestral Beings and figure prominently in many creation stories.

DAVID WELCH

This large panel of bent-knee Bradshaw figures may illustrate some form of ceremonial gathering.

Further Reading

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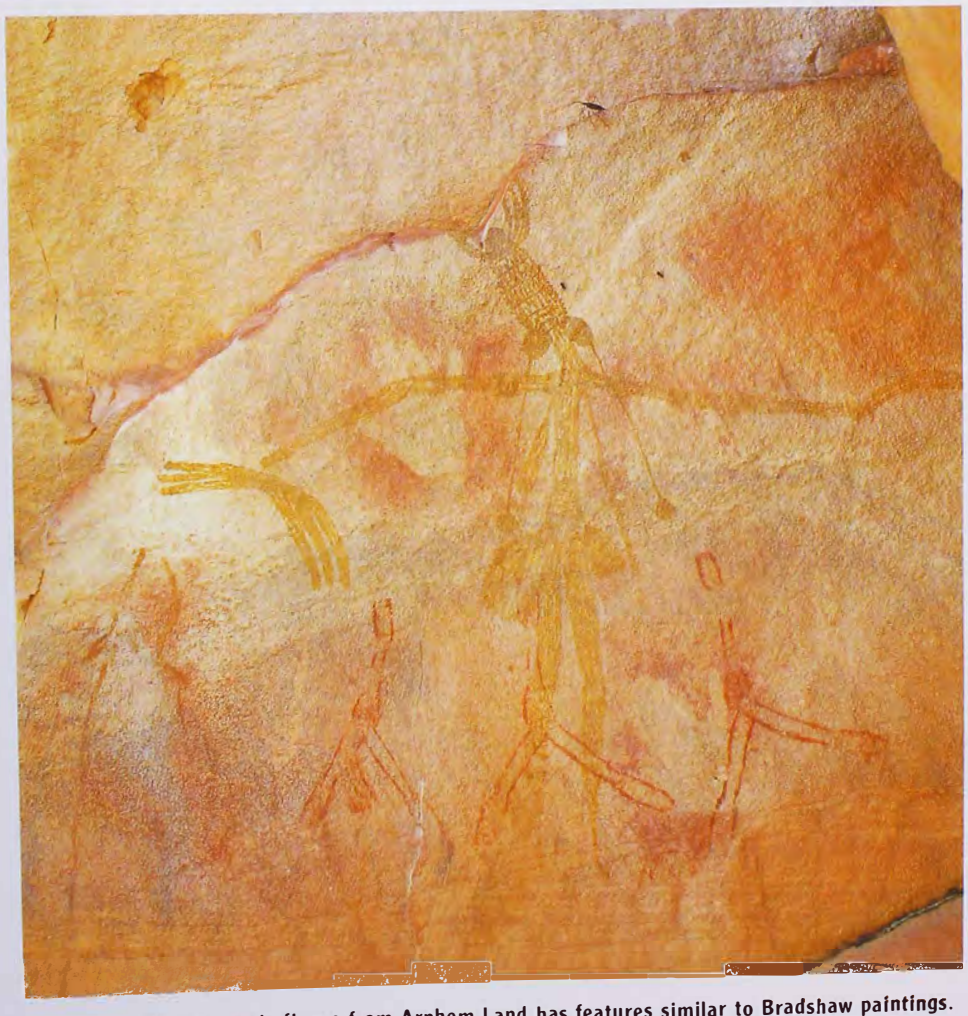


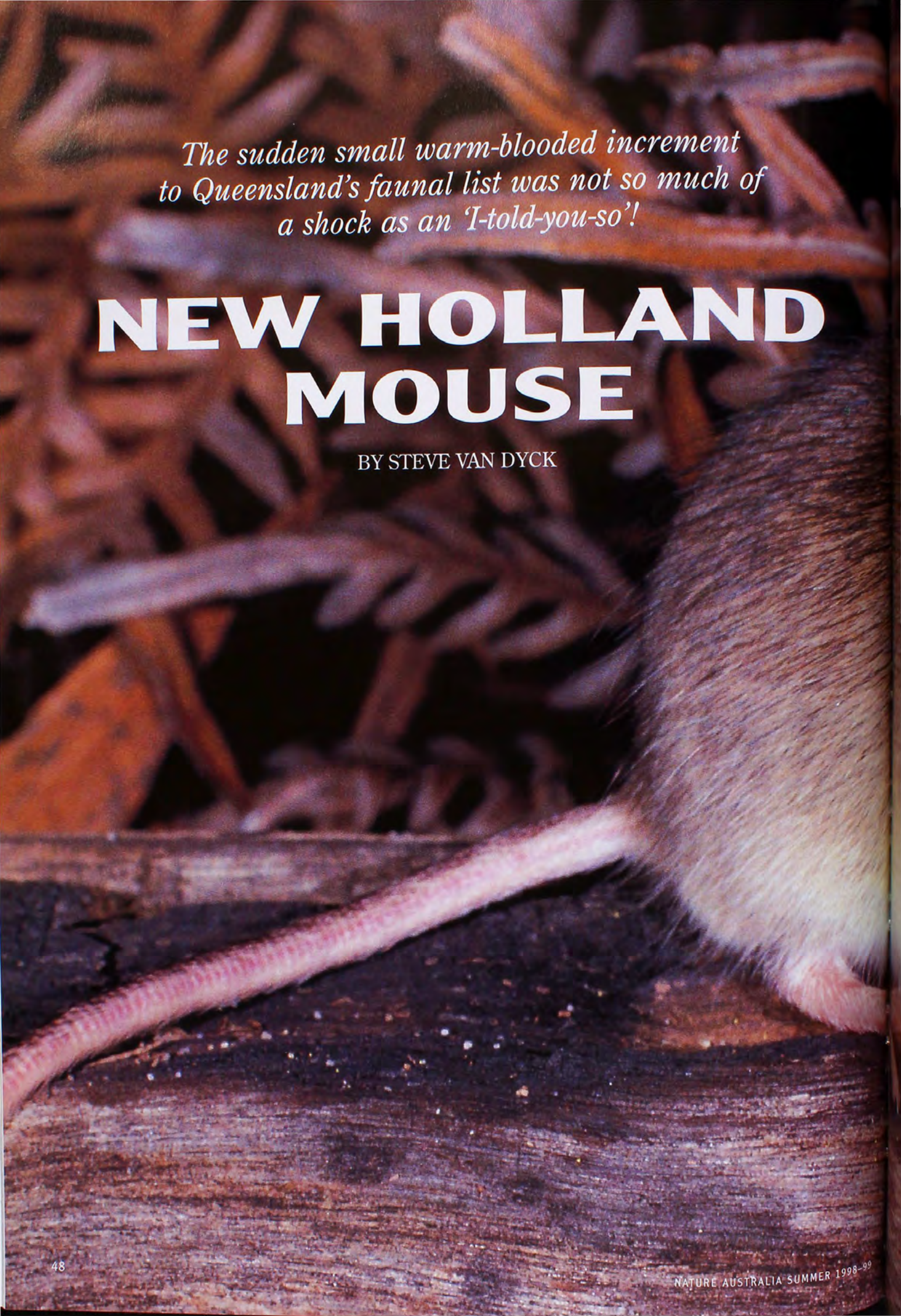
PAUL S.C. TAÇON

This rare yellow Dynamic figure from Arnhem Land has features similar to Bradshaw paintings. Recent work has shown Dynamic figures to be the Bradshaws' closest 'cousins'.

The sudden small warm-blooded increment to Queensland's faunal list was not so much of a shock as an 'I-told-you-so'!

NEW HOLLAND MOUSE

BY STEVE VAN DYCK



Of all the Australian native mice, few share such a strong superficial resemblance to the introduced House Mouse as the New Holland Mouse (shown here). How many New Hollands have escaped detection through confusion with their bad-smelling distant cousins?

DICK WHITFORD/NATURE FOCUS

IT IS HARD NOT TO CRACK A WRY SMILE at the sense of double-dutch in the recent discovery of the New Holland Mouse (*Pseudomys novaehollandiae*) in Queensland. The Sunshine State, that rich northern smelting pot of biodiversity, has a depressing history of environmental sensitivity that smoulders among more pressing jobs like brigalow clearing, cave blasting, whale harpooning, mangrove reclaiming and overstocking. The New Holland Mouse brings with it an ironic, back-slapping addition to the biodiversity of the State that, in one hand, holds a very dead Paradise Parrot (the mainland's only bird extinction), in the other hand a very dead Retro Slider (the nation's first reptile extinction), while juggling in between all sorts of management headaches like Dugongs, Mahogany Gliders, Gouldian Finches, Boggomoss Snails and Flightless Dung Beetles.

Just over 30 years ago the New Holland Mouse, a tiny 14-gram native rodent that ill-fatedly resembles a House Mouse (but without the stench), was believed extinct or extremely rare in Australia. At that time, given its remarkably obscure status since its description in 1843, few would have given a rat's hat. Mammalogy was a sunrise industry then. The Australian Mammal Society numbered around 50 (its membership now stands at over 500), and Australian rodent specialists numbered less than a Numbat's stripes.

However, in December 1967 and February 1968, amid a resurrection saga the likes of which every discovery-junkie dreams, the elusive little New Holland Mouse, known from three museum specimens all collected before 1856, was found alive at two localities, Ku-ring-gai Chase National Park and Port Stephens, both in central coastal New South Wales. In a tumbling dominoes effect, it was recorded three years later from Victoria and in 1975 it was discovered in Tasmania. Since then it has turned up in widely scattered east-coastal localities between Evans Head in northern New South Wales, and Friendly Beaches in Tasmania. In Victoria the species is now the object of considerable conservation concern and is listed as endangered.

Almost every time a New Holland Mouse has cropped up in a new locality, current opinion as to what constitutes its preferred habitat has had to be revised. In New South Wales and Victoria it has now been recorded in the literature from densely shrubbed dry sclerophyll forest on sand dunes, from around the sedgy edges of freshwater swamps between dunes, and from coastal heaths, particularly those regenerating after sandmining. In Tasmania it has been found in the woodland/heath mosaics of the coastal north-east. In general, New Holland Mice have nearly always been associated with a coastal (low-altitude) location on sandy soil with a dense understorey. And most New Holland Mouse experts agree that early successional vegetation (three to four years after a major disturbance like fire or sandmining) is terribly important for this species.

But both its recent discovery in Queensland, and unpublished trapping records from northern New South Wales, suggest that the habitat prescription usually associated with the New Holland Mouse either needs further modification or, worse yet, that the animals we have been calling 'New Holland Mice' are really elements of a species complex of genetically (but not morphologically) distinct forms (in other words, a taxonomic mega-toothache).

THE SUDDEN APPEARANCE OF THE NEW Holland Mouse in Queensland occurred unassumingly in August 1996 at Bruce Lawrie's farm house next door to the Crows Nest cemetery. This particular Crows Nest (not the Sydney suburb) is 100 kilometres north-west of Brisbane, on the eastern edge of the Great Dividing Range. Both the cemetery and Bruce's house are tucked into the side of a hill known locally as 'Dingo Mountain', overlooking the lovely country town whose clean mountain air can reach flashpoint in summer and go brass monkey six months on.

One night Bruce put some traps out the back to prove to some of the locals that the currently plaguing 'field' mice were nothing more than smelly House Mice (*Mus musculus*). Twenty-six years of fauna surveying, land-use planning and off-park nature conservation with the Queensland Department of Environment had matured in him a certain resistance toward new-wave designer baits (like pistachio essence) and, preferring to stick with the tried and true, he baited 12 small Elliott mammal traps with bread and jam, and set them in the tall open forest behind the chook sheds.

Next morning the traps held three House Mice and two unfamiliar rodents suspected by Bruce to be native Delicate Mice (*Pseudomys delicatulus*). He couriered one of these odd bods, a 12-gram male, live in a Milo tin to me at the Queensland Museum and the other he released at the capture site. In assigning an identity to this specimen, I drew on the experience of at least eight years of "Sesame Street" re-runs to conclude that

COURTESY BARBARA WILSON

Barbara Wilson (Deakin University) applies a little rouge to the cheeks of a New Holland Mouse before its big night on the town. A few back-flips in a bag of fluro-powder and everything the mouse touches on its way home will light up.

COURTESY BARBARA WILSON

Under UV light, the tell-tale trail of a fluro-charged New Holland Mouse is as plain to see as a red carpet laid out for its arrival home. Researchers can find nesting burrows and see the extent of nocturnal wanderings using this harmless method.

there was a strong resemblance between Sesame's Gonzo and the Crows Nest mouse that was not seen in either the Delicate Mouse, or any others I knew about. The 'Gonzo Syndrome' is a darkening behind the nose that gives the snout a more elongate, weasel-like appearance on an otherwise very domestic-looking mouse. The Crows Nest specimen was compared with specimens of New Holland Mice from Victoria and New South Wales, and with type material of another look-alike, the Pilliga Mouse (*P. pilligaensis*) from northern New South Wales. Samples of its hair were sent off for analysis and photos of the living animal posted to southern specialists for their opinions. Eventually it was decided that the affinities of the Crows Nest specimen lay most comfortably with the New Holland Mouse.

The sudden small warm-blooded increment to Queensland's faunal list was not so much of a shock as an 'I-told-you-so', because a niggling suspicion that living New Holland Mice might also occur in Queensland had been aroused in 1993 by student Veronica Hinman. Then a fresh science graduate from the University of Queensland, she had won a Queensland Museum Student's Summer Scholarship to analyse, in this case, regurgitated owl pellets stored in the Museum's mammal collection. (Owls spit up a slippery ball of fur and bones not long after swallowing their dinner.

BRUCE COWELL/QUEENSLAND MUSEUM

Fresh from its Milo tin and still with bread and jam on its breath, this is the 12-gram male New Holland Mouse couriered from Crows Nest to the Queensland Museum by Bruce Lawrie.

The bony contents of the balls can tell a revealing story about the small fauna brought up in the surrounding countryside.) Among everything else, she encountered some bits of tiny mouse skulls and lower jaws that did not fit any of the taxa currently known from Queensland, and she astutely attributed these remains to the New Holland Mouse. They had come from pellets hurled up at three localities—a cave near Gatton, a rocky overhang at Cania Gorge near Monto, and a steep gorge inside Crows Nest National Park!

Seeking safety in a number of opinions, we sought confirmation of the identity of the Gatton and Cania Gorge fragments from Alexander Baynes of the Western Australian Museum. Alex, who has more experience identifying microscopic chips of Australian native rodent bone than probably anyone else in the world, attributed the nine Cania Gorge jaws to a then-unknown pebble-mound mouse (now known to be the recently rediscovered *Pseudomys patrius*; see

G.A. & M.M. HOYE/NATURE FOCUS

NEW HOLLAND MOUSE
Pseudomys novaehollandiae

Classification
Order Rodentia, family Muridae.

Identification
Greyish brown dorsally with an off-white belly, darker fur behind the nose; head–body length 60–88 mm; tail about 85 mm. Distinguished from House Mouse by a lack of notch behind the cutting edge of the two upper front teeth (incisors). Its tail (brown above and off-white below) is longer than a House Mouse's by 10–15%. It lacks the characteristic House Mouse stink, and will not be found in packets of Corn Flakes.

Distribution and Habitat
From south-east Qld to Tas. usually in thickly shrubbed dry sclerophyll forest (often on soft or sandy soil), edges of freshwater swamps between dunes, and coastal heaths (particularly those regenerating after sandmining or fire).

Behaviour
Usually nocturnal, nesting in burrows up to 5 m long. Becomes sexually mature at 7 weeks, 2–6 young per litter; gestation period 32 days; up to 4 litters per year by 2nd-year females. Life span up to 2 years.

Diet
Omnivorous (seed, insects, vegetation and fungi all in season).

Nature Aust. Spring 1997). But he was reluctant to assign an identity to the bit from the Gatton individual, its broad, more rounded molars and the unusual arrangement of its cusps being unlike his comparative material of New Holland Mice from New South Wales. Given this finding we temporarily shelved the more incomplete Crows Nest National Park fragments and moved on to more important matters.

Not long after that, some very mature specimens arrived on loan from the Museum of Victoria that suggested to me that the Gatton specimen was, after all, attributable to a large, old individual of *P. novaehollandiae*, and reappraisal of the other shelved fragments confirmed Veronica Hinman's original assessment that New Holland Mice occurred at Crows Nest.

The Gatton and Crows Nest National Park sites are about 65 kilometres south and five kilometres east, respectively, of Bruce Lawrie's capture site where, despite over 1,000 trap-nights since his discovery, we have been unsuccessful in locating any more living New Holland Mice. At Gatton, however, an unbelievable coincidence occurred.

ELEVEN MONTHS AFTER BRUCE LAWRIE'S chance capture at Crows Nest, Peter Lehman from the Queensland Department of Environment put out 25 traps in the cattle-hammered Blue Gum–Blady Grass pasture alongside a road at Glen Rock, about 40 kilometres south-east of the site where the bone material that Veronica Hinman had identified as New Holland Mouse in 1993 had originated. Peter was initiating 12 Commonwealth Youth Training Scheme participants into the frustrations of fauna surveying and, after three days of it, with one House Mouse to its capture credits, the group was pulling up the trap line. With the surprise announcement that some Johnny-come-lately mouse had sneaked into one of their traps during the day, Peter thought he was going to be able to double his embarrassment by adding another House Mouse to the list of captures. However, something unusual about the shape of the rodent made him feel he may have turned up one of the New Holland Mice he'd heard so much about. He was right. We now had living confirmation of the New Holland Mouse from both of the owl pellet sites.

Something was wrong however. The Crows Nest and Glen Rock sites from which the live specimens had come seemed just too atypical for your normal garden variety *P. novaehollandiae*. Both were relatively high (at altitudes around 565 metres), both were a good distance from the coast, both almost totally lacked a dense shrub layer, and the Crows Nest site had not been fired for around 30 years. Both collection sites seemed as far removed from the optimum habitat proposed in 1974 (coastal heath, actively regenerating from fire) as they were from those lowland, densely shrubbed, sandy habitats occupied in Victoria and New South Wales.

However, a check of the literature showed that the distance from Crows Nest and Gatton to the coast (around 100 kilometres) is actually exceeded by the distance (166 kilometres) from the coast to "Yarrandi" (near Scone, New South Wales), where the first specimens were collected in 1843. Nearby collection sites at "Belltrees" and farther east at Barrington Tops are additional examples of New Holland Mouse habitat situated far from the coast. Furthermore, examination of unpublished reports and relatively recent trapping records from Marengo, Carai and Chaelundi State Forests, Oxley Wild Rivers National Parks, Timbarra Plateau and Lindesay View suggest that, around the northern limits of its range, high altitude and low longitude are regularly encountered features of the New Holland Mouse profile.

But the lack of a dense understorey at both Queensland sites is more difficult to interpret. In 1981 Barry Fox (University of New South Wales) and George McKay (Macquarie University) suggested that the habitat requirements of New Holland Mice are most likely contained completely within the shrub layer of heath-type species and that the presence or absence of trees is unimportant.

More recently Barry Fox described the New Holland Mouse as a species selecting bare ground and vegetation open to a height of 20 centimetres (typical of the early stages after fire). But he showed that, although in open forest its maximum abundance occurs around 1.5 years after burning (followed by decreased abundance), it re-peaks about 16 years after the initial burn, by which time the understorey is open to around two metres above the ground. In heath, similar peaks occur at three and 13 years following fire.

The occurrence of the New Holland Mouse near Evans Head on the far northern New South Wales coast suggests that, in the north at least, habitat selection is much broader than previously ascribed to the species. Indeed, there seems little reason to doubt that it should also occur in coastal Queensland. Habitat resembling that used by the New Holland Mouse in Victoria and New South Wales would appear to occur in coastal and offshore south-eastern Queensland heaths and sedged dunes, particularly in localities such as Coolangatta, North and South Stradbroke Islands, Moreton Island and the Great Sandy Region. Some of us will be keeping a much closer eye on what the Cat drags in from these localities in the future.

The niggling question of whether we are dealing with one widely distributed species selecting a broad range of habitat types, or whether we are mistaken in calling this mouse 'New Holland' throughout that wide distribution, will probably eventually be solved by biochemists. The task for them will pivot on obtaining tissue from animals caught as close as possible to "Yarrandi" where the original specimens were captured. These mice, by taxonomic convention, form the benchmark against which the taxonomic status of all others must be assessed. There is always a possibility that the newly discovered Queensland mice are biochemically distinct and might not qualify for recognition under the name 'New Holland' . . . but then again the chilling possibility exists that those from coastal New South Wales and Victoria mightn't either! ■

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BRUCE COWELL/QUEENSLAND MUSEUM

'Dingo Mountain', Crows Nest. This is the spot where Bruce Lawrie captured Queensland's first live New Holland Mice . . . literally a stones throw from his back door.

How could all these extraordinary features have come together to make a viable species?

KAKAPO: THE PARADOXICAL PARROT

BY STEVE TREWICK

AMONG BIRDS, THE PARROTS ARE A GROUP that few people would fail to recognise. The hooked beak, clasping foot and intelligent eye, coupled with a well-developed and sometimes destructive curiosity, distinguish members of the group. All these attributes are expressed in New Zealand's Kakapo (*Strigops habroptilus*), yet there is much about this bird that renders it utterly distinct from other parrots and, in fact, any other bird. The extreme rarity of the Kakapo does nothing to ease the task of interpreting its nature and this is unfortunate as it is our lack of knowledge that has impeded conservation efforts. Even after differentiating between the bird's inherited and unique characteristics, the Kakapo remains a paradox.

ROD MORRIS

The face of a Kakapo is quite different from that of other parrots. A disk of fine pale feathers around the eyes gives the bird an owl-like appearance and this, combined with the nocturnal habit and seemingly thoughtful countenance that Kakapo often adopt, led to the use of the name 'owl-parrot' by early biologists. The generic classification, *Strigops*, reflects this.

The Maori name Kakapo means night parrot (*po* = night; *kaka* = the name of the common New Zealand parrot). Although unusual, the Kakapo is not the only nocturnal parrot. Australia's aptly named Night Parrot (*Pezoporus occidentalis*) and its near relative the Ground Parrot (*P. wallicus*) are also largely nocturnal. Because of this and similarities in plumage, these parrots would appear to be closely related to the Kakapo. However, genetic studies have shown that the Australian and New Zealand species are very different and have closer relatives in their own countries. The morphological and behavioural similarities are instead the result of evolutionary convergence for similar reasons such as camouflage.

The most extraordinary behavioural characteristic of Kakapo is that they do not fly. Although well feathered, the wings of Kakapo are relatively small and the keel of the breastbone to which wing muscles would normally attach is tiny.

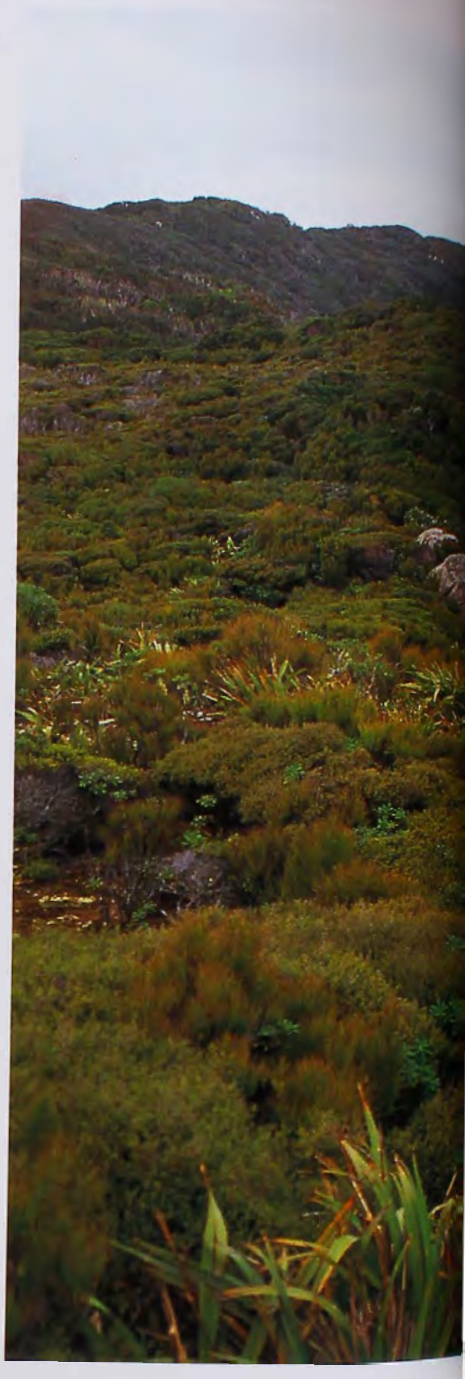
The Kakapo is the only known flightless parrot and ranks with the Dodo as an oddity in this respect.

The Kakapo is the only known flightless parrot and ranks with the Dodo (an anomalous pigeon) as an oddity in this respect. As with the Dodo and other birds that have evolved flightlessness on islands, Kakapo are large and heavy compared with their flying relatives. The Kakapo, in fact, ranks as the world's heaviest parrot, with males typically weighing 2–3.5 kilograms. By comparison the Sulphur-crested Cockatoo (*Cacatua galerita*), which is one of the larger flying parrots, has a maximum weight of less than a kilogram.

Gigantism in birds is often associated with herbivory, perhaps because a low-quality plant diet requires the consumption of large volumes of food; and here again the Kakapo is unusual. Although parrots are predominantly vegetarian, many if not all species other than Kakapo also eat animals (usually invertebrates). However, field observations and microscopic examination of droppings have shown that Kakapo are strict herbivores even as chicks, a time when many otherwise herbivorous birds utilise animal protein in their diet.

As some compensation for this dietary restriction, Kakapo forage in a wide range of vegetation both on the ground and in trees, which they climb proficiently using their beak and zygodactylous feet (two toes forward and two back). They feed on a diversity of plant species and plant structures, depending on the availability and nutrient quality, and use a specialised ridged palate to help grind food. In some instances Kakapo will feed on tough leaves, swallowing only the soft tissue and soluble component and leaving characteristic fibrous 'chews' hanging on the plant. At other times they will carefully bite out only the softest parts of leaves, avoiding hard midribs and stems altogether. Fruits, roots and the seeds of grasses are also eaten when available.

As a flightless and strictly herbivorous parrot, the Kakapo is wholly dependent



KAKAPO

Strigops habroptilus

Classification
Order Psittaciformes, family Psittacidae.

Identification
Very large, mottled green parrot. Length 63 cm. Weight about 2 kg for males, 1–2 kg for females.

Distribution
Endemic to NZ. Once present throughout scrub and forested areas and hilltops of North, South and Stewart Islands. Today, all surviving individuals are translocated to predator-free islands including Little Barrier, Codfish and Maud. No natural populations known to remain.

Behaviour
Nocturnal, flightless and cryptic. Solitary except for mating; large home range. A strict herbivore feeding on leaves, fruits and roots of many plants. Forages on ground and in trees using feet to hold food and beak to assist climbing. Typically leaves distinctive 'chews' on or near fibrous plants. Usually silent but may emit various squeals and screeches. Males produce low-frequency 'booming' and 'ching' calls when breeding. Roost by day in natural cavities often beneath tree roots, in hollow logs, or in dense foliage.

Reproduction
The only lek-breeding parrot. Breeding attempts coincide with abundant fruiting of native plants. Males aggregate at night on 'track-and-bowl' sites and use 'booming' vocalisation to attract females. After mating all nesting and rearing undertaken by female, a period of up to 8 months. Nests built in burrow as with roosts; 2–4 eggs laid. Adult sex ratio significantly skewed to males.

Status
Endangered. Total 1997–98 population 54 (20 females, 34 males).

DON MERTON

Most of the habitat in which Kakapo have been found this century is mixed shrubby vegetation in southern New Zealand. Early observations and evidence from recent fossil bones indicate a widespread use of forests in the past.

on nutrient-rich fruits and seeds to feed the chicks. However, many of New Zealand's grasses and trees do not produce abundant fruit crops throughout Kakapo habitat every year. In some years and places there will be almost no fruit and in others there will be a glut. The frequency of these fruiting or 'masting' events varies from every second to fifth year. It has long been known that Kakapo attempt to breed only in years of fruit abundance. This synchronism exists despite the fact that mating and egg-laying has to take place before the fruit arrives. How the parrots know when it's going to be a good year is unclear.

Unlike all other parrots, which are monogamous, Kakapo are 'lek' breeders. In this system males advertise themselves, and females choose the best mates. Males, however, take no further role in producing offspring.

At the start of breeding, male Kakapo construct special arenas on hill tops and ridges by clearing vegetation from small patches of ground, often near a rock or tree stump, and along paths in between. These are known as track-and-bowl systems and the males perform in the bowls during the night. The display consists of a series of low-frequency vocalisations called 'booming'. Male Kakapo have a special air chamber in their chest that helps resonate the sounds they make and, in combination with the acoustic properties of the bowls, allows them to be heard up to a kilometre away. Females, attracted by the noise, visit the leks and select a male to mate with. It appears that it is the largest males that are generally chosen. Copulation takes place in one of the bowls and soon after the female returns to her own home range in the forest. Here she builds a nest, lays two to four eggs and raises her chicks alone. Meanwhile, the males carry on booming every night for several months in the hope of securing further matings, although most will achieve no matings at all.

ROD MORRIS

Male Kakapo construct display arenas by clearing vegetation from the ground. A series of hollows (bowls) are interconnected by tracks. Bowls are usually positioned beside a suitable acoustic reflector such as a log, boulder or in this case a small vegetated bank.

WHY LEKKING BEHAVIOUR HAS evolved in the Kakapo and other species is an active area of research. One feature that is common to many different lekking species is an inability of males or pairs to control an important resource. Commonly this resource is food, and if the availability of preferred foods is not predictable (either in space or time), then defending territories becomes pointless and the mutual benefits of monogamy break down as males and females try to get the best deal for themselves. In all mating systems males and females try to maximise the number of offspring that carry their respective genes into the next generation. In many birds and other animals, the male contribution to reproduction can be very small. Once fertilised, a female is left holding the eggs but a male has the opportunity to fertilise the eggs of other females, thereby increasing the number of offspring carrying his genes. However, selection will operate against this tendency in situations where both parents are required to successfully rear a single clutch. The breeding system that arises in any given situation therefore results from a process of evolutionary optimisation, although it often appears that some individuals or one sex get(s) a raw deal.

The Kakapo is especially interesting from this point of view. Even in the years of fruit abundance when breeding is initiated, females barely manage to rear young on their own. Of the breeding events that we have observed, female Kakapo have generally failed to fledge chicks or have struggled to rear even a single offspring. This is despite the strenuous efforts of the New Zealand Department of Conservation (providing supplementary feed) and the female Kakapo which work throughout the night and even into the day to feed the chicks. Females will spend three months provisioning chicks in the nest, literally running between food sources and the nest. During this time chicks normally end up being heavier than their mother was at the start of breeding, while the female's own weight drops by as much as 80 per cent. This contrast was documented by New Zealand's pioneer Kakapo conservationist, Richard Henry, at the turn of the century: "... the mother's feathers are draggled and worn, and I have often wondered how she could tramp away and carry home sufficient food to keep two or three young ones like balls of fat. The males are also very fat, while the mother is like skin-and-bone . . .".

When lekking, male Kakapo will fight (sometimes to the death) for track-and-bowl sites and thus benefit from being big, strong and aggressive.

The differences in activities of males and females may explain a further peculiarity of Kakapo—that of sexual dimorphism. In most parrot species, the sexes are very similar in size but in Kakapo, the male is significantly bigger and typically weighs 2–3.5 kilograms to the female's 1–2 kilograms.

When lekking, male Kakapo will fight (sometimes to the death) for track-and-bowl sites and thus benefit from being big, strong and aggressive. Females seem to prefer the biggest males as mates but different selection pressures are operating on themselves. Whereas large male size seems to have been fashioned mainly by sexual selection, females have apparently been honed by

DON MERTON

In addition to calling from their track-and-bowl arenas, male Kakapo perform a display dance. Although the display has never been observed in the presence of a female Kakapo, this dance presumably acts as a visual stimulus to prospective mates attracted by calling.

natural selection. With the sole responsibility for rearing chicks, female Kakapo have to be exceptionally good at supplying plenty of high-quality food. Being smaller and having a relatively large wing area for their body weight may enable females to forage more quickly, higher up fruiting trees and even to leap or parachute from one tree to another or to the ground. This latter behaviour has been observed in the wild, even though nocturnal activity and rarity reduce the likelihood of such sightings.

Accompanying sexual dimorphism in Kakapo is yet another peculiarity. Instead of the normal one-to-one sex ratio present in most birds, Kakapo have more than twice as many males. This was initially assumed to be an artefact associated with human-induced changes in the environment. In particular, it was thought that predation by introduced Cats, Pigs and Stoats might

ROD MORRIS

Male Kakapo expand an air chamber in their chest to produce their low-frequency 'booming' call. Booms can be heard for up to one kilometre away but are not directional. A higher frequency, and thus directional, 'ching' call is produced intermittently, and this may help females locate individual males at close quarters.

ROD MORRIS

Kakapo are usually solitary but occupy large overlapping home ranges. Without the stress of breeding they have little trouble maintaining themselves on a diverse vegetarian diet. Their tails, however, are often bedraggled from contact with the ground and use of the thickly quilled feathers as additional support when climbing and perching.

somehow have a greater effect on female Kakapo than males. I recently had the opportunity to test whether the skewed sex ratio had existed prior to the arrival of humans, by examining fossilised bones that had accumulated in caves 2,000–5,000 years ago. The bones amassed as flightless birds, including Kakapo, fell or wandered into cave systems and died there. Because the size dimorphism of Kakapo is reflected in the size of their bones, I was able to use the numbers of leg bones of different lengths to estimate the prehistoric sex ratio. This turned out to be nearly three males to each female, indicating that the unusual excess of males has persisted for many generations. Although predation by introduced mammals has brought the Kakapo to the brink of extinction, the skewed sex ratio in the surviving population is evidently not the result of any predation-bias toward females.

In species where males and females are monogamous a ratio of one to one is generally expected and found. In most lekking species the sex ratio is also usually about one to one, although the operational ratio favours females because few males actually get to mate at all and therefore do not contribute to the next generation. Certainly it is hard to see why having more males would be favoured in an evolutionary context. It is a cruel irony that, given the effort required to raise a chick, a female Kakapo will often be wasting her time when her offspring are male. This is because, even if her sons carry genes for being big and loud (that is, good lekkers), they may not get a chance to express them, as achieving large adult size is dependent on the size achieved in the nest. Due to the way avian skeletons develop, bone length and thus overall skeletal size are fixed by the time a bird fledges. If food is poor, then male Kakapo chicks will be small despite their genes. In good years of course, male chicks will be big because their fathers' 'big' genes can be fully expressed. Female chicks, however, have genes for small skeletons; their reproductive potential is not limited by size.

Observations of nesting Kakapo reveal that, even in the absence of predators, many breeding attempts fail. Success is dependent on the continued availability of good-quality food throughout the growth of the chicks. When food at the nest becomes scarce (because the mother is having trouble finding enough) some or all chicks will go hungry. As with most birds, the largest chicks dominate the food supply until they are sated. In Kakapo nests the largest chicks are usually going to be males because they have greater potential growth rates than females. In addition, aggressive traits (favoured in successful lekking adult males) may also be expressed in male chicks. These features may combine to give male Kakapo chicks competitive advantages over female siblings to the extent that females may suffer higher nest mortality. This would lead to a greater proportion of males in the adult population.

HOW COULD ALL THESE EXTRAORDINARY features have come together to make a viable species? Whatever the reasons that led to Kakapo evolving a lek breeding system in the first place, it is likely that the environment in which

DON MERTON

Female Kakapo are solely responsible for the care of eggs and chicks. The nest generally consists of a hollow in a decayed log, among tree roots or other vegetation. The eggs are small (five centimetres long), and the hatching and survival of the chicks depend on the quality of food available to the mother. The longer she is away from the nest foraging, the greater the chance of eggs or chicks chilling. In conditions of abundant food, chicks rapidly gain weight and are soon heavier than their mother.

ROD MORRIS

Kakapo are inquisitive and, despite their large size, are capable climbers. The typical parrot beak and zygodactylous feet (two toes forward and two back) are put to good use when foraging on the forest floor and in trees.

they did so differed from that in which they live today. I believe that the most profound change that has occurred in New Zealand's recent biological time (excepting human interference) was climate cooling. This was most extreme during the period of glaciation that ended about 15,000 years ago, although temperatures remain lower than before the ice age. During the warmer climates that existed for most of New Zealand's prehistory, plant diversity was higher and abundant fruiting may well have been more frequent. In such conditions Kakapo would have produced successful broods more often and chicks would not have been in competition for food.

If Kakapo evolved lekking in such conditions, they may now be maladapted and have limited evolutionary opportunities because of the nature of their breeding system. This is not to say they cannot

ROD MORRIS

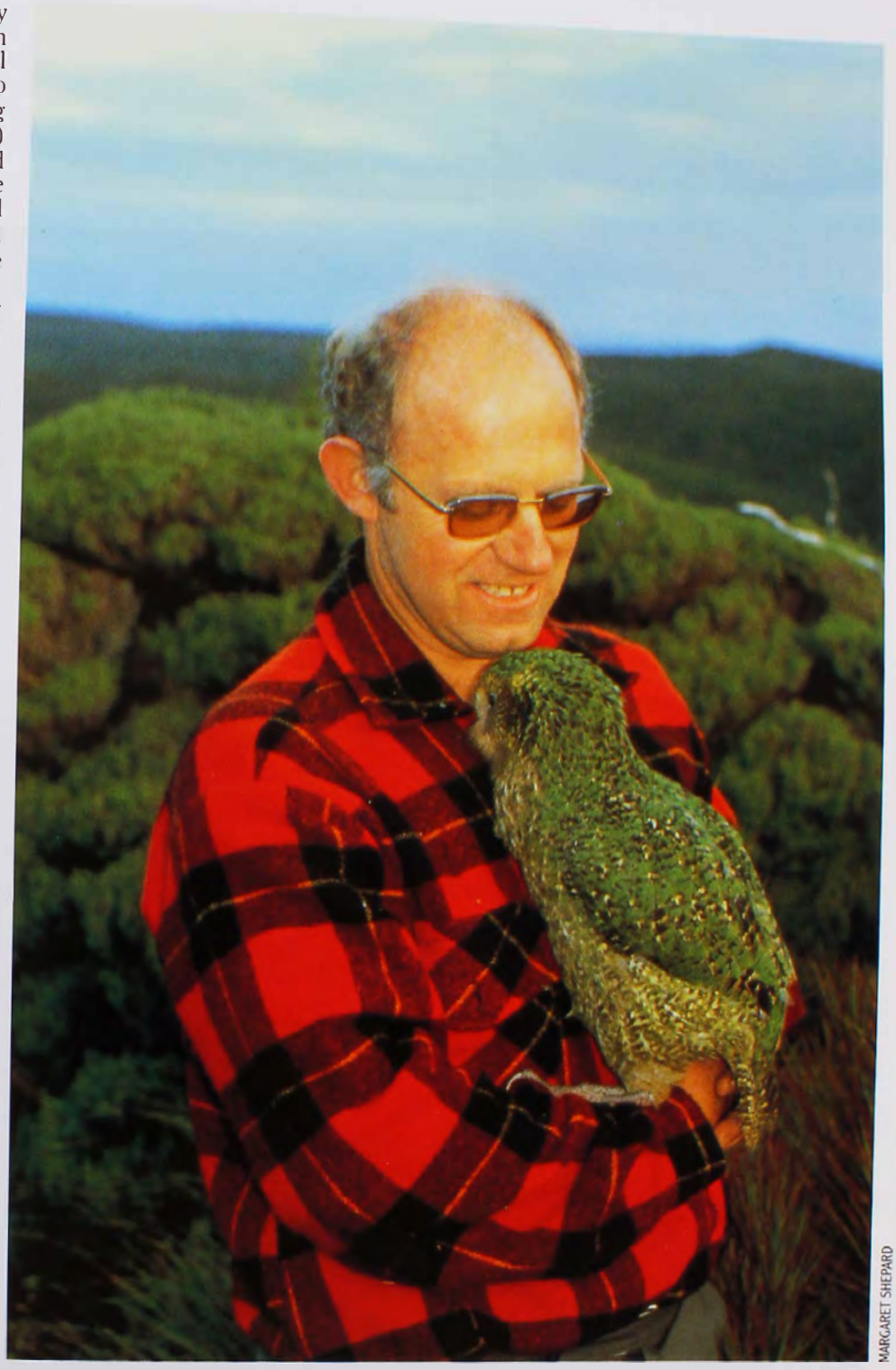
Kakapo spend most of their time on the forest floor among shrubs, mosses and ferns where they are well camouflaged. If disturbed by a potential predator, Kakapo freeze until the danger has passed. This is the only means of defence they have and it is no match for introduced Cats or Stoats.

persist as a species but that they may exist as a biological oddity. Even though failure of fruiting crops at the critical moment of chick rearing leads to increased stress to mothers, sibling rivalry (causing female chick mortality) and the overproduction of undersized males, the species has persisted. In the absence of mammalian predators and blessed with a long life expectancy of at least 50 years, the Kakapo can survive despite its odd sex ratio.

Today conservation efforts are being directed at protecting Kakapo from introduced predators and, in a sense, from themselves. Eradication of introduced mammals on potential island reserves was once an almost untenable prospect, but now appears to be relatively straightforward. On the other hand, ensuring that Kakapo initiate breeding attempts and have sufficient food to successfully rear healthy chicks of both sexes is demanding very special efforts in the way of providing appropriate analogues for masting fruits. This includes the identification of cues that stimulate initiation of breeding, determination of the important nutrient components in the diet, production of suitable supplementary foods, and mimicking the fluctuating abundance of natural foods. There is no way we can alter the sexual behaviour of Kakapo but, by understanding how it evolved, we have the opportunity to alter the outcome of that behaviour.

As I write, one Kakapo receiving supplementary food is tending a nest and caring for two fat chicks, a male and a female. This is only the second surviving female to hatch since 1981. A third (male) chick that hatched last was smaller than its siblings and did not compete well for food. It is now being hand-reared and is also doing well. It is interesting to note that, despite being the first to hatch, the female chick is not the biggest any more, having been outgrown by its slightly younger male sibling. If the food was not as good as it is, we can well imagine that this faster-growing male would have the advantage over his sister, with the dire results that we see represented in the existing population.

Kakapo biologists are very encouraged by these latest results and, although not all individuals have responded in the same way, it could be that, at last, the Kakapo is making a comeback. We can look forward to the continued success of conservation efforts and to having evermore evidence to help us understand the nature of the Kakapo, New Zealand's paradoxical parrot. ■



MARGARET SHEPARD

The trusting nature of Kakapo is one feature that assists their conservation. This 12-week-old fledgling nestles against Don Merton, a key figure in the New Zealand Department of Conservation Kakapo recovery program.

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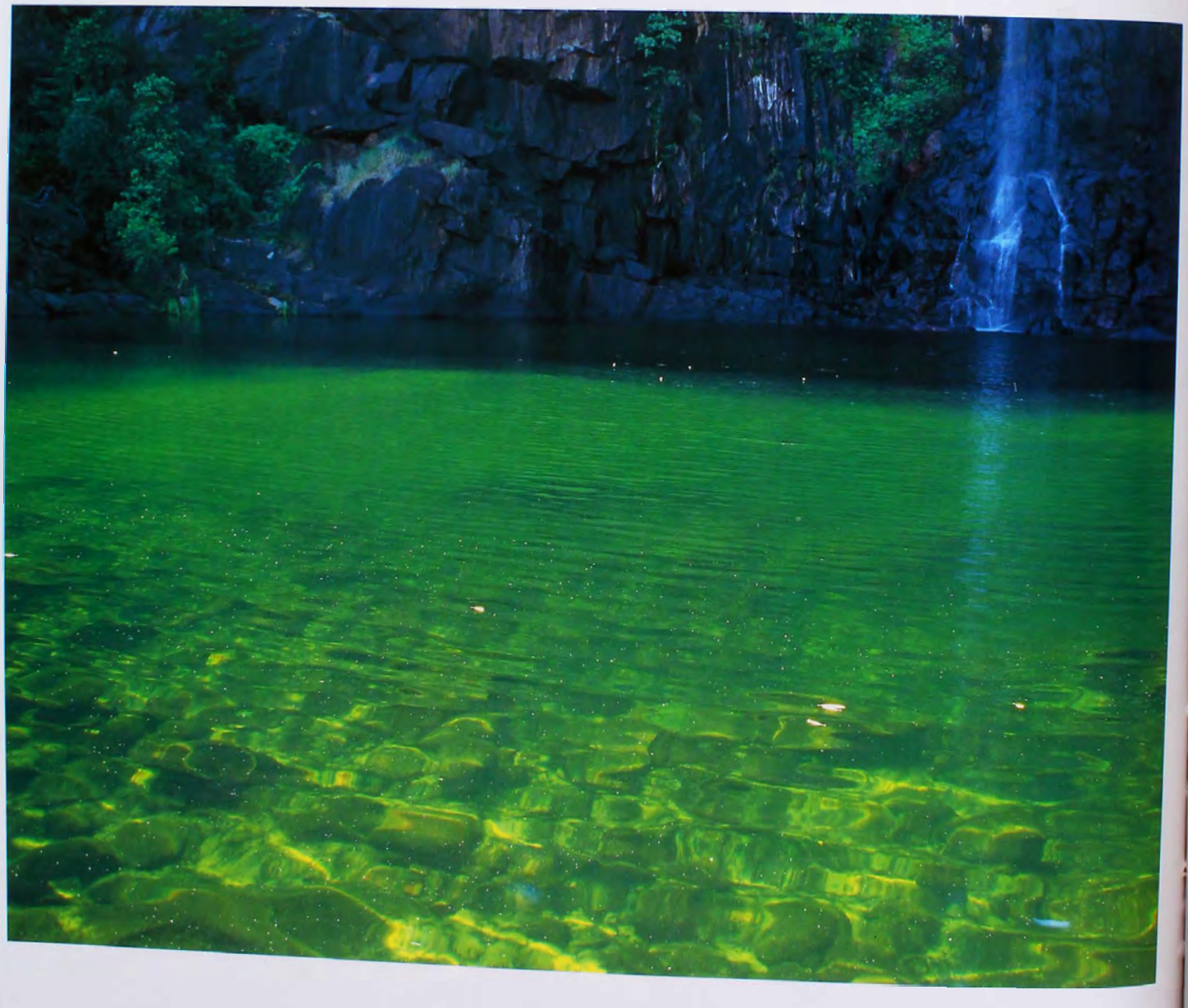
Dr Steve Trewick is a Postdoctoral Fellow in the Department of Zoology, University of Otago. His research interests include the evolution and implications of flightlessness in birds, speciation and diversity in invertebrates, and island biogeography. He is currently engaged in molecular research exploring the evolutionary impact of geophysical events on invertebrate biodiversity and distribution in New Zealand.

P H O T O A R T

BILLABONGS

BY RAOUL SLATER



P H O T O A R T

PHOTOART

Ever since Australia was ripped free from Antarctica, it has been a large target bobbing about in a sea surrounded by millions of species mindlessly straining to expand their territory.

A LEGACY OF BOATS, BLOATS AND FLOATERS

BY MICHAEL ARCHER

WHEN FRANÇOIS Pelsaert, Commander of the Dutch merchant ship *Batavia*, awoke just before sunrise on 4 June 1629, it was to the sickening sound of splintering wood—his ship had struck a reef on Houtman Abrolhos. Like all Dutch East India Company commanders since 1613, he had sailed eastwards after rounding the Cape of Good Hope to take advantage of the hastening easterly currents and winds of the Indian Ocean. Had his luck held out, he would have missed the reefs and turned north towards India after sighting a more benign stretch of the Western Australian coast. For 125 of the passengers who struggled unsuccessfully to survive at the hands of a few mutineers, five months on the tiny islands near the fatal reef were a nightmare. For Australia, it was the first good look at European civilisation.

Although a disaster for the *Batavia*, the ship's unexpectedly abrupt encounter with the Western Australian coast may have followed a tradition far more ancient than anything the Dutch dreamed up. Ever since Australia was ripped free from clinging Antarctica, sometime between 45 and 35 million years ago, it has been a large target bobbing about in a sea surrounded by millions of species mindlessly straining on distant shores to expand their territory. How many of these began a journey towards Australia, only to sink forlornly into the dark waters of the Indian Ocean, we will never know. But some most certainly did succeed. The fossil record tells us that many groups of bats, for example, dropped in to stay at various times during the last 55 million years, varanid lizards and elapid snakes probably swam in from south-eastern Asia sometime before 20 million years ago, and rodents floated into northern Australia, probably on a pile of flotsam, between eight and four million years ago. The closer Australia came to south-eastern Asia, the greater the likelihood that wandering waifs, including eventually humans, would strike it lucky.

But between dismal failures and stunning successes, there is an in-between class of intercontinental mariners: those that may have landed but, like the *Batavia*'s wretched occupants, made no profitable use of their miraculous survival. In the late 1960s I stopped at a roadhouse in Dandaragan, south of Geraldton, Western Australia, where a strange curved object dangled from a string on a window latch. It was chocolate brown and about 40 centimetres in length. I was told that it had been picked up on the beach nearby but no-one had any idea what it was. I thought I did and excitedly asked to borrow it. As I suspected, it turned out to be an elephant's tusk, albeit a very small one that was probably fossilised. I returned the enigmatic object as promised, resolving to pursue the matter when in the area again, but when I came back years later the roadhouse was gone and its owner locally forgotten. Australian elephants? In spite of the provocative tusk, I thought 'no way'.

Yet in 1844, Sir Richard Owen named *Mastodon australis* on the basis of a fossil molar in the collections of the Royal College of Surgeons of England that was said to have come from Australia. He regarded it to be an Australian member of an extinct group of elephants once

JEAN-PAUL FERRERO/AUSCAPE

Were elephants, alive or dead, among the bloaters and floaters that found their way to the Australia?

common in Eurasia. The tooth was supposedly brought to England by De Strzelecki in 1843 after being found in a cave "further in the interior than those of Wellington Valley". Unfortunately, the tooth has since disappeared.

But it was not alone. In 1882 Owen described a second extinct Australian elephant: *Notelephas australis*. This time the fossils, including three portions of an elephant's tusk, did not disappear; they are still secured in the collections of the British Museum of Natural History. They were said to have been discovered by Fred N. Isaac in a fossil deposit on the Darling Downs.

Is it so inconceivable that a sea-going pachyderm scared the pooh out of a bug-eyed kangaroo as it hauled its wrinkled, barnacle-encrusted bulk onto an Australian shore?

If these fossils, including the missing Dandaragan tusk, are not parts of ghastly mix-ups or mischievous frauds, how could their discovery in elephant-free Australia be explained? During the 'glacial' periods of the Pleistocene when sea levels were lower, many of the islands of south-eastern Asia were joined or separated by only very narrow water gaps. Even the relatively wide stretch of water between Timor and north-western Australia became much narrower. In the late Pleistocene, Java had, among other territory-hungry mammals, Orang-utans, extinct hippos, two rhinoceroses, Panthers, Tigers, Sun Bears, Bantengs . . . and lots of elephants, including a variety of pygmies (*Stegodon* spp.). Even Timor, the last stop on the way to Australia, had large and small elephants, all anxious for more space.

Living elephants are very capable swimmers, some having been known to snorkel and dog paddle their way across 45 kilometres of open ocean. Is it then so inconceivable that a sea-going pachyderm every once in a very rare while scared the pooh out of a bug-eyed kangaroo as it hauled its wrinkled, barnacle-encrusted bulk onto an Australian shore? Or, for the less fortunate adventurer, how far could a cyclone drive a bloated grey floater before it exploded and sank? Such a horror mightn't lead to a thriving race of Australian elephants, but if on its arrival it bogged in the right sort of mangrove mud, it might well make a puzzling Australian fossil.

When a gigantic 32-centimetre-long, 2,000-year-old egg was found in 1992 in sand dunes near Cervantes, Western Australia, amazed palaeontologists found themselves staring across the sea towards the island of Malagasy where identical, comparable-aged fossil eggs had been laid by the extinct 2.5-metre-tall, half-tonne Madagascan Elephant Bird (*Aepyornis maximus*; see *Nature Aust.** Summer 1993–94). Another, slightly smaller but otherwise identical egg had been found in 1930 in sand dunes near the mouth of Scott River, Western Australia. Although once thought to have been flotsam from wrecked Dutch ships that had visited Malagasy, John Long (Western Australian Museum) and colleagues argue that these eggs would have been highly efficient, long-distance dispersers. In this case, they would have been driven by the same easterly winds and currents that raced the Dutch ships to our shores. Addled eggs of King Penguins (*Aptenodytes patagonicus*) discovered in 1974 along the Western Australian coast must have similarly drifted, in this case at least 2,000 kilometres from the nearest sub-Antarctic colonies. Bloated floaties happen.

No doubt future fossil discoveries will reveal many other hopeful invaders that once tried our shores. Even Riversleigh has produced a few suspiciously alien creatures (try 'Bizarrodonta', a beast whose teeth resemble, among other things, the molars of primitive primates). But with our arrival, deep oceans and unfavourable winds are no longer obstacles to colonisation. As we insanely continue to shoe-horn into Australia every foreign beast from Cats to Cows, Llamas to Leopards and Oats to Ostriches, the besieged survivors of the ancient Gondwanan groups, once secure in the keep of Australia, should gather at the western edge of the Tasman Sea to think wistfully about New Zealand. ■

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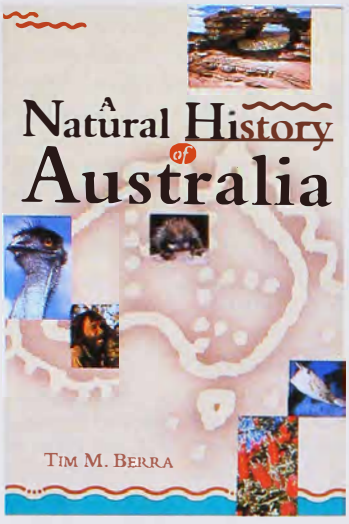
Professor Michael Archer lectures in biology and geology at the University of New South Wales. Most of his non-teaching hours are devoted to the study of the fossil faunas of Riversleigh, north-western Queensland.

*Previously ANH

REVIEWS



A Natural History of Australia

By Tim M. Berra. UNSW Press, NSW, 1998, 312pp. $45.00rrp.

I know Tim Berra to be an energetic American with a lively interest in a diversity of things. Clearly Australia is one of those interests. This book reflects a certain eclectic enthusiasm in the author but is also very uneven in its coverage.

Some sections, including the State descriptions, read like extracts from a tourist magazine, detached and unimaginative. Berra shows a preoccupation with quantitative details—the precise lengths of numerous rivers listed for each State, areas given in square kilometres and square miles, volumes of lakes, and so forth. We learn interesting little snippets such as that Adelaide has "no slums [and] few traffic jams", and that Darwin was destroyed by bombing in WWII.

The photographs, many taken by the author himself, are by and large good to very good. The same can't be said for most of the line drawings, which are too small to show distinguishing characteristics of their subjects. Nor can it be said for many of the maps.

Reference to Indigenous Australians is scant, oversimplified and sometimes offhand in style. Berra casually ignores the core elements of Indigenous rights to self-determination and in his opinion the return of human remains to descendants is an unnecessary threat to good science.

The chapter on plants is reasonably informative but, as elsewhere in the book, could have benefited from more critical proofing. Small things can be irritating, like comparing the sizes of two trees but citing one's trunk diameter and the other's circumference. Acacias are described as being of "two types"—those with pinnate leaves and those with spine-like leaves—overlooking the many species with long flattened leaves, one of which is illustrated.

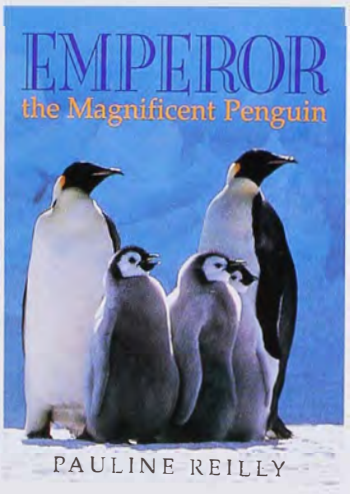
The only marine ecosystem featured is the Great Barrier Reef. Where are the mangroves, sandy beaches and rock platforms? There is mention of some families of reef fishes but then there's an entire chapter on freshwater fishes that are rarely encountered relative to their marine counterparts. Two pages are dedicated to the rare Megamouth Shark that washed up in Western Australia . . . not something the typical beachcomber will ever encounter.

Insects get four pages in total, plus a special entry for Bush Flies. The only spiders worthy of note are funnel-webs and Redbacks. The snake section is fuller but the line drawings are useless for identifications. Birds rate a bigger section again but the selection is puzzling. If only one duck is to be mentioned, why a shelduck? If one were to assign special mention to an Australian bird, would it be the Little Penguin (it rates three full pages)? The mammal chapter is interesting, although marine mammals are not included at all and the cause of extinction of Australia's megafauna is less 'agreed' than Berra would suggest.

It would have been nice if Berra had allowed his natural humour to shine through more often, as he does occasionally; for example, in observing the good fortune of Platypus males in having internal testes. It would certainly have been better to do more of this than the periodic insertion of unnecessary scientific jargon that adds nothing to the readers' appreciation of the subject matter.

In short, Tim Berra's book is a strange melange, a combination of scientific detail in places, anecdotal recounts in others, and all manner of things in between. Is it really a natural history of Australia, or a simple and rather simplistic guide for a visiting American with some interest in Australia's wildlife? Rather more the latter I think, but there's probably a place for that.

—Gary Morgan
Australian Museum



Emperor: The Magnificent Penguin

By Pauline Reilly. Simon & Schuster, NSW, 1998, 32pp. $9.95.

This is an unusual little book. It is only 32 pages long and at first sight looks a bit like a magazine, although the cardboard cover is a bit thicker. When you leaf through it, you get the initial impression that it's a children's book. Indeed it certainly appears geared to the younger reader but it is also packed with a lot of information. Based around the breeding cycle of one male penguin ('Emperor' who may or may not be fictional), it shows much of the Emperor Penguin's life, warts and all.

Adults will be as much entertained by the story as the kids and can make any adjustments thought necessary for younger listeners if it is read to them. Older kids should be able (and interested enough) to read it by themselves, although some help may be necessary with certain words and concepts. The book is filled throughout with beautiful colour photos illustrating scenery and of course the penguins and their fluffy chicks.

As mentioned, the text does not spare any detail and some of it could have benefited from a glossary of terms at the back. Still, having said that, I don't think the text would defeat anyone with an interest in penguins. It would also make quite a good reference book for nature libraries, as it includes a list of references for anyone who would like to know more.

This is an unusual but entertaining nature book recommended for penguin lovers and naturalists young and old.

—Martyn Robinson
Australian Museum

King Koala

Video by Wild Releasing, NSW, 1997, 46min. $29.95rrp.

"King Koala" takes the approach of many fauna documentaries these days and looks at the life of a particular animal, in this case the Koala, by filming various aspects of its behaviour, then weaving this into a story. Each animal is given a name and its supposed relationship to the other Koalas explained. Against this story-style backdrop, various messages are incorporated into the film. These are about conservation, dwindling fragmented habitat, man-made threats such as cars and Dogs, and some of the research techniques used such as radio-collars to track or follow individual animals.

I found the first few words of the introduction a bit unfortunate as they included incorrect statements about the Koalas feeding exclusive-

ly on eucalypt leaves (it has been acknowledged for quite some time that Koalas do eat other foliage) and it being the only marsupial totally dependent on eucalypt forests for its survival. This of course is not the case, most of the other arboreal marsupials in Australia are equally dependent on the continued existence of these coastal forests.

This documentary certainly does not exaggerate the threats Koalas face in New South Wales, where they are listed as a threatened species, however it gives only part of the story for Australia. In parts of Victoria and Kangaroo Island, for example, Koalas are so numerous that they are eating themselves out of house and home. Still, the video shows some great footage, and can help to dispel the notion of the Koala as a quiet, cuddly, retiring animal.

—Linda Gibson
Australian Museum

BBC Wildlife Videos: Wolf, Leopard, Humpbacked Whale, Crocodile, Eagle and Polar Bear

Six ABC Videos released by Roadshow Entertainment, NSW, 1998, 50 mins each. $24.95rrp.

This is the video version of the six-part BBC Wildlife series shown on the ABC. They are all narrated by David Attenborough and each is titled according to its subject matter.

The series boasts that each program reveals either footage or behaviour never before filmed or recorded. This is achieved by using techniques such as infra-red photography to record behaviour at night when it may be so dark even the animals themselves cannot see as well as the camera. "Wolf", and to some extent "Leopard", weren't that different from previous documentaries about wolves and Leopards, although I appreciate that the animals may be wary and any footage hard won. The infra-red photography at least showed them moving about in the dead of night. They were pleasant documentaries—just not astounding.

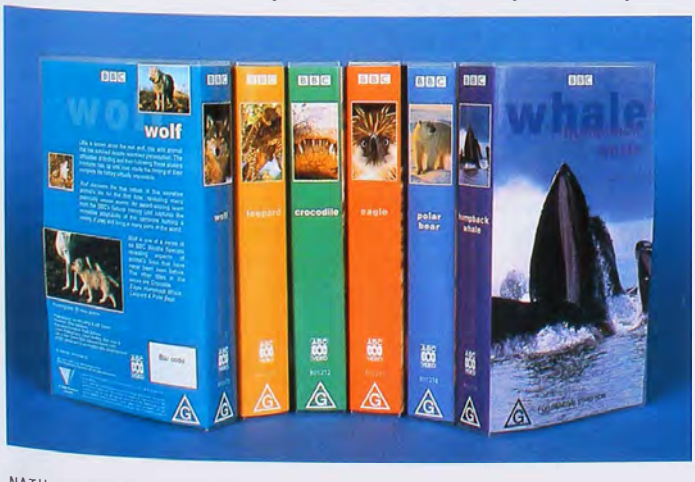
"Humpbacked Whale" was more or less about material you might expect or have read about, but it was still impressive to see it on film. "Polar Bear" also had what you would expect, but it was nice to see excellent moving footage of Polar Bears trying to stalk seals, or swimming and diving under water. "Eagle" was very dramatic in its photography but did have what looked like computer-generated scenery as background in some 'over the shoulder' shots. It was also probably the broadest program in the series, trying to cover all the different types of eagle lifestyles around the world .

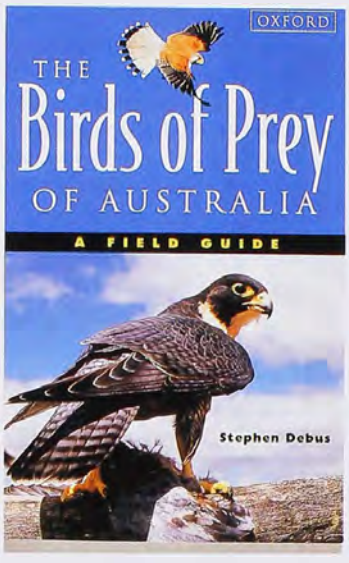
For me, the prize for the most astounding goes to "Crocodile". Crocodiles using their own bodies to trap and herd fish towards their mouths, caimans leading their tiny babies on long dangerous overland journeys to reach safe havens, even crocs cooperating to catch migrating zebras—were all fascinating and, to me, unexpected bits of footage.

Certainly all the films are worth seeing but some are more impressive than others—but perhaps that's just my bias.

The series seems a little sanitised as you rarely see any of the predators catch living prey, let alone kill it. However this may be a plus not a minus to some viewers who have been shocked at the gory footage of past documentaries. This might make it more suitable for families with 'alarmable' small children. All in all the series presents an impressive in-depth look at some familiar animals showing many things that may surprise you. Recommended to all who like good nature programs.

—Martyn Robinson
Australian Museum





The Birds of Prey of Australia: A Field Guide to Australian Raptors

By Stephen Debus. Oxford University Press, Vic., 1998, 152pp. $19.95rrp.

Some types of birds attract aficionados with a dedication exceeding that of more general birdwatchers. One such group is the diurnal birds of prey—the hawks, eagles and falcons.

By covering only the 25 species of birds of prey, the author is able to give each a more in-depth treatment than is possible in field guides that cover all Australian birds, while keeping the size of the book down. The convenient size makes this volume easily portable in the field.

As is appropriate for a field guide, most of the text is directed towards identification, concentrating on the plumage variation related to age, sex and colour morphs. In addition to the written descriptions, the birds are

well illustrated by colour paintings, line drawings and photographs. The book has been produced in conjunction with Birds Australia, and this relationship is shown by the reproduction of 26 of the fine colour plates from that organisation's *Handbook of birds of Australia, New Zealand and Antarctica*.

The species' accounts also include succinct discussions on other aspects of their biology. Although not presenting anywhere near the depth of coverage of the Handbook, these topics are more detailed than in field guides. As such, they are helpful adjuncts that facilitate the identification process. There is also a strong emphasis on the conservation of birds of prey, with relevant comments in each species' account, and an extensive concluding chapter.

The field guide is by no means the exclusive domain of bird-of-prey fans. Bird-watchers, nature lovers and anyone with a passing interest in this group of impressive birds will find it a handy and attractive addition to field outings. Recommended.

—Walter E. Boles
Australian Museum

Saving Our Natural Heritage? The Role of Science in Managing Australia's Ecosystems

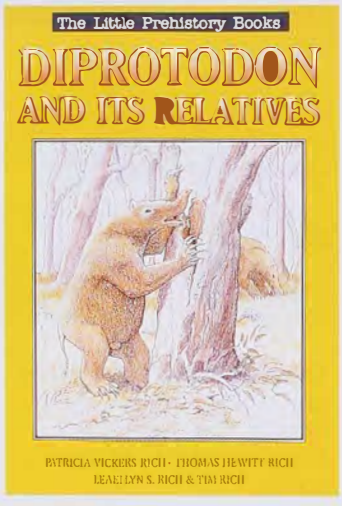
Ed. by Craig Copeland and Damian Lewis. Halstead Press, NSW, 1997, 309pp. $19.95rrp.

A thought-provoking and rewarding book containing 16 papers from Australia's leading ecologists, journalists and research scientists. Topics covered in the individual papers include: Australian forests, rangelands, estuaries and wetlands, and inland rivers.

While the collection of papers deals with specific and complex Australian ecosystems, the focus is on the contribution this research has made (or not made) towards addressing environmental issues. The editors identify that, while scientists are providing a wealth of information and recommendations for ecosystem management, this information is not being widely used.

The papers are well set out and supported by informative graphs and case studies. A great reference for current scientific issues and debate on ecosystem management.

—Nik Plunkett-Cole
Australian Museum



The Little Prehistory Books:

1. Australia's Ancient Backboned Animals (31pp.); 2. Australian Dinosaurs (22pp.); 3. Australia's Ancient Birds (31pp.); 4. Diprotodon and its Relatives (25pp.).

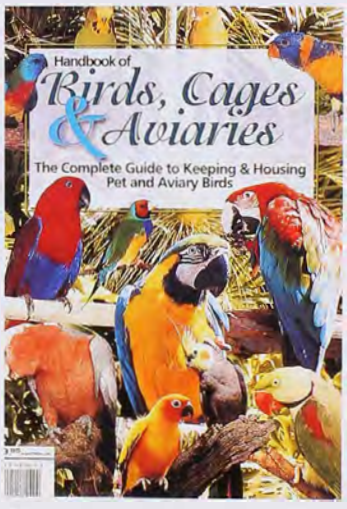
By Patricia Vickers-Rich, Thomas Hewitt Rich, Leaellyn S. Rich and Tim Rich. Kangaroo Press, Sydney, 1997. $9.95rrp each.

Over the years there has been a succession of books dealing with animals of Australia's past and aimed at the younger age group. Many of these are written by authors who have only meagre knowledge of the subject. In the case of this series, however, the principal auth-ors are both professional palaeontologists and accomplished writers.

This series of four small books aimed at the 10–14-year-old age group is well written and illustrated, and stands out from other similar works because of its scientific accuracy and quality of illustrations. Together the books feature a good selection of Australian vertebrate fossils from Ordovician fish through to Pleistocene megafauna. The language used is not too technical, which makes them easy to read, with scientific terminology and names explained in a glossary at the back of each book. Frank Knight's reconstructions of the prehistoric creatures are well executed and were produced in cooperation with Tom and Pat Rich. A further-reading list and an index are welcome additions that enhance the usefulness of these books.

If you are looking for something for a young fossil enthusiast, then these books would be ideal and you could be secure in the knowledge that they are accurate and up to date.

—Robert Jones
Australian Museum



Handbook of Birds, Cages & Aviaries: The Complete Guide to Keeping and Housing Pet and Aviary Birds

Published by ABK Publications, NSW, 1997, 128pp. $19.95rrp.

Here is a book for Australian bird keepers. Straight away this makes it an improvement over most of the other pet books on birds written in the United States, as conditions are often rather different overseas even for the same species. It is also edited by *Australian Bird Keeper* magazine with contributions from a number of experienced authors, so the information should be well chosen and accurate.

I appreciate that some people have misgivings over the keeping of birds in the first place but, if it is going to be done at all, it should be done correctly, and this book tells you how. The book is 128 pages long and illustrated with excellent colour photos. It is also quite broad in its coverage, including parrots, finches, softbills, pigeons, doves, quail, pheasants and waterfowl—about the only birds missing are chooks!

The book starts with an interesting introduction on the history of bird keeping, and the rules and regulations involved with keeping birds today. The next chapter is entitled "Choosing Your Bird" and mentions the types of species you might consider keeping, and also the appropriate birds for different purposes (companion, an aviary inhabitant, breeding stock etc.). It wisely recommends that you find out what the requirements are of the bird you're interested in before you get it.

Other chapters deal with maintenance and how to keep a pet bird happy, cage and aviary designs, breeding and husbandry, and general management.

In the last major chapter, "Healthy Birds", apart from the essential information on recognising disease, setting up a quarantine program, and first-aid treatment, there is a positive message on the value of aviculture to conservation.

Overall it is a good general guide to keeping birds. I have just two qualms. There seems to be a bias towards parrots and some people might find the advertisements for different bird supplies scattered throughout the text pages a little off-putting. Major pluses are the handy lists and addresses included in the back, and the helpful tips from people with practical experience.

This will be a useful book for anyone likely to keep birds, from the hobbyist and professional breeder to the wildlife carers who need to know how best to look after their patients until release.

—Martyn Robinson
Australian Museum

SOCIETY PAGE

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

ANIMAL WELFARE

Australian Wildlife Protection Council
247 Flinders Lane
Melbourne, Vic. 3000
Ph: (03) 9650 8326 or
(03) 5978 8570 after hours
Contact: Maryland Wilson

Annual Membership fee: $20.00

Fauna Rescue of SA
PO Box 241
Modbury North, SA 5092
Ph: (08) 8264 4958
Contact: Mrs Sheila Burbidge

Membership fee: $30.00 family; $20.00 single; $10.00 pensioner/student

Free the Bears Fund Inc. (NSW Branch)
PO Box 673
Mona Vale, NSW 2103
Contact: Melinda Page

Membership fee: $28.00

Native Animal Trust Fund Inc.
PO Box W100
West Cessnock, NSW 2325
Contact: Annette Rees

Membership fee: $15.00

Sydney Metropolitan Wildlife Services Inc.
Lane Cove National Park
PO Box 78
Lindfield, NSW 2070
Ph: (02) 9413 4300

Membership fee: $30.00

ASTRONOMY

South East Queensland Astronomical Society
PO Box 516
Strathpine, Qld 4500
Ph: (07) 3205 4541
Contact: Grahame Long

Membership fee: $20.00

BIRDS

Bird Observers Club of Australia
PO Box 185
Nunawading, Vic. 3131
Ph: (03) 9877 5342
Contact: Mrs E. McCulloch

Membership fee: $48.00 standard; concessions are available

Hunter Bird Observers Club
PO Box 24
New Lambton, NSW 2305
Ph: (02) 4958 5942
Contact: Peter Phillips

Membership fee: $20.00 family; $16.00 single; $2.00 junior

CONSERVATION

Kosciusko Huts Association
PO Box 3626
Manuka, ACT 2603
Ph: (02) 6286 2517
Contact: Jane Wheaton

Membership fee: $25.00

EDUCATION

CSIRO's Double Helix Science Club
PO Box 225
Dickson, ACT 2602
Ph: (02) 6276 6643
Contact: Lynn Pulford

Membership fee: $25.00

SA Science Teachers Association
1st Floor, 211 Flinders Street
Adelaide, SA 5000
Ph: (08) 8224 0871
Contact: Judy Morton

Membership fee: $80.00 secondary; $69.00 primary

ENVIRONMENTAL

Nature and Society Forum Inc.
PO Box 11
Canberra, ACT 2601
Ph: (06) 288 0760
Contact: John Schooneveldt

Membership fee: $25.00 or $12.00 concession

FROGS

NSW North Coast Frog Study Group
PO Box 61
Lismore, NSW 2480
Ph: (02) 6624 7448
Contact: Jeremy Morante

Membership fee: $15.00 adult; $10.00 concession; $20.00 family; $5.00 junior

Queensland Frog Society
PO Box 7017
East Brisbane, Qld 4169
Ph: (07) 3366 1806
Contact: Jenny Holdway

Membership fee: $10.00 single; $15.00 family; $8.00 junior; $5.00 under 10s

INSECTS

Entomological Society of Victoria
56 Looker Rd
Montmorency, Vic. 3094
Ph: (03) 9435 4781
Contact: Ian Endersby

Membership fee: $20.00 metro; $16.00 country; $12.00 student

MARSUPIALS

The Marsupial Society of Australia Inc.
GPO Box 2462
Adelaide, SA 5001
Ph: (08) 8374 1783
Contact: Catherine Whittington

Membership fee: $25.00 full; $5.00 associate; $35.00 overseas

MUSEUM

TAMS, The Australian Museum Society
6 College St
Sydney, NSW 2000
Ph: (02) 9320 6225
Contact: Michelle Ball

Membership fee: $55.00 single; $70.00 household; $40.00 student/pensioner

NATURAL HISTORY

NT Field Naturalists Club
PO Box 39565
Winnelie, NT 0821
Ph: (08) 8981 0939
Contact: Annette Gaborlt

Membership fee: $30.00 family; $25.00 single; $15.00 concession/student

REPTILES

Victorian Herpetological Society Inc.
16 Suspension St
Ardeer, Vic. 3022
Ph: (03) 9363 6841
Contact: Brian Barnett

Membership fee: $32.00–$45.00

WA Society of Amateur Herpetologists Inc.
9 Birch Place
Stoneville, WA 6081
Ph: (08) 9295 3007
Contact: Brian Bush

Membership fee: $15.00

WETLANDS

The Wetlands Centre — Shortland
PO Box 130
Wallsend, NSW 2287
Ph: (02) 4951 6466
Contact: Tim Bowring

Annual Membership fee: $20.00

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Call Robbie Muller on (02) 9320 6119 for more information.

Q&A

Froglids

Q: *Do frogs have eyelids?*

—Janice Muller
Bracken Ridge, Qld

A: Most frogs have what is called a nictitating membrane or third eyelid. This is a thin and transparent membrane that acts to protect the eye when the frog is sleeping or swimming under water. The membrane is drawn across the eyeball from the base of the eye upwards and acts as a lubrication for the eyeball itself. Frogs can close their eyes by retracting their eyeballs into their heads. Frogs will often do this when eating as it helps them to swallow their food.

—Kate Lowe
Australian Museum

PIC TEASER

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, *Nature Australia* Magazine. Please don't forget to include your name and address. The first correct entry will win a signed copy of Tim Flannery's latest book *Throwim way leg*. Spring's Pic Teaser was Organ Pipe Coral (*Tubipora musica*).

MICHAEL TRENERRY/NATURE FOCUS

Dead Crabs?

Q: *I was walking around the rocks that surround the Women's Pool near Coogee Beach when I noticed a number of dead crabs in the various rock pools. These pools were several metres above water level and were presumably full of rainwater. There were dead crabs of varying sizes in nearly every pool I looked in.*

Only a metre away in the crevices were living crabs, scurrying about eating the algae and pipis that clung to the damp sides of the rocks. The crabs were green–grey with white-tipped claws and their bodies ranged in size from 2–7 centimetres.

What species of crab were they and why were there so many dead crabs in the rock pools above?

—Alexandra Lowe
South Coogee, NSW

A: The 'dead' crabs are most likely shed skins from the Purple Rock Crab (*Leptograpsis variegatus*), also known as the Swift-footed Shore Crab. This is easy to verify because if the 'bodies' are very soft, translucent, light and appear hollow (often with a reddish brown pattern), they are cast skins. If on the other hand they are heavy (about what you'd expect a crab of that size to weigh), reasonably firm, and opaque with darker olive or black patterns, then they truly are dead crabs and we'd probably need to see some of the bodies before passing judgement on what happened.

Why rock crabs enter these fresh- or brackish water puddles (which is what they are if above the high-tide mark) is still a bit of a mys-

DOMINIC CHAPLIN/NATURE FOCUS

The eye of a Fringed Tree Frog (*Litoria eucnemis*), but where's the lid?

What animal is responsible for this damage?

tery, but it probably helps the shell to split due to osmosis (the freshwater will seep into the crab's body because it has a higher concentration of ions). These crabs can manage without fresh water puddles, but if they are there they tend to use them.

—Martyn Robinson
Australian Museum

Who Chewed my Tree?

Q: *Could somebody please explain to me what animal damaged this immature eucalypt? The tree is on my property of native bushland in the granite belt region. There are no destructive feral herbivores in the area so I suspect a brushtail possum was after the sap.*

—Steve Haslam
South Tweed Heads, NSW

A: The damage to your young eucalypt was probably caused by a Yellow-tailed Black-Cockatoo (*Calyptorhynchus funereus*). These birds search for insect larvae, including large cossid moth grubs, which are found in the heartwood of wattles, snow gums and other eucalypts, and smaller beetle larvae that are found under the bark of dead eucalypts and in the flower spikes of grasstrees (*Xanthorrhoea* spp). Cockatoos search a tree for larvae using their bill like a stethoscope, sensing the sounds and movement in the trunk. They insert the point of their bill in the bark or frass hole and, once satisfied that the grub is mature, the excavation begins. Black-cockatoos can exert enormous pressure with their bill. They force their upper mandible under the bark and pull down a two-to-three-centimetre strip of bark at an angle of about 50^0 to the trunk (to make a platform). The bird then continues to remove strips of bark by levering and pulling, using its weight and the additional pulling power gained by pressing its tail against the tree. The bird generally excavates from left to right and does not remove more wood than is necessary to expose the larvae. The strips are bitten off and dropped to the ground. When the larva is finally extracted (it generally takes about 20 minutes to excavate a larva from the heartwood of an eight-centimetre branch) it is eaten and the tree is left as you found it.

—Kate Lowe
Australian Museum

COURTESY STEVE HASLAM

Answers to Quiz in Nature Strips (page 16)

1. Female
2. Rabies
3. Wallace's Line
4. In its eyes
5. Jim Frazier
6. Downwards
7. Yes
8. Algae
9. Four
10. Birds Australia

This is a mass stranding, the kind of event that ignites every human emotion and draws odd neighbours to common purpose.

WHALE STRANDINGS: SHOULD WE INTERVENE?

BY JOSEPH GERACI

IMAGINE A WHALE CARCASS AFTER A week on a hot beach, skin cracked like desert clay and so bloated with gas it's about to burst. Only a resolute museum type, a bone hunter, would get within smelling range, and maybe a hungry gull or two.

Now let's step back to the day the whale came ashore, more noble then. Waves rock her from side to side. Her flukes pound into sharp rocks and unyielding sand. Smothering under her own weight, she gasps for air, each breath more threatened by the rising tide. Would the scene be as lonely? Certainly not. I picture a growing crowd flocking to the helpless animal, digging, dousing, pulling, pushing, determined to save her life.

Imagine now that she is only one of a pod. Whales everywhere, some cast beyond reach of the next tide or stuck in mud flats, and just offshore mothers safeguard their frightened calves. This is a mass stranding, the kind of event that ignites every human emotion and draws odd neighbours to common purpose. Help the whales; return them to sea.

But the chance of succeeding is awfully thin, as I explained to a gathering of townsfolk who had fought to exhaustion as they tried to turn back a pod of pilot whales one frigid night in Cape Cod, Massachusetts. I described how a whale out of water overheats, how quickly stress and shock strangle the circulation causing widespread organ damage that may never heal, and why a whale released in this condition has little chance of surviving. Then I delivered the news that euthanasia was the only humane option. Those words drew a strong enough reaction from the crowd that a fisheries warden had to race across the beach to my rescue.

In hindsight, what other response could I have expected? There I was, a recent arrival on the scene, preaching that the weakened whales would have almost no chance of survival, to the same people whose time as care-givers had strengthened the bonds that made release seem all the more imperative. Euthanasia or rescue? Either way, our task was impossible.

A few years ago at a workshop held in Chicago, world experts shared their opinions on how to deal with stranded whales. Most agreed to intervene, that is to save as many animals as possible and euthanase the rest. But the real problem for veterinarians and others who respond to strandings is determining, in an atmosphere highly charged with emotion, which of the individual whales will survive and which will not. Perhaps one day we will develop some kind of electronic device which, when held against the skin of a stranded whale, will produce a reliable reading on the 'Survival Scale'. But I doubt that even such a miracle of technology would entirely resolve the problem. Most of us feel compelled to help an animal in distress, often beyond the degree that would be dictated by reason alone. And, for the growing numbers of our society who conclude that too many strandings are caused by pure human thoughtlessness, rescue is not an option but a responsibility.

A False Killer Whale (*Pseudorca crassidens*).

JIRI LOCHMAN/LOCHMAN TRANSPARENCIES

There are other reasons we get involved. Throughout history, whales and dolphins have stranded. The ancients welcomed them as gifts from the sea; indeed, some cultures still do. In a way, scientists also view stranded animals as a gift, but of knowledge rather than meat, oil or bone. What little is known about certain species, especially small cetaceans, comes from stranded or beach-cast animals. We learn about their birth and how long they live, where they reside and visit, what they eat, what keeps them healthy or makes them sick, and what effect we have on their lives. So, while compassion drives one person to rescue a stranded whale, another, compelled more by curiosity, seizes the opportunity to learn. We measure and observe, count and collect, tag and monitor, and use the information to improve our management of wild populations. From a stranded (and later released) Pygmy Sperm Whale treated at the National Aquarium in Baltimore, for example, we gained knowledge of a species rarely seen alive; we observed first-hand the consequences for a small whale that mistakenly eats plastic bags instead of squid.

Saving our noble whale may do little or nothing for the population; rarely can we claim that our efforts have a direct conservation value. However, the whale's presence on the beach pulls our attention away from human endeavours. Her plight forcibly reminds us of our role as stewards of the Earth's environment. Our response melds compassion, intellectual curiosity and a sense of duty into a force that can have immeasurable value to local and global conservation programs. If we use the stranded whale for the mighty symbol she is, she may be a key to saving her species and her environment.

Now to the question I gingerly evaded. Should we intervene when a whale strands? In truth, I could have answered in a heartbeat. Whether intervention takes the form of euthanasing a dying animal or attempting to rescue one in distress, slight though its chances of survival may be, the answer is "Yes". This is no longer an intellectual exercise. We do it because we must. ■

Dr Joseph R. Geraci is Senior Director of Biological Programs at the National Aquarium in Baltimore, and Research Professor, Comparative Medicine Program, at the University of Maryland, School of Medicine.

The Last Word is an opinion piece and does not necessarily reflect the views of the Australian Museum.

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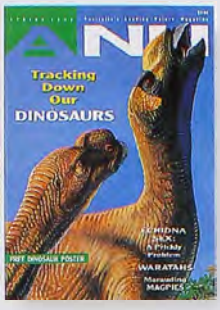

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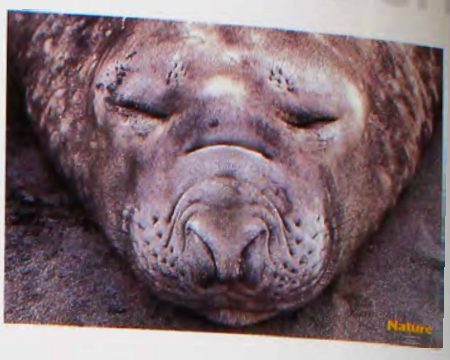

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