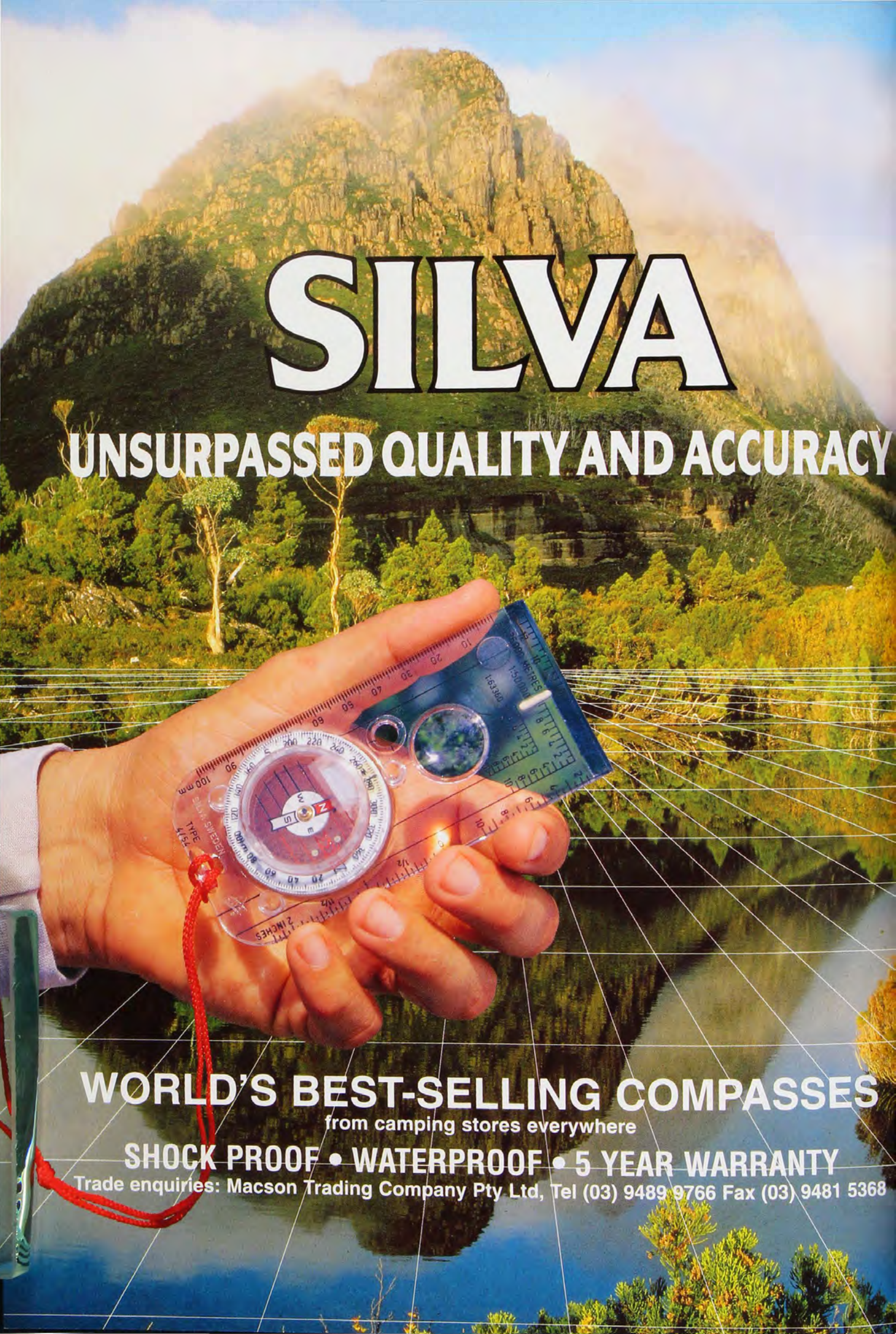

$8.95
AUSTRALIA
Nature
SPRING 1996
Urban
PLATYPUS
Native
BEES
Sleepy
LIZARDS
Sunset
FROGS
Australia's
Kangaroos are
HOPPING
MAD
Free
Kangaroo
Poster
ISSN 1324-2598
03
AUSTRALIAN MUSEUM
AM


SILVA
UNSURPASSED QUALITY AND ACCURACY
WORLD'S BEST-SELLING COMPASSES
from camping stores everywhere
SHOCK PROOF • WATERPROOF • 5 YEAR WARRANTY
Trade enquiries: Macson Trading Company Pty Ltd, Tel (03) 9489 9766 Fax (03) 9481 5368

Up Front

With a propensity for lying around and not doing too much of anything, you could be forgiven for thinking that Shinglebacks (*Tiliqua rugosa*), or Sleepy Lizards as they are also known, are fairly unremarkable reptiles in the scheme of things. Even scientists have described them as ethologically boring. But a recent discovery by Associate Professor Michael Bull has changed all that and put these large Australian skinks on the map! And their new found fame is all because, year after year, they remain faithful to one partner. Just how they manage to find each other after spending most of the year apart is unknown, but one study pair has been getting together every year for the last 14 years! It's a world first and you can read all about it on page 34.

Sleepy Lizard.

Have you ever wondered why kangaroos hop? No other large mammal in the world has adopted this form of locomotion, so why have our macropods? Is it because they have found it to be a more efficient and energy-saving way of getting about? Professor Uwe Proske has investigated the mechanics of hopping and presents us with his findings on page 56. This story is also special because it is illustrated with a number of images by Jan Aldenhoven and Glen Carruthers. They are the multi award-winning Australian team that brought us the highly acclaimed and spectacular documentary "Faces in the Mob". Their amazing photos also grace our cover and poster.

Mountain Pygmy-possums are furry little creatures that would fit into the palm of your hand. They certainly don't look big or tough enough to travel incredibly long distances for food, or to live in snow-covered granite boulderfields where surface temperatures can be as low as -20° C. But they do, and Dr Linda Broome has survived many freezing nights (although more than once she wondered why!) to bring us their story on page 40. For Dr Broome it may have been no pain, no gain, but for Dr Tim Heard who studies native stingless bees, that was definitely not the case. As their name suggests, these bees don't use a sting to defend themselves and, as a result, their honey can be enjoyed without fear.

Mountain Pygmy-possum.

And that's just the beginning. You can also read about the newly discovered Sunset Frog, view a spectacular bunch of Western Australian wild flowers in Photoart, and discover that you may be living closer to a Platypus than you thought possible. One thing is for sure, after reading this issue you will be reminded how special the animals, insects and plants of Australia really are.

—Jennifer Saunders

AUSTRALIA
Nature

SPRING 1996 VOLUME 25 NUMBER 6

Published by
The Australian Museum Trust
6 College Street,
Sydney, NSW 2000.
Phone: (02) 320 6000
Fax: (02) 320 6073
Trust President: Malcolm Long
Museum Director: Desmond Griffin

EDITOR
Jennifer Saunders, B.Sc.

SCIENTIFIC EDITOR
Georgina Hickey, B.Sc.

PHOTO RESEARCHER
Kate Lowe

DESIGN AND PRODUCTION
Watch This! Design

PRINTING
Excel Printing Company

MARKETING AND SALES
Howard Dimond
Phone: (02) 320 6331

ADVERTISING
Phone: (02) 320 6331

SUBSCRIPTIONS
Michelle Atzemis
Phone: (02) 320 6119
Toll-free (1800) 028 558
Fax: (02) 320 6073

Annual subscription (4 issues)
Within Australia $A33 Other countries $A45
Two-year subscription (8 issues)
Within Australia $A63 Other countries $A83
Three-year subscription (12 issues)
Within Australia $A89 Other countries $A116

New subscriptions can be made by credit card on the *NATURE AUSTRALIA* toll-free hotline (1800) 028 558 or use the form in this magazine. If it has been removed, send cheque, money order or credit card authorisation to the address above, made payable to the 'Australian Museum' in Australian currency. Opinions expressed by the authors are their own and do not necessarily represent the policies or views of the Australian Museum. *NATURE AUSTRALIA* is printed on archival quality paper suitable for library collections.

Published 1996
ISSN–1324–2598

NATURE AUSTRALIA (as ANH) is proud winner of the 1987, '88, '89, '90 , '91, '92 & '93 Whitley Awards for Best Periodical, and the 1988 & '90 Australian Heritage Awards.

Front Cover
After weaning, young female Eastern Grey Kangaroos (*Macropus giganteus*) often go through a stage where they play with natural objects. This female's favourite 'toy' was a lump of dry cow dung. Photo by Jan Aldenhoven.

CONTENTS

Articles

Regular Features

Columns

LETTERS

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

The Name of the Dingo

I read with great interest the Dingo article by Dr Laurie Corbett in the Summer 1995–96 issue of *Nature Australia*. Being a veterinarian, I was surprised to learn that, contrary to what I have been taught, domestic dogs did not derive from wolves, but from Dingoes!

Please, please, please, even if this is true, do not change the Latin name of the Dingo, nor the one of the dog! It is so confusing to juggle all these different scientific names for a given species that come along each time a new parenthood is discovered. This habit makes bibliography difficult and also abolishes the initial purpose of the Linnean classification of giving one single non-ambiguous name for each living species. Being European, I have been interested in the cultural comparison of Dingoes with wolves. I remember having read, heard and seen, as a child, so many frightening stories about wolves that I understand many adults can still be terrified even by the name of wolf.

Now, being French born, I have also been surprised by the definition of a native Australian as: "one that lives in Australia and has ecological and/or cultural impact, regardless of taxa, birth site, race, language, length of time in Australia etc." Since I live in Sydney, have a cultural impact (at least on my neighbourhood) and a (hopefully limited) ecological impact—certainly less than the one from certain other French activities—I would be very proud to be called an Australian native. But I am not sure everybody will share this broad-minded view.

Thankyou for a very interesting article with beautiful photographs of this wonderful animal.

—Pierre E.J. Baychelier
Elizabeth Bay, NSW

JOE SHEMESH/NATURE FOCUS

Should the scientific name of the Dingo be changed?

Wee Jasper Caves

I am writing to express concerns about the article "In the Dark about Tropical Caves" by Dr Philip Weinstein (*Nature Aust.* Summer 1995–96) and in particular the discussion of histoplasmosis.

First, I would like to correct a plain, if unfortunate, error that will have economic impact on the tiny community of Wee Jasper. The sentence "In the 1970s, epidemics of histoplasmosis led to the closure of *Histoplasma*-ridden tourist caves at Wee Jasper..." is completely wrong. True, six to eight youths came down with 'flu-like' symptoms, which were attributed to *Histoplasma* infection from Church Cave. True, a number of researchers came down with sub-acute histoplasmosis a few years later when trying to isolate the fungus from Church Cave and its surrounds. But Church Cave has never been a tourist cave and never will be. It is, however, an important maternity site for the bat *Miniopterus schreibersii*. This species is listed as rare and endangered on Schedule 12 of the National Parks and Wildlife Act because of its dependence on a few caves with specific characteristics.

Church Cave is a completely different environment to the five-kilometre-distant Careys Cave in which tourism operations have been conducted since the mid 1960s. Your article has had an impact on the operation of Careys Cave, which has safely given pleasure and education to tens of thousands of visitors. The cave is well worth a visit for many values including its aesthetics and

ROGER BROWN/NATURE FOCUS

Raptors, like this Black Kite, can be difficult to identify when in flight.

setting.

Histoplasmosis is not a notifiable disease in Australia and thus it is difficult to know how many cases there have been. I have been able to track down one death in Australia from undoubted histoplasmosis, and even that is hearsay. This was not associated with a cave, but had its origins in a 'chook' shed in the Adelaide Hills. I have further hearsay evidence of a handful of cases from far north Queensland. Dr Weinstein may well have a better idea of what is happening there. It is undoubtedly more common in the tropics than in southern parts. It is very difficult to isolate the fungus.

Although it may be the case overseas, the term 'killer' fungus is not appropriate to the Australian situation. As observed above, such stereotypes do not help in the ongoing conservation of, as Dr Weinstein ably documents, a very important class of ecosystem.

—Andy Spate
NSW National Parks and Wildlife Service

Media reports at the time of the cave closures and subsequent secondary sources refer to the infected caves collectively as "Wee Jasper Caves", an overgeneralisation that I am guilty of perpetuating. Histoplasmosis is a potentially lethal infection that kills many people every year in endemic areas such as the eastern USA. This fact does not detract from the conservation value of caves any more than mosquito-borne disease detracts from the conservation of wetlands.

—Philip Weinstein
Senior Adviser Environmental Health
Ministry of Health, NZ

Attracting Men

In the Nature Strips article "Laws of Attraction" (*Nature Aust.* Summer 1995–96) the claim is made that men are universally attracted to women with 'youthful' looks and that such features in women provide an indicator of fertility. This view has been put forward quite a lot and I am amazed that no-one has questioned it.

The looks that men find attractive are often described as 'child-like', and with good reason. Large eyes, small nose and chin, hairless skin and long legs are all characteristics of childhood. In Western culture you can add blonde hair (which often becomes brown later in life) and blue eyes.

Now let's take a good look at this fertility theory. A woman remains fertile until menopause, which usually starts around the age of 40 or 45. That leaves a lot of time at peak fertility when she is not exactly 'youthful'.

Okay, let's look at youth. Are teenagers more fertile? No. In fact studies of hunter-gatherer tribes show that, although girls began menstruating at an average age of 16, their first live birth didn't occur until between 19 and 20 years of age due to subfertility and miscarriage. The teenage years of subfertility, characterised by erratic menstrual cycles and repeated miscarriages, have been well documented.

So why are men attracted to child-like looks? I believe that children provoke a caretaking response from males, helping to ensure the survival of young. Women with child-like looks and secondary sexual characteristics evoke this powerful urge to protect and provide, as well as sexual excitation—a heady cocktail. Women who behave in a child-like manner increase their attractiveness again.

—Kayley Usher
Glen Forrest, WA

Raptor ID

Stephan Marshall's "Little Eagle" photo on page 69 of the Summer 1995–96 issue of *Nature Australia* is, in fact, a Black Kite (*Milvus migrans*), as revealed by the bill and head shape, wing shape, small feet and, above all, the long tail which even half-spread shows a slightly forked tip. (A characteristic of the bird, also known as Fork-tailed Kite, is a forked tail!) This mistake nicely illustrates the difficulty of identifying raptors in flight, as discussed in my Red Goshawk article in the same issue!

—Stephen Debus
University of New England, 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 each issue will receive a $20.00 gift voucher from the Museum Shop catalogue. The winner this issue is Kayley Usher.**

Nature Strips

COMPILED BY
GEORGINA HICKEY

Chameleon's Telephoto Eye

Chameleons would have to rate as the most bizarre lizards around with their long, sticky tongue, slow, jerky gait and, of course, their famous ability to change colour. But it's their strange, turreted eyes, capable of moving independently, that really set them apart. Matthias Ott and Frank Schaeffel from the Eberhard-Karls University Eye Hospital at Tübingen, Germany, looked deep into those eyes and things became even weirder.

It's been known for some time that, unlike most other animals, chameleons use the state of focus of their eyes to judge the distance to their prey, much like focussing a camera lens and then reading the distance off the focus ring. This technique requires that the images on the retina at the back of the eye are large, and indeed Ott and Schaeffel found that image magnification in chameleon eyes is higher than in any other vertebrate eye scaled to the same size. Chameleons achieve this feat using another animal first: a lens that has negative refractive power. This gives the chameleon eyes a set-up much like that in a telephoto lens where a negative, concave lens is placed behind a positive, convex lens (the cornea), increasing the effective focal length of the eye and so making the image magnification larger for a given eye size.

—G.T.

Supreme Sacrifice

Motherly instinct is the motivator for some extraordinarily selfless acts. But maternal sacrifice appears to reach its zenith in the Australian spider *Diaea ergandros*, according to a report from University of Melbourne biologists Theodore Evans, Elycia Wallis and Mark Elgar.

In this species, the female produces only one clutch of young, after which her ovaries shrivel and she becomes incapable of further reproduction. But she labours hard to ensure the survival of her solitary brood. First, she constructs a protective nursery from eucalypt leaves in which the young spend most of their early development. Then she captures insects to feed them.

Her final act of devotion comes as the brood approaches adulthood. Inside her distorted ovaries she has been storing nutrients in the form of unviable food eggs.

S. WILSON

Chameleons' eyes are not only weird on the outside, but the inside too.

These are too large to pass down her oviducts and be laid, but it is thought that the mother subsequently converts the nutrients from these eggs into haemolymph (blood) in her circulatory system.

The developing spiderlings benefit from this food supply by slowly cannibalising their mother, supping initially on small tastes of haemolymph from her leg joints. She offers no resistance and weakens gradually over several weeks as the young step up their act of matriphagy, finally consuming their mother completely.

By offering *herself* as food to her babies, the mother spider reduces the possibility of cannibalism among the brood, thereby increasing the potential number of her spiderlings that may reach maturity.

—K.McG.

Hatch or Be Snatched

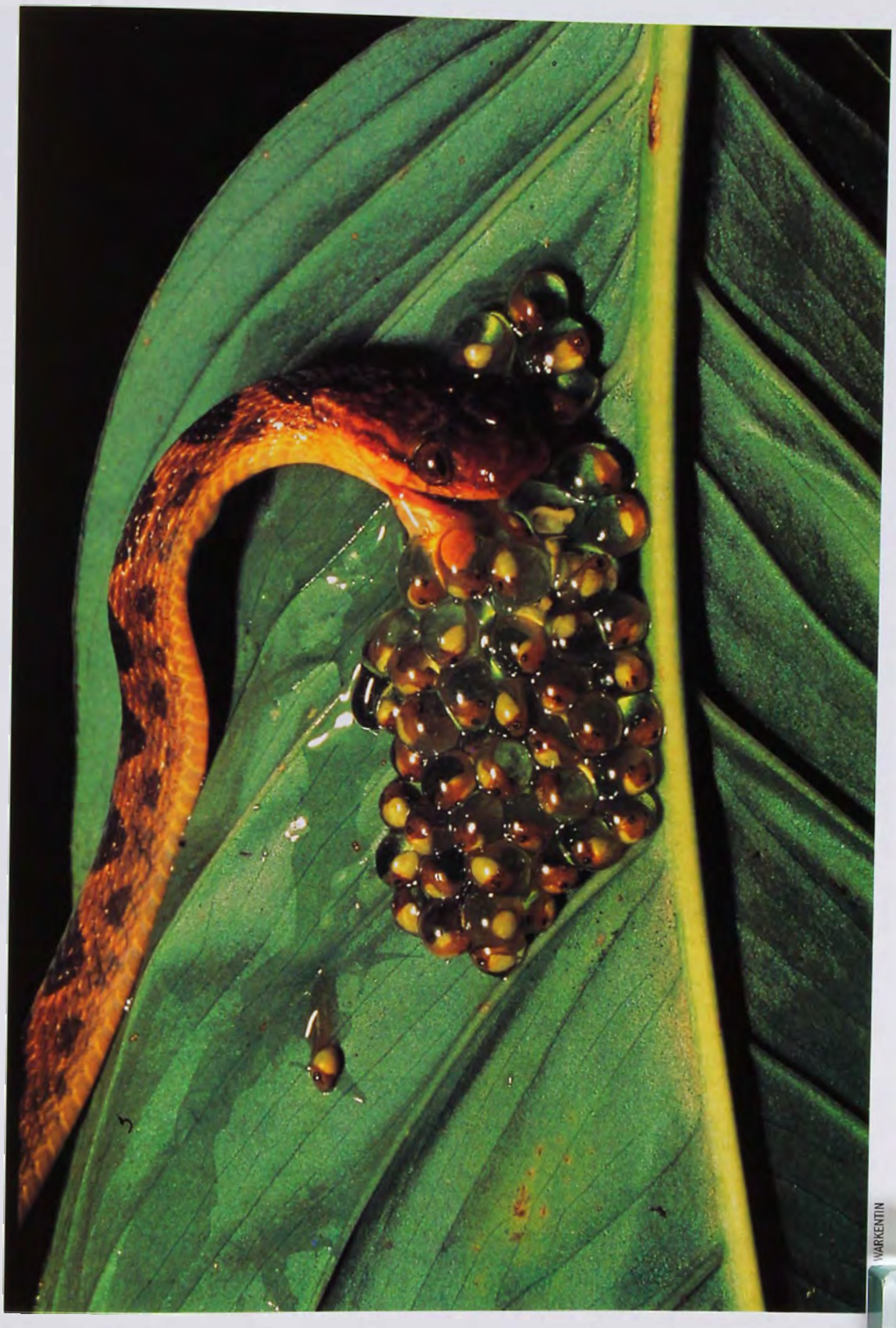
It's a case of the frying pan or the fire. The Central American Red-eyed Tree Frog (*Agalychnis callidryas*) lays its eggs on leaves of plants overhanging water. After a few days the tadpoles hatch out of the eggs and fall into the water where they continue their development, eventually emerging as miniature versions of their parents. Unfortunately the water contains all sorts of nasty predators just waiting to feast on a fat little tadpole, so one might think that it would pay to stay in the egg as long as possible. The problem is that, if they wait around too long, they might end up as food for another predator, the Cat-eyed Snake (*Leptodeira septentrionalis*), a serpent that is very fond of frogs' eggs.

Karen Warkentin from the University of Texas at Austin studied this tadpole quandry in Corcovado National Park, Costa Rica. In a series of experiments she looked at when the tadpoles hatched, how tadpoles of different ages fared when placed together with aquatic predators, and what happened when the eggs were exposed to the attentions of Cat-eyed Snakes.

She found that the eggs usually hatched after about seven days when left to their own devices and that younger hatchlings were significantly more vulnerable to predation by fish and shrimps. However, once they reached five days of age, if attacked by a snake the eggs hatched immediately. In fact, they hatched so fast that most of the tadpoles were able to escape, some tadpoles even jumping out of the snake's mouth.

But how did the tadpoles distinguish between a snake attacking them and some other disturbance such as rain falling on them? Warkentin found that young eggs hatched if she mimicked a snake's jaws by sliding forceps between them, but not with some other disturbances. This means that the tadpoles can wait until the very last moment before jumping out of the frying pan.

—G.T.



WARKENTIN

Jumping out of the jaws of death: tadpoles of the North American Red-eyed Tree Frog can hatch prematurely if attacked by a Cat-eyed Snake.

D. PARER & E. PARER-COOK/AUSCAPE INTERNATIONAL

Intentional stranding by Killer Whales is a risky hunting technique that takes lots of practice and needs to be taught from an early age.

Teaching Beaching

Adult Killer Whales (*Orcinus orca*) devote much time and effort to the development of their offspring. These highly intelligent marine predators live in stable and social matriarchal family groups. Their hunting is cooperative and sophisticated, and the techniques must be taught to the young.

Christophe Guinet and Jérome Bouvier from the National Scientific Research Centre in France have found that this period of apprenticeship appears to last longer for the Killer Whales of the Crozet Archipelago, near Possession Island in the Indian Ocean, than it does in populations from other areas. At Crozet, elephant seal pups are the main prey items and these are often snatched from beaches using the risky and difficult technique of 'intentional stranding'.

Calves, under the watchful tutelage of adult females, begin 'beaching play' or intentional stranding practice at about the age of four years. The risks of this behaviour were clearly demonstrated on one occasion witnessed by the researchers when a practising calf had problems returning to the water. Its mother responded by accelerating rapidly towards the beach and turning sharply at the shore to create a wave that lifted her stricken offspring back to safety.

Guinet and Bouvier believe the difficulty in learning intentional stranding accounts for the fact that calves at Crozet remain dependent on their mothers until they are six or seven years of age, while the young of North Pacific populations that feed on salmon are independent at three years. It may also explain why the reproductive rate at Crozet is much lower than in the North Pacific.

—K.McG.

Fish Drink Sperm

The South American catfish *Corydoras aeneus* is a popular fish among aquarium owners and its reproductive behaviour is well known. During copulation the female adopts a T-position, whereby she attaches her mouth to the male's anal region, causing him to release sperm. Eggs are released and held in a pouch formed by her pelvic fins.

Until now it was assumed that sperm flowed over the female's body to the pouch, where fertilisation of the eggs occurred. But Masanori Kohda and colleagues from Osaka City University in Japan noticed that the female's gill covers were closed as if she were drinking. An experiment in which blue dye was released at the female's mouth while in the T-position confirmed this to be the case. Within about five seconds the blue dye appeared from her anus and was funnelled into the pouch. Eggs were then released one or two seconds later and immediately fertilised.

This is the first time that fertilisation by sperm drinking has been reported in the animal kingdom. The authors believe the evolution of this bizarre form of fertilisation was facilitated by their ability to breathe through their intestine. Like other fish that live in low-oxygen waters, *Corydoras aeneus* gulps air and passes it quickly through the intestine where oxygen is absorbed. This, and the fact that other species are known to adopt the T-position, may mean that fertilisation by sperm drinking may be more common than is currently realised.

—G.H.

Far North Queensland A Bird Watching Experience.

Base yourself at Silky Oaks Lodge, the Daintree's "Ultimate Rainforest Resort" and discover the birdlife and wildlife of the Wet Tropics region of Far North Queensland. The rich diversity of habitats surrounding the Lodge makes it the ideal base for the birdwatching enthusiast and we have sighted over 180 species within a 5km radius.

BIRD SPECIES

Southern Cassowary
Great-billed Heron
Brahminy Kite
Wompoo Fruit-Dove
Pied Imperial-Pigeon #
Double-eyed Fig-Parrot
Papuan Frogmouth
Buff-breasted Paradise-Kingfisher #
Atherton Scrubwren
Macleay's Honeyeater
Pale-yellow Robin
Pied Monarch
Shining Flycatcher
Yellow-breasted Boatbill
Victoria's Riflebird
Tooth-billed Bowerbird
Golden Bowerbird
Blue-Faced Parrot-Finch #
Metallic Starling #

#Denotes seasonal visitor.

Day 1

After being picked up at Cairns Airport in a chauffeur driven limousine, you'll have time to settle into your chalet at the Lodge, before an early evening briefing at the Lodge by our activities staff.

Day 2

Guided walk in search of the birdlife found around Silky Oaks Lodge. Habitats inc. Rainforest, River, Open Eucalypt Woodland and the nearby Cane Fields. In the afternoon, ornithologist Del Richards will accompany you on your "Fine Feather" Tour of the Lowland Coastal areas around Mossman.

Day 3

Join your Australian Natural History Safari to explore the secluded Mt Lewis World Heritage Region and the real Australian Outback of the Mitchell River. This safari is lead by David Armbrust one of North Queensland's leading naturalist Guides.

Day 4

An early departure for Chris Dahlberg's Morning River Cruise on the Daintree River. On this cruise you'll see up to fifty different bird species as well as reptiles and the occasional mammal.

The Far North Queensland Bird Watching Experience really is a holiday with a difference. Packages are now available from just $949 per person, twin share and feature all the following inclusions;*

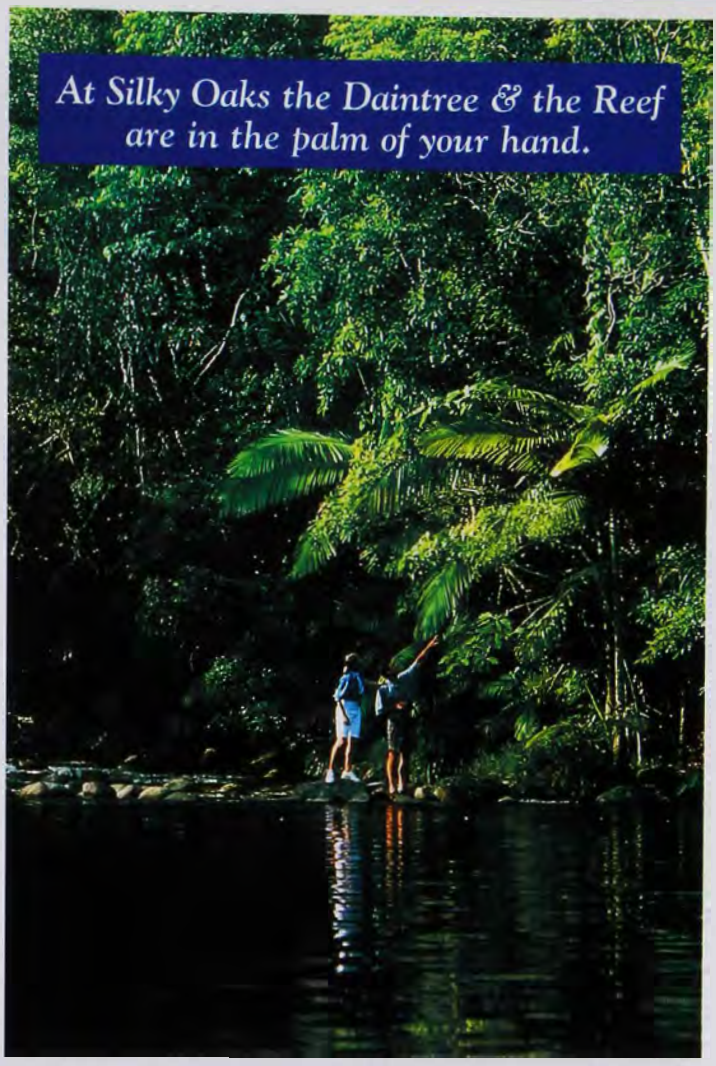
- 3 nights Chalet accommodation at Silky Oaks Lodge.
- Tropical continental breakfasts.
- Luxury Limousine transfers to and from Cairns Airport
- Lunch and Morning Tea on the Australian Natural History Safari.
- All specialised birdwatching tours.
- Reference books and binoculars supplied on loan for all specialised tours.

(Tour starts in Cairns on Sunday and Thursday. We require a minimum of 2 guests per booking.)
**Offer valid 1.4.96 to 31.3.97.*

Holidays with a Difference

For a full itinerary and booking details, contact your Travel Agent or P&O Resort Holidays on **132 469.**

FROM P&O RESORTS



In the tradition of the world's great retreats, Silky Oaks has redefined the Daintree experience.

Silky Oaks Lodge has won repeated acclaim as the Daintree's ultimate rainforest resort. An idyllic retreat, where this rare World Heritage wilderness is enjoyed in supreme comfort. Silky Oaks is in the perfect position to explore the tropical wonders of Far North Queensland. From the oldest living rainforest on earth, to the Great Barrier Reef, Port Douglas and the beauty of Cape Tribulation, it's all right here on your doorstep.

Right now you can spend 3 nights at Silky Oaks for **$562.50*** per person, twin share, including a tropical breakfast and a Wilderness Safari to Cape Tribulation including a Daintree River Cruise.

The trip to Cape Tribulation features spectacular scenery.

For further information and bookings see your Travel Agent or call P&O Resorts on 132 469 or Silky Oaks direct on **1-800-641363.** *Offer valid to 1.4.96 to 31.3.97.

Please send me your free colour brochure.

Name: _____

Address: _____

_____

_____ P/Code: _____

POS 0950

P&O Resort Holidays

P&O Resorts Pty Ltd A.C.N. 009 692 887

Send to: GPO Box 5287
Sydney NSW 2001

SILKY OAKS LODGE

The Daintree's ultimate rainforest resort.

PETER SCHOUTEN

A rich pterosaur deposit found at the foothills of the Andes in northern Chile suggests these flying reptiles had much stronger legs than was previously supposed and were capable of running take-offs.

Pterosaur Flight

Pterosaurs are thought to have been the first vertebrates capable of flight, emerging 220 million years ago (during the late Triassic), 70 million years before the first birds. These flying reptiles are not well represented in the fossil record, partly because their bones were light and fragile, in keeping with their aerial lifestyle.

What has been recovered, however, has come mostly from fine-grained, shallow, marine sediments. This has contributed to the popular belief that, although the group probably had a world-wide distribution, pterosaurs were clumsy and inelegant fliers, restricted to life on coastal fringes where they could become airborne by leaping into updraughts off high cliff faces.

Now, a recent discovery in the foothills of the Andes in northern Chile is telling a different story. There, in what would have once been a flat desert plain tens of kilometres from the coast, a rich deposit of pterosaur bones has been found over an area of more than a square kilometre in a two-metre-deep layer of compacted sand and gravel.

Mike Bell, from the Cheltenham and Gloucester College of Higher Education, and Kevin Padian from the Museum of Paleontology in Berkeley, California, believe the site represents an inland breeding colony or colonies of a ground-nesting pterosaur species that, as an adult, would have had a two-metre wingspan.

The bones are thought to be mostly of juvenile birds overcome by a flash flood. (Adults would have survived the catastrophe because of their capability for flight.) Bell and Padian argue that pterosaurs wouldn't have used such a site if they were as incapable of take-offs from flat land as has been previously thought. They believe that the legs of these creatures were not weak but were adapted to permit running take-offs.

But why choose an inland rookery where food was probably scarce? One reason may have been its remoteness from predators. This strategy is adopted today by several gull species, which nest in large inland colonies but feed on the coast. If pterosaurs were indeed strong fliers, they could easily have ranged long distances from nesting sites in search of food.

—K.McG.

COURTESY JOH R. HENSCHEL

The burrows of the newly described 'slit spider' from the Simpson Desert are horizontal slits made into the crusty sand of sloping dunes.

Life in a Slit without Silk

A new genus and species of spider has been found in the sand dunes of the Simpson Desert, central Australia. It was named *Fissarena ethabuka*, or 'slit spider', by Joh Henschel (Desert Research Foundation of Namibia), Valerie Todd Davies (Queensland Museum) and Chris Dickman (University of Sydney).

Like most desert spiders it avoids climatic extremes and predators by dwelling in a burrow—in this case a horizontal slit made into sloping sand. What makes it unusual is that it does not use silk to reinforce the walls of its shelter. Instead, it exploits sand that has already been consolidated by a crust. Crusts two to five millimetres thick commonly form across some sections of the dunes. Although their composition is unknown, the crusts are probably held together by filamentous remnants of cyanobacteria, algae, mosses and/or lichens. This is one of the few known cases of sand crusts being put to good use by an animal.

The shelter consists of a wide horizontal opening that gradually narrows into a flat burrow. A ridge of loose sand in front of the opening, swept out during excavation, forms a trap for prey. When small invertebrates (particularly ants) climb this micro-hill and slip down the tiny cliff on the other side, the spider pounces.

So far, only the female has

been described. It is a pale bronze colour and very flat. Adult body length is about one centimetre and it measures about three centimetres from leg tip to leg tip. Hearth-brush-shaped hairs on the spider's front feet are used to sweep sand from its burrow.

—K.McG.

Predators to the Rescue?

What do you do when you're being attacked by a predator? Why, call a few more over to join the party, of course. This seemingly paradoxical behaviour appears to be behind an 'alarm signal' produced by Fathead Minnows (*Pimephales promelas*) when their skin is damaged.

Most alarm signals, such as the calls of birds or the leaping of antelope, are used before the predator has done any damage, warning others of the presence of the predator and, in the case of the antelope, letting the predator know that the prey is fit and will be able to escape. Alicia Mathis and colleagues at the University of Saskatchewan in Canada were curious as to the benefits of alarm signals that are given off *after* the animal has been injured.

They figured that there were two possibilities: that the signal either deterred predators or attracted them. In a series of experiments with Northern Pike (*Esox lucius*) and diving beetles, both potential predators of Fathead Minnows, they demonstrated that the chemical alarm signal attracted predators.

But why? The researchers suggest that the arrival of other predators might disrupt the predation event. If, for example, a minnow is being attacked by a small pike, it is unlikely to be swallowed whole. So, if the minnow can attract a bigger pike, the new arrival might actually eat the small pike (a much more substantial meal than a little minnow) and let the minnow escape.

—G.T.

Sneaky Guppies

Foreplay's all well and good but there are times when it's just not appropriate, a fact that male Trinidadian Guppies (*Poecilia reticulata*) know only too well. These fish have two alternative mating tactics: males will either display to a receptive female prior to attempting to copulate with her, or dispense with the formality and try to quickly copulate with her without displaying or without prior receptive response from her.

Jean-Guy Godin of Mount Allison University in Canada speculated that the reason for this 'ungentleman-like' behaviour was that the male Guppies risked being eaten by a predator if they used the more showy courtship display behaviour. In order to test this idea he investigated the mating tactics of wild male Guppies with and without a model of a cichlid fish predator nearby.

Sure enough, without the model, male Guppies usually displayed to their prospective mates but, when the model was in place, the number of fish going for the quick and sneaky option increased. So, rather than avoiding copulation altogether when there is a predator present, male Guppies simply adjust their mating behaviour to get it over with as quickly and surreptitiously as possible.

—G.T.

AC–DC Spider

A mysterious gaze seemed to emanate from the deep darkness of a silk-lined hole beneath a rock in Namibia. When American arachnologist Vince Roth opened this crevice, he revealed a woolly chamber harbouring a gem: a velvet spider (family Eresidae), as pretty as unusual. Its left half was adorned with streaks and blotches in various shades of red, brown, white and black. In contrast to this, its right half was dotted black on white with brown shading. Rosy legs on the left were

LABAT-LANCEAU/AUSCAPE INTERNATIONAL

When Guppies mate, the male may choose to court the female first, or get straight down to business. It all depends on who's watching.

COURTESY JOH R. HENSCHEL

Half male–half female: an unusual velvet spider from Namibia.

paired to zebra-striped legs on the right.

Normally velvet spiders are sexually dimorphic, with males often being more brightly coloured than females. This particular Namibian spider, however, combined features of both sexes in such a way as to look like a brightly coloured male on the left and a cryptic female on the right. Such individuals are known as bilateral gynandromorphs and result from an imbalance of male hormones during the developmental stage. Unfortunately no external sexual organs of either sex were clearly developed to enable confirmation of its bisexuality.

Although no normal adults have been found for identification, this jewel probably represents a new species—not unusual in Namibia, where an estimated 90 per cent of the spider species remain undescribed.

—Joh R. Henschel
Desert Research Foundation of Namibia

This particular Namibian spider combined features of both sexes in such a way as to look like a male on the left and a cryptic female on the right.

The Humpbacks of Hong Kong Harbour

Hong Kong harbour, one of the busiest in the world, is hardly a place you would expect to find dolphins. Yet, for more than a thousand years this toxic soup of pollutants has been the home to Indo-Pacific Humpbacked Dolphins (*Sousa chinensis*).

This species of dolphin has a colour pattern that varies with age and geographical area. In the western Indo-Pacific regions, light-coloured calves darken with age to become dark grey above and light grey below. Off Malaysia and northern Australia calves and adults can be nearly white; and in Hong Kong harbour, calves are born dark grey, but this turns to white or bright 'bubblegum' pink.

Hong Kong's humpbacked dolphins have been threatened in recent years by a combination of development, overfishing and pollution, but now their situation has become critical. The dolphins mainly inhabit the shallow and brackish waters around a pair of islands called Lung Kwu Chau and Sha Chau. This area was put forward as the potential site for a marine sanctuary for the dolphins. However, the Provisional Airport Authority (PAA), in charge of Hong Kong's multi-billion dollar new airport project, had also earmarked Sha Chau island as the site for an oil tanker fuelling terminal to supply the new airport. In February 1995 this project was given the official go ahead.

In addition to the tanker terminal, by the year 2000 over 350 million litres of raw sewage will be pumping directly into the dolphins' habitat every day. This sewage will be coming from

NEW VISION

LEICA CAMERA GMBH, OSKAR-BARNACK-STRASSE 11, D-35606 SOLMS. TEL. +49 (06442) 208-403, FAX 4 10

MADE BY LEICA

LEICA BINOCULARS sharpen your view of the world, bringing alive fascinating details in amazing clarity and colour. Expand your vision while enjoying their compact size, light weight and high magnification. At your finger tips is an unlimited spectrum of use with Leica´s top quality optics, award-winning exemplary design and ergonomics. Experience LEICA BINOCULARS and see what you´ve been missing – at your qualified Leica speciality dealer.

Leica

The freedom to see.

TOM JEFFERSON

An adult Indo-Pacific Humpbacked Dolphin and calf in Hong Kong Harbour.

just two of the over 11,000 sewage outfalls emptying into the waters adjacent to the two islands. The amount of boat traffic is immense: each day several hundred boats, barges and cargo ships sail around the islands, including 30 jetfoil ferries. Several dolphins show severe wounds and gashes caused by the blades of propellers and many animals are known to have died from these collisions.

In 1990 the Worldwide Fund for Nature estimated there to be 400 Indo-Pacific Humpbacked Dolphins in Hong Kong. In 1994 researchers reported this was down to just over 80. A recent report to the United Nations Environmental Program predicted that, if the current death rate continues, Hong Kong's Indo-Pacific Humpbacked Dolphins may be locally extinct in a few years. So, although the dolphins have been living in Hong Kong's waters for over a millennium, escalating pollution and the Hong Kong Government's reluctance to put endangered species before industrial development could put an end to all that.

—Chris Parsons
Dolphin Research Group
Swire Institute of Marine Science
Hong Kong

When threatened, the giant South American Goliath spider produces a peculiar hissing noise by rubbing its 'hairy' front legs and pedipalps together.

Spider's Velcro Defence

Since its invention, we've found a million uses for Velcro, from watch straps to fridge locks. Now Sam Marshall from the University of Cincinnati and colleagues have described a way in which it can be used to deter would-be attackers. But before you start tearing off your Velcro-laced sneakers and frantically opening and closing them in a mugger's face, this innovation applies only to spiders.

When threatened, the giant South American Goliath spider (*Theraphosa leblondi*) produces a peculiar hissing noise by rubbing its 'hairy' front legs and pedipalps (feeding appendages) together. Examination under an electron microscope has revealed the detailed structure of these 'hairs', more properly called setae, showing them to be equipped with hooks on the tips and filaments on the shafts. When the two opposing surfaces are pushed together, the hooks on one side get entangled with the filaments on the other, just like Velcro, and when they are pulled apart, they make the hissing sound.

These spiders are also equipped with special hairs that they shed when handled and that cause itching in their attackers (see *Nature Aust.* Winter 1995). Marshall and colleagues suggest that the hissing sound produced by the 'Velcro' reminds predators that trying to eat them will only result in a mouthful of itchy hairs.

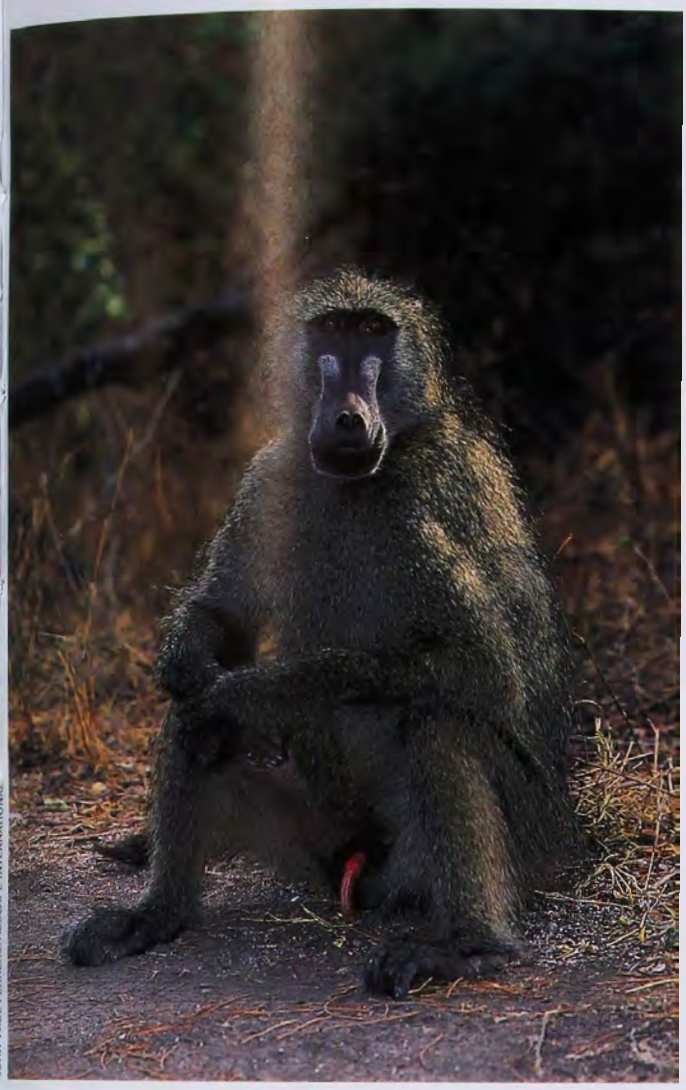
—G.T.

Mitey Survivors

For most arthropods, setting up house in a carnivorous plant would be suicidal. Stalked glands on the leaves of certain carnivorous plants secrete sticky globules that trap small prey for their digestion. It was with some surprise, therefore, that a species of mite (*Oribatula tibialis*) was found thriving on the insectivorous butterwort plant *Pinguicula longifolia*.

To find out how this mite manages to evade a sticky end, Ramón Antor and María García of the Pyrenean Institute of Ecology in Spain examined and compared the leaf morphology of *P. longifolia* with two other species in the genus. It appears that *O. tibialis* is able to survive on *P. longifolia* because the mite's average height of 154 microns (or thousandths of a metre) is slightly below that of the stalked glands (164 microns). This allows the mite to move about the plant, while avoiding the sticky traps. On the other butterwort species, *O. tibialis* is not so lucky; the stalked glands are shorter and denser, and consequently ensnare the mites.

What makes this situation even more interesting is the apparent mutualism that exists between plant and mite. The microenvironment provided by the leaf offers the mite a stable, predator-free habitat in which to live and breed. The mite also benefits from the plant's carnivorous habits by scavenging on the remnant carcasses of its host's prey. This,



JOHN PAUL FERRERO/AUSCAPE INTERNATIONAL

This male Chacma Baboon will never know for sure if he's the father because the noisy, promiscuous female likes to keep him guessing.

in turn, may benefit the plant by removing a potential source of infection. Furthermore, being fungus-eaters, the mites probably help prevent fungal parasitism of the plant. *Oribatula tibialis* is able to live in harmony with this insect-eating plant for, unlike other mites, it does not suffer the shortcomings of height.

—Karina Bull

Copulation Calls

The next time you stay in a cheap hotel and intimate noises from the next room make sleep impossible, it will probably come as no comfort to know that there are a lot of other primates that would make worse neighbours. The grunts and barks of a copulating female Chacma Baboon (*Papio cynocephalus ursinus*), for example, can carry for over 100 metres.

No-one is sure what, if any, evolutionary significance lies behind the noises made during sex by many female primates. But recent research by University College London biologists Sanjida O'Connell and Guy Cowlishaw helps to explain the copulation calls of female baboons.

Studying wild Chacma Baboon populations in Namibia, O'Connell and Cowlishaw found that females actually called *after* copulation, often as they were scurrying away once the act was completed. The researchers believe the female baboons call to attract and encourage other prospective mates while they are sexually receptive.

There are potentially two advantages to having multiple partners. First, it provides the opportunity for competition between the sperm of different males. This would increase the female's chance of securing high-quality sperm for her offspring.

Second, it could create

uncertainty about the paternity of offspring and help to discourage attacks on babies by non-related males. Infanticide can be a common cause of infant mortality in baboon troops, with dominant males frequently maiming and killing babies that are not theirs. If a female has taken several mates and a male believes there is a chance that he has sired a particular baby, he is likely to leave it alone.

—K.McG.

Whales Carry the Dead

Cetaceans have long been observed carrying dead members of either their own or, in captivity, other cetacean species. But why indulge in such morbid, seemingly energy-consuming behaviour?

During a nine-year study of Short-finned Pilot Whales (*Globicephala macrorhyncus*) and other cetaceans in southern California, USA, Susan Shane (University of California) observed pilot whales carrying dead California Sea Lions (*Zalophus californianus*) for extended periods of time. She recently investigated several possible explanations for this behaviour, including prey consumption, play, strong social bonds between the living and deceased, and conferring of social status on the carrier.

Pilot whales were seen pushing sea lion bodies with their melons, and using their flukes to tow the corpses. They also carried the corpses draped over their dorsal fins, swam with them in their mouths, and occasionally dived with the bodies, which were in various states of decomposition. The corpses were handled firmly but gently and the whales guarded their trophies carefully. At no time were they seen playing with or eating the sea lions.

As to what lies behind this behaviour, pilot whales are highly social and their propensity for carrying dead sea lions might carry over from their habit of carrying dead pod members or sick individuals to the surface to breathe. However, not all dead animals encountered by the whales were carried and Shane suggests that possession of a dead sea lion may instead confer status to the whale.

If this is the case, the social benefits would have to outweigh the costs to the whale, such as an inability to feed, limitations of social contact and the energetic costs of swimming with a corpse.

—R.S

Desert Frogs Have it in the Bag

The formation of a cocoon by arid-zone frogs during aestivation (the summer equivalent to hibernation) has been reported in two, possibly three, Australian genera. The cocoon is a water-saving structure that covers the entire body surface, including mouth, eyes and cloaca, but not the nostrils. Although cocoon formation was first described in 1967, no detailed studies had ever been made on the structure of the cocoon of Australian frogs, until now.

Phil Withers from the University of Western Australia induced aestivation in 11 desert frogs (three species of *Cyclorana* and eight *Neobatrachus* species). He observed them over a period of five months and took samples of the cocoons for examination using scanning and transmission electron microscopy.

At the onset of aestivation, the frogs adopted a 'water-conserving' posture, in which the front and back legs were

AUSTRALIAN PICTURE LIBRARY

Pilot whales have been observed carrying dead sea lions around for extended periods of time.

SHOP!

Visit the best Natural History shop in Australia

by Post

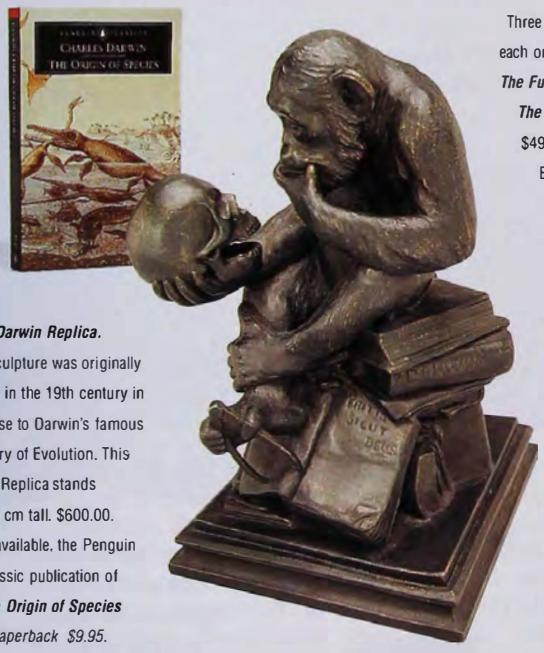
THE AUSTRALIAN MUSEUM

'Venus of Willendorf'
An exact replica of a Stone Age Fertility Fetish.
$50.00

UNIQUE OFFER

Three new books by Museum scientists, each one individually signed by the author.
The Future Eaters by Tim Flannery $24.95
The Vocanic Earth by Lin Sutherland $49.95 ***The Mammals of Australia*** Edited by Ron Strahan $75.00

Sterling silver men's hard gold clad ***Opal Triplet Cuff Links*** $75.00
Tie Tack $65.00
also available matching ***Shirt Studs*** (set of 4) $75.00.
Each set is presented in a stylish giftbox.



Darwin Replica.
This sculpture was originally created in the 19th century in response to Darwin's famous Theory of Evolution. This Replica stands 35 cm tall. $600.00.
Also available, the Penguin Classic publication of ***The Origin of Species*** *Paperback $9.95.*

Magnificent Opal Triplet Jewellery. Sterling Silver hard gold clad ***Pendent*** $75.00, matching ***Bracelet*** $75.00, and matching ***Ear Studs*** $49.00. Each is presented in a blue giftbox.

Profits from the Australian Museum shop help to fund research by the Museum's scientists.

Post or fax orders to this address:

Mail Order Shop
Australian Museum
6 College Street
Sydney NSW 2000
Fax: (02) 320 6066
Phone: (02) 320 6150

New CD rom releases. (Both run in Windows 95 and 3.1) ***Australian Mammals*** by Ron Strahan *$49.00*, ***Australian Birds*** by Terence Lindsey $49.00, ***Australian Frogs & Reptiles*** by Harold Ehmann and Michael Tyler $49.00. Also available Australian Museum Information discs ***Australian Frogs*** $19.00 ,or ***Australian Cicadas*** $19.00. (Requires IBM compatible computer with Windows 3.1 and VGA video adapter displaying 256 colours, 3Mb free disc space.)

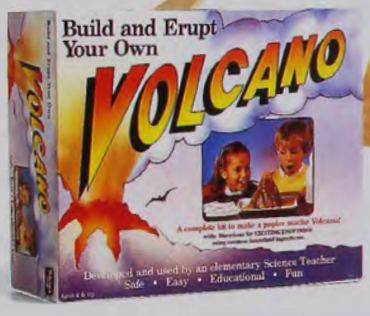
Aboriginal Art: World of Art Series. Perhaps the best overview of Aboriginal Art from rock painting to contemporary art. (paperback) $29.95. ***Tobwabba Art Fine China Plate*** (212mm) is a living portrayal of the rich and diverse culture of the Worimi people. $24.95. Matching ***Mug*** $12.95 ***Learn to Play the Australian Aboriginal Digeridu*** with a cassette tape by Peter Kaje. $16.00 (Available in German, Italian, Japanese, French and Spanish.) Go walkabout from the safety of your lounge with the ***'On Walkabout' Cushion Cover.*** $27.95

Payment should be made in *Australian Dollars* by Visa, Bankcard, Mastercard, American Express,or by personal shopping only.

Postage and packing (surface mail only):
Up to $29.95 = $3.50
$30 to $49.95 = $5.00
$50 to $69.95 = $6.50
$70 to $89.95 = $8.00
$90 to $109.95 = $9.00
$110 to $150.00 = $12.50

SHOP!

Build and erupt your own paper mache ***Volcano!*** For ages 4 and up. (Baking Soda and vinegar not included.) $39.95



Wooden Frog Construction Kit. This frog model kit requires no glue, just patience. Measures 14 x 5 x 10 inches. For ages 7 and up. $17.95

Nature in a box. Explore the world right outside your door with a ***Nature Craft Field Kit*** $24.95 or create one-of-a-kind prints using sunshine and water with a ***SunCraft Field Kit*** $24.95

Museum Fun Pack For Kids. Something for everyone here! It contains: ***My Animal Sticker Dictionary*** with over 100 stickers, ***Activities with Eric, Dinosaur Mazes*** an educational and activity book and a ***Grow your Own Sunflower kit!*** $19.95 the lot. *(Items not sold individually.)*

Anatomical fun! The foldout consertina ***Human Body*** book is packed with info $16.95. If you want more, ***The Human Body Kit*** is an interactive guide with models, book, poster and much more. $29.95

The Australian Museum and Mrs Cox presents ***The Minerals of Australia Collection.*** It contains 45 individually identified specimens. $12.95

Profits from the Australian Museum shop help to fund research by the Museum's scientists.

Jam Jar Science. Take the lid off a world of exploration and fun. Available: Birds, Bugs, Movement or Colour. $24.95 each. For ages 4 and up.

FUN THINGS 4KIDS

Australian Museum Frog T-Shirt. Kids sizes 4,6,8,10 or 12 $14.95. Adult sizes S M L XL $19.95.

Post or fax orders to this address:

Mail Order Shop
Australian Museum
6 College Street
Sydney NSW 2000
Fax: (02) 320 6066
Phone: (02) 320 6150

Payment should be made in *Australian Dollars* by Visa, Bankcard, Mastercard, American Express, or by personal shopping only.

Postage and packing (surface mail only):
Up to $29.95 = $3.50
$30 to $49.95 = $5.00
$50 to $69.95 = $6.50
$70 to $89.95 = $8.00
$90 to $109.95 = $9.00
$110 to $150.00 = $12.50

H. EHMANN

The transparent cocoon formed by this Water-holding Frog (*Cyclorana platycephala*) covers the animal's entire body surface, except for its external nares (nostrils).

tucked under the body, the head was bent down, and eyes were shut. Within a week a thin, see-through cocoon formed and this became progressively thicker and more opaque as the weeks went by.

Unlike lungfish cocoons, which are made from dried mucus, frog cocoons are formed by an accumulation of shed layers of outer skin. Normally this 'exuvium' is eaten by the frog but when the frog becomes inactive during aestivation it is allowed to accumulate, with an extra layer added every two to four days.

Although cocoon formation during aestivation appears to be a successful adaptation to the arid zone, not all desert frogs form one. Some rely on other tricks to maintain water balance, like urea accumulation while buried beneath the ground. But how do these frogs manage *not* to form cocoons? Presumably they are able to maintain some degree of activity, enough to periodically ingest the shed skin. But it is also possible that they might somehow, perhaps through hormonal control, stop shedding their outer skin layer.

—G.H.

Sizing up Ant-eaters

Specialised ant- and termite-eating mammals (myrmecophages) are found in Australia and southern Africa. But even where climate and soils are similar, Australian ant-eaters are significantly smaller than their African counterparts. In fact, Australia's largest ant-eater, the Short-beaked Echidna (*Tachyglossus aculeatus*) is only one-tenth the size of Africa's largest, the Aardvark (*Orycteropus afer*).

To shed some light on what factors might be responsible for this size difference, biologists Anthony Milewski (Museum of Natural History, Chicago), Max Abensperg-Traun (CSIRO Division of Wildlife and Ecology, Western Australia) and Chris Dickman (University of Sydney) recently investigated the history and ecology of myrmecophages on both continents.

Even where climate and soils are similar, Australian ant-eaters are significantly smaller than their African counterparts.

The researchers examined fossil and living evidence of the distribution and abundance of ant-eaters and their prey at a number of comparable study sites in Australia and southern Africa. They found no evidence that isolation or any phylogenetic constraints have restricted the development of large ant-eating mammals in Australia. Instead, Milewski and his colleagues suggest that the size difference between continents is a product of ecological factors: termites and ants are less productive and a more seasonably variable food source in Australia than southern Africa.

This is partly because Australian insects lack the

FERRERO/LABAT/AUSCAPE INTERNATIONAL

Africa's ant- and termite-eaters, like this Aardvark, dwarf their Australian counterparts.

QUICK QUIZ

1. Which of the world's penguins is the smallest?
2. What are jew's ears, earthballs and ink caps?
3. Snakes eat only live prey: true or false?
4. What is the title of the sequel to Michael Crichton's *Jurassic Park*?
5. Name the only State in Australia that can boast the absence of foxes.
6. What sort of bird is a Kea?
7. Give the name of the astronomical formation that orbits the sun between Mars and Jupiter.
8. What was Howard Florey (1898–1968) famous for developing?
9. Name the strait between Cape York Peninsula and New Guinea.
10. What is the largest invertebrate in the world?

(Answers in Q&A)

rich source of nutrients provided to their African counterparts by the trampled vegetation and dung that is produced by large numbers of large herbivores. Also, in Australia, the abundance of termites, and possibly ants, is limited by intense fires, which destroy much of the foliage and vegetation on which they depend for food.

So, despite superficial similarities between parts of the continents, it appears that large myrmecophages, like the African Aardvark, cannot be supported in Australia.

—R.S.

Roly-poly Salamander

A North American salamander really has a ball when escaping its predators. Mario García-París and Stephen Deban of the University of California at Berkeley made a startling discovery when they turned over a rock while working on the steep slopes of the northern Sierra Nevada of California. Underneath was a pair of salamanders (*Hydromantes platycephalus*) that promptly coiled up, tucked in their front and hind legs, and rolled about half a metre down the slope. They tested 12 more and all but one curled up into a tight ball and

COURTESY STEPHEN DEBAN

To escape from predators, the salamander *Hydromantes platycephalus* curls itself up in a ball and rolls down the hill.

rolled passively down the slope.

Coiling is quite a common defence among salamanders, so, in order to see if the rolling was just a fluke, García-París and Deban returned to the lab and tested another 15 salamander species for coiling and rolling. They tested for coiling by tapping the amphibians on the back or on the head. Seven species showed some form of coiling behaviour, although few species formed the really tight balls seen in *H. platycephalus*. They then tested for rolling by placing coiled salamanders on a 45 degree incline of moist paper towel. Only two species showed any signs of rolling and in these it was only partial.

The researchers speculate that the unique habitat of *H. platycephalus* is responsible for its novel escape behaviour. This species is the only one in its genus to live among volcanic and granitic rocks at high elevation. The combination of steep slopes and the presence of lots of small stones allows the salamanders to roll away relatively unnoticed, for the coiled salamanders look just like small stones when rolling down the slope.

—G.T.

Brontosaurus: Doubly Dead

What ever happened to poor old *Brontosaurus*? Not only did it become extinct like the rest of the dinosaurs but, to add insult to injury, it's now lost its name.

It started in 1877 when the palaeontologist Charles Marsh wrote a paper describing some of the dinosaur fossils recovered from the United States. He named one small sauropod (long-necked) dinosaur *Apatosaurus* and later, in the same paper, he described a much bigger sauropod as *Brontosaurus*. *Brontosaurus* soon became famous around the world because it was a relatively complete specimen of gigantic proportions, while the small, scrappy specimen of *Apatosaurus* was relegated to relative obscurity.

But in 1903 Elmer Riggs showed that *Brontosaurus* and *Apatosaurus* were actually one and the same, the *Apatosaurus* specimen being a juvenile *Brontosaurus*. Strictly speaking, the first name proposed (*Apatosaurus*) should take precedence, yet people had become very comfortable with the term *Brontosaurus* and continued to use it. Familiarity is a hard thing to kick.

The issue was forgotten until the 1970s when more complete specimens of '*Brontosaurus*' were found and it was realised that the original specimen had been given the wrong head. (It was a bit like having a monkey's head on a human skeleton!) So, with the publication of this news, the authors saw it timely to remind the world that, according to the International Code of Zoological Nomenclature, the real name for '*Brontosaurus*' is *Apatosaurus*. So *Brontosaurus* is dead. In more ways than one.

—Paul M.A. Willis
Quinkana Pty Ltd

Further Reading

Antor, R.J. & García, M.B., 1994. A new mite–plant association: mites living amidst the adhesive traps of a carnivorous plant. *Oecologia* 101: 51–54.

Bell, C.M. & Padian, K., 1995. Pterosaur fossils from the Cretaceous of Chile: evidence for a pterosaur colony on an inland desert plain. *Geol. Mag.* 132: 31–38.

Evans, T.A., Wallis, E.J. & Elgar, M.A., 1995. Making a meal of mother. *Nature* 376: 299.

García-París, M. & Deban, S.M., 1995. A novel antipredator mechanism in salamanders: rolling escape in *Hydromantes platycephalus*. *J. Herpetol.* 29: 149–151.

Guinet, J. & Bouvier, J., 1995. Development of intentional stranding hunting techniques in killer whale (*Orcinus orca*) calves at Crozet Archipelago. *Can. J. Zool.* 73: 27–33.

Godin, J.-G.J., 1995. Predation risk and alternative mating tactics in male Trinidadian guppies (*Poecilia reticulata*). *Oecologia* 103: 224–229.

Henschel, J.R., Davies, V. Todd & Dickman, C.R., 1995. The slit spider (Araneae: Clubionoidea) that constructs fissures in the sand dunes of the Simpson Desert, Central Australia. *J. Nat. Hist.* 29: 137–145.

Kohda, M., Tanimura, M., Kikue-Nakamura, M. & Yamagishi, S., 1995. Sperm drinking by female catfishes: a novel mode of insemination. *Environ. Biol. Fishes* 42: 1–6.

Marshall, S.D., Thoms, E.M. & Uetz, G.W., 1995. Setal entanglement: an undescribed method of stridulation by a neotropical tarantula (Araneae: Theraphosidae). *J. Zool. Lond.* 235: 587–595.

Mathis, A., Chivers, D.P. & Smith, R.J.F., 1995. Chemical alarm signals: predator deterrents or predator attractants? *Am. Nat.* 145:994–1005.

Milewski, A.V., Abensperg-Traun, M. & Dickman, C.R., 1994. Why are termite- and ant-eating mammals smaller in Australia than in southern Africa: history or ecology? *J. Biogeog.* 21: 529–543.

McIntosh, J. & Berman, D.S., 1975. Description of the palate and lower jaw of *Diplodocus* (Reptilia: Saurischia) with remarks on the nature of the skull of *Apatosaurus*. *J. Paleontol.* 49: 187–199.

O'Connell, S.M. & Cowlishaw, G., 1994. Infanticide avoidance, sperm competition and mate choice: the function of copulation calls in female baboons. *Anim. Behav.* 48: 687–694.

Ott, M. & Schaeffel, F., 1995. A negatively powered lens in the chameleon. *Nature* 373: 692–694.

Shane, S.H., 1994. Pilot whales carrying dead sea lions. *Mammalia* 58: 494–498.

Warkentin, K.M., 1995. Adaptive plasticity in hatching age: a response to predation risk trade-offs. *Proc. Natl Acad. Sci. USA* 92: 3507–3510.

Withers, P.C., 1995. Cocoon formation and structure in the aestivating Australian desert frogs, *Neobatrachus* and *Cyclorana*. *Aust. J. Zool.* 43: 429–441.

Carrie Bengston (a science communicator for the CSIRO), Karen McGhee and Rachel Sullivan (freelance science writers living in Sydney) and Geordie Torr (a zoologist at James Cook University) are regular contributors to Nature Strips.

PETER SCHOUTEN

***Apatosaurus*: a new name and facelift for *Brontosaurus*.**

High as kites on anything from crunched-up superphosphate to old car tyres, they gormandise, run, fight, build nests and grind their teeth all night.

RATBAGS OF THE RAFTERS

BY STEVE VAN DYCK

SOME THINGS LIKE HAIRCUTS and rodents are introduced so early in life that it is almost impossible to remember your first. On the way home from school on Sydney's Central and Wynyard railway platforms we used to fire stones from slingshots at the rats that were thick in the black eerie tunnels. In between train arrivals they would run out of the darkness, through the cigarette butts and along the tracks, grabbing spilled Twisties and unspeakable lumps of gristle spat from meat pies, screeching and fighting with each other, before charging back into the gloom when the rumble of the next train was almost upon them.

Those big, greasy brutes were everything a rat was supposed to be, and a memorable introduction to something you'd never want living on your doorstep. I could be forgiven then, after moving with my parents up to Brisbane, for wondering what sort of black hole we'd come to, when among the first of our visitors were two big grunting men from the Council with funny metal buckets, spades and vicious fox-terriers on one of their regular patrols—looking for...rats...around people's houses! I couldn't sleep at night knowing that those doberman-sized Wynyard rodents had hopped a train to Brisbane. It would surely be only a matter of time before they recognised me and the smell of my slingshot!

But the Brisbane 'roof rats' or 'climbing rats', as the Council 'ratters' called them, were as different from the Sydney tunnel variety (Brown or Sewer Rats, *Rattus norvegicus*) as the gauge of the tracks between them. The 'roof rats' were really Black Rats (*Rattus rattus*).

Black Rats are sleeker, less vicious, more timid and arboreal than Brown Rats and, with a constitution evolved for mischief-making, it is probably just as well the natural life span of a Black Rat only amounts to about 12 months. So just when it has parented 60 to 100 offspring, and perfected the technique of chewing electrical wiring down to the copper, its life is suddenly snuffed out along with its first birthday candle.

The very nature of that awesome reproductive potential—five to ten pups born after a 21-day gestation period and weaned after three weeks, five to six litters per year and the young sexually mature at three months—means one sure thing: that where there is one Black Rat, there will be a ceiling full.

In 1758 Linnaeus chose the short, crisp scientific name *Rattus rattus* to christen the medium-sized, blackish rat that was common in Europe (and, according to recent Australian biochemical research, that probably had its origins in South-East Asia). This species, now more common in Australia than it is in Europe, embodies most of everything we have come to regard (and detest) as 'rat-like'. It was responsible for piggybacking the flea that carried the bubonic plague bacillus, plunging Europe into the 'Black Death' where, in London alone, 100,000 people died in 1665. Even today the Black Rat transmits salmonella and leptospirosis through its urine and droppings.

You don't even have to be tardy with the housekeeping to be visited by this rat either. Because of its round-the-coast distribution in mainly disturbed habitats of Australia, and its affinity for all things human, there really are very few houses that haven't had a call from the Black Rat. To add a beguiling touch of irony to its affinity with us, so appealing is this masquerader in its sleek suit of steel grey–black with white belly and sparkling big black eyes, that it is often mistaken (and excused—even fed and encouraged) for something native and far less noxious.

But don't be fooled. This rat is a snake in the grass. Its long history of close association with humans has bred into it a cunning strong enough to resist the most tempting bait laid so carefully on a straining trap.

Locally, we recognise the work of Black Rats by any combination of the following: neat gouges drilled out of ripening paw paws, mangoes hollowed out from one end, Niagara Falls cascading from behind the washing machine through chewed-out rubber hose pipes, macadamia nuts drilled out and robbed of their treasure, pitter-patter and squeals-d'amour in the ceiling at night, day-old chicks roughly scalped, potted

MARIE LOCHMAN/LOCHMAN TRANSPARENCIES

The Black Rat travelled from South-East Asia to Europe and then onto Australia with the First Fleet.

seedlings ripped up and their roots nipped off, curtains stripped and stolen for nesting. If these signs are unfamiliar, you might have noticed big caches of garden snail shells under pieces of corrugated iron, or huge nests of sticks or grass and leaves measuring up to two metres across. It takes either a penthouse resident or a fibber to come away from this list shaking his head in denial.

If you have ever had to spend a night in a shed or house infested with Black Rats, you will appreciate what wild affairs all-night rat-parties are. The going down of the sun is the signal for all lusty rats to rise, select their partners and rush onto the dusty floor and commence the rodent-rigadoon. With screeches of joy and rage they chase one another around the rafters, across the fibro and down the architraves. Commonly used runways and squeeze-holes quickly take on a greasy, stained tinge, souped up by the rats' chin and belly rubbings, which help delineate territories. Any wood in the way is quickly whittled down with those notorious, constantly growing, yellow incisors.

High as kites on anything from crunched-up superphosphate to old car tyres, they gormandise, run, fight, build nests and grind their teeth all night. One Australian study showed that during July, Black Rats hunted baby birds and eggs which made up 40 per cent of their diet. At other times they ate an astonishing amount of underground fungus. In mangroves, where they are abundant and often mistaken for native Water-rats (*Hydromys chrysogaster*), they kill large crabs and mud lobsters leaving extensive middens of crustacean shells up in tree hollows.

But don't conclude that the entire Black Rat story is a negative one. They do have their uses. A friend of a friend managed to inject some genuine passion into a religious revival meeting by smuggling in a wild Black Rat concealed in a bag. After a rousing sermon where the aging evangelist pleaded for signs and manifestations from heaven, the congregation plunged into prayer. The pastor, sensing the receptive disposition of the flock, called for the praying sinners to come forward in a public display of their new commitment.

This was the awaited moment, and the livid rat was liberated among the kneeling legs. The holy reverend, in his weakest moments of self-indulgence, had never dreamed he was capable of drumming up such a response. He beamed as one by one bodies leapt into the air, arms were flung up above the bowed heads, and people clambered up onto their seats. The religious fervour was spreading like a holy plague. Women were fainting like soldiers in the sun, and hardened grown men were hurling themselves into the aisles. The elated rector was beside himself. And, judging by the shouting, the unfamiliar language and the assorted calls to one or more of the Trinity, for a while he concluded that here, truly, was a return to Pentecost.

But don't be deceived. If your belled, curfewed and sterilised cat catches a sleek rat in the laundry, see if the rodent's tail is longer than its body. If it is, and its big ear can be pushed forward to cover its eye, then the cat deserves the meal. There is no other native, rat-sized mammal that can be easily confused with this long-tailed impostor. *Rattus rattus* may already be a champion climber, but no other rat so richly deserves a helping hand up the stairway to heaven. ■

FERRERO/LABAT/AUSCAPE INTERNATIONAL

Black Rats have an almost frightening capacity for reproduction, with females giving birth to 60–100 young in their first and only year of life.

BLACK RAT
Rattus rattus

Classification
Order Rodentia, family Muridae.

Identification
Steel grey–black to brown, often with pure white belly; head and body length 16–21 cm; tail about 1.5 times that of the long, slender body; longish ears.

Distribution and Habitat
Originally from South-East Asia, and accidentally introduced to Europe in 13th century, and from there to Australia with First Fleet. Lives in most of the Australian coastal cities and towns, in cool temperate to tropical regions.

Behaviour
Nocturnal; good climber and swimmer; builds nest of sticks, grass or leaves. Becomes sexually mature at 3 months; 5–10 young per litter; gestation period 3 weeks; 5–6 litters per year. Lifespan 1 year, although up to 3 in captivity.

Diet
Food scraps, carrion, wide range of plant material including fruits, fungi, even baby birds and eggs.

Further Reading

Watts, C. & Aslin, H., 1981. *The Rodents of Australia.* Angus & Robertson: Australia.

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

The discovery of this frog has profound implications for our knowledge of the biogeography of south-western Australia.

THE SUNSET FROG

BY GRANT WARDELL-JOHNSON, DALE ROBERTS & PIERRE HORWITZ

A BIZARRE NEW FROG WAS discovered in January 1994 during a survey of wetlands in Western Australia's south-west corner. The Sunset Frog was immediately recognised as unique, as it has an external appearance like no other Australian frog. It is brilliantly coloured, with a mottled blue and white belly contrasted against bright orange legs, hands, chest and throat. The back is covered with knobbly brown skin. It is a moderately large frog with the females around 35 millimetres long and males slightly smaller. Molecular studies have since shown that this new genus (in the family Myobatrachidae) represents a relictual lineage, possibly up to 30 million years old.

The Sunset Frog is known from just three well-separated peat swamps, all at about 110 metres elevation within 30 kilometres of the south-west coast. Its habitat covers just five hectares over an area of less than four square kilometres and, as such, the frog has the dubious honour of being one of Australia's most restricted known vertebrates. We are yet to learn whether the three populations are genetically discrete, which may indicate a long period of isolation. The discovery of this frog has profound implications for our knowledge of the biogeography of south-western Australia, and also for the management of this area.

The Sunset Frog, as well as two other recently discovered frogs in the south-west region of Western Australia—the White and Orange-bellied Frogs (*Geocrinia alba* and *G. vitellina*)—were all found in organically rich, isolated, permanently moist swamps in a seasonal environment. Over the last 20 years, south-western Australia has been the subject of numerous *ad hoc* surveys as well as area-based surveys for specific groups. As a result, the vertebrate fauna was thought to be well known. These discoveries, however, demonstrate a need to re-examine our assumptions about the biodiversity of south-western Australia. The wet zone, in particular, may include a richer biota of phylogenetic relicts than previously thought. The change from subtropical wet to seasonally arid climates five to six million years ago, and an associated increase in the frequency of fires, have meant that relicts may remain only in pockets of favourable microhabitat that most resemble the earlier, wetter environment. These species have persisted through millions of years and their precarious status in well-separated swamps is no doubt attributable to this change in environment.

PHOTOS: GRANT WARDELL-JOHNSON

The males of the Sunset Frog emit a loud and deep 'du-duck' call from shallow pools when the temperature rises in late spring and early summer. The eggs are deposited in the pools individually (that is, not in a clump or mass) and, like most frogs, there is a free-swimming tadpole stage. A fire in the spring of 1994 burnt much of the swamp habitat in one of the three sites, including the surface layer of large areas of peat, the substrate upon which the species depends. However, 150 or so frogs were subsequently heard calling from the pools or seepages in the burnt area (the species had not been heard calling prior to this fire), and eggs were also laid. More intense fires in summer or autumn, when the surface of the peat becomes drier, may be of greater potential danger to the frogs. We suspect such fires may have been responsible for the older, metre-deep holes that scar the peat of many swamps in the area.

Much is still to be learnt about the Sunset Frog and its habitat. How can its habitat be managed to avoid the loss of the fire-sensitive substrate? Can the slowly accumulating peat layer be replenished during the interval between fires? The answers to these questions may well decide the future of the Sunset Frog. Other likely future threats to the habitat of the frog include pigs, and plant disease such as that caused by the fungus *Phytophthora*, which kills many plant species and has simplified many biotic communities in south-western Australia.

The Sunset Frog occurs entirely within publicly managed land. Thus, once the needs of the species are understood, there is a chance to maintain its habitat within an area of continuously distributed native vegetation. However, the declaration of its habitat as national park will not in itself be enough to secure its survival. Careful fire management to maintain its organic-rich habitat, disease and pest control, and access limitations may all be necessary if we are to ensure the persistence of the Sunset Frog. ■

Further Reading

Wardell-Johnson, G. & Horwitz, P. (in press). Conserving biodiversity and the recognition of heterogeneity in ancient landscapes: a case study from south-western Australia. *Forest Ecology and Management.*

At the time of writing, Dr Grant Wardell-Johnson was a Senior Research Scientist with the Western Australian Department of Conservation and Land Management, based at Woodvale. He is currently working in the Botany Department of the University of Namibia. Dr Dale Roberts is a Senior Lecturer in Zoology at the University of Western Australia; and Dr Pierre Horwitz is a Senior Lecturer at the Centre for Ecosystem Management at Edith Cowan University, Western Australia.

Among Australian pioneers there was a popular view that bitter-tasting plants were medicinal.

BITTER BARKS AND BERRIES

BY TIM LOW

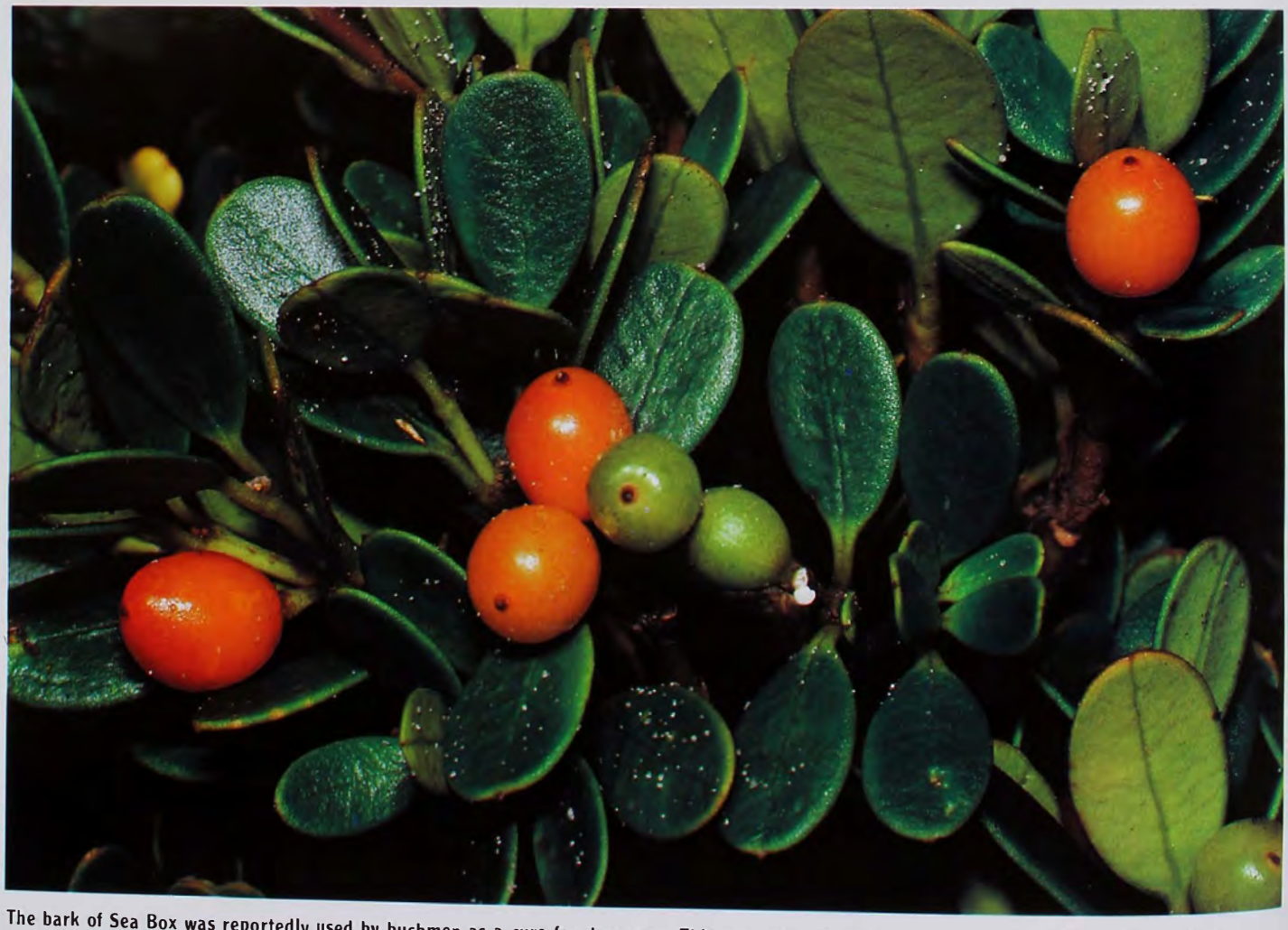
THE LEICHHARDT TREE (*NAUCLEA orientalis*), found along stream banks in northern Australia, is one of those plants that gives bush tucker a bad name. Its strange brown fruits are edible, and smell pleasantly like bananas, but once sampled they assault the tongue with so much bitterness they are impossible to enjoy. Literally, they are a bitter disappointment.

This bitter taste extends to the bark, which northern Queensland pioneers used in lieu of hops for brewing beer. Even the wood is bitter, and it was carved by bushmen into a 'bitter cup', as Robert Johnstone described in 1904: "This is done by making a cup and filling it with water, and letting it stand at night; in the morning it is very bitter, and drunk in cases of fever". Johnstone claimed the fruits were also good for fever.

Among Australian pioneers there was a popular view that bitter-tasting plants were medicinal, and that the bitter property was especially effective against fevers. It was well known that European willow bark (from *Salix fragilis* and *S. purpurea*) eased general fevers, and that South American cinchona bark (from *Cinchona* species) cured malaria. Willow bark contains a glycoside (salicin) and cinchona bark contains an alkaloid (quinine), both of which taste bitter. From this it was assumed that anything bitter was therapeutic.

Two native plants from Queensland and northern New South Wales became very popular as bitter remedies—Quinine Bush (*Alstonia constricta*) and Quinine Berry (*Petalostigma pubescens*). The reputation of Quinine Bush, a shrub or small tree with milky sap, can be gauged from its remarkable range of common names. Farmers to this day know it as Quinine Tree, Quinine, Bitter Bark, Fever Bark or Peruvian Bark.

Colonial botanist Joseph Maiden wrote tellingly that the bark "tastes remarkably like Cinchona bark, and seems to partake somewhat of the properties of both quinine and strychnine. This drug is undoubtedly worthy of



PHOTOS: TIM LOW

The bark of Sea Box was reportedly used by bushmen as a cure for dysentery. This attractive shrub is common on coastal dunes in southern Australia.

careful experiments by medicinal men."

Experiments were forthcoming from Brisbane doctor Joseph Bancroft, who wrote in 1886 that "After fifteen years' experience of the use of Alstonia the writer is of opinion that there is no better or more generally useful tonic."

The bark was exported to London, and a decoction was peddled in the colonies as 'bitters'. Prepared as a tincture (infused in alcohol) it supposedly cured early stages of typhoid fever. Colonial chemists testing the bark could find no quinine, but they did find other alkaloids such as reserpine, which tranquillises and lowers blood pressure.

Quinine Berry, also known in the past as Bitter Bark, Native Cinchona and Quinine Tree, is a small spreading tree bearing crops of hard orange fruits. Both fruits and bark are so intensely bitter they were both deployed in bush medicine. Bushmen popped the fruits into their tea believing this bestowed protection from malaria. Some colonial writers claimed the extracts were an excellent tonic and fever cure, but others were critical, as no therapeutic compounds could be found. One doctor dismissed the bark as physiologically inert, or practically so.

Another bitter plant that earned the scorn of science was Sea Box or Dysentery Bush (*Alyxia buxifolia*), a sprawling shrub of southern seashores used to treat dysentery. A patent was granted in 1888 to produce 'Austral Marine Bitters' from this plant. Joseph Maiden was scathing: "An 'extract' of this plant, presumably of the bark, was sold as a patent medicine for a short time, and wonderful were the virtues claimed for it on the prospectus. I do not doubt that these claims are every bit as valid as those of quack or patent medicines in general."

Other bitter plants tested or taken as remedies included Red-fruited Laurel (*Cryptocarya laevigata*), Native Gardenia (*Tabernaemontana pandacqui*), Tape Vine (*Stephania japonica*), Native Centaury (*Centaurium spicatum*) and Mountain Gentian (*Gentianella diemensis*). In some cases a bitter taste was taken as proof of medical powers, but the more prominent colonial doctors were more critical, subjecting these plants to detailed analysis, including cruel experiments on animals. Dr Thomas Bancroft injected bitter extracts of Socketwood (*Daphnandra repandula*) into cats, guinea pigs, frogs and grasshoppers, paralysing them.

Today there is renewed interest in Australian medicinal plants, inspired in part by the dramatic success of the tea tree oil industry. One starting point for modern research would be the many articles written by doctors and botanists in the late 19th century, analysing, extolling and sometimes dismissing the therapeutic properties of a swag of bitter native plants. ■

Mountain Gentian was recommended last century as a substitute for European Gentian, a bitter herb prescribed to aid digestion.

Further Reading

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. & Leight, J.H., 1992. *Plants of western New South Wales.* Inkata Press: Melbourne.

Johnstone, R.A., 1984. *Reminiscences of pioneering in north Queensland.* J.W. Johnstone-Need: Cairns.

Maiden, J.H., 1898. Indigenous vegetable drugs. Part II. *Agric. Gaz. N.S.W.* 40–53: 131–141.

Tim Low is a Brisbane-based writer and environmental consultant.

METROPOLITAN MONOTREMES

BY MELODY SERENA

The capture of a juvenile female near the mouth of Diamond Creek indicated that Platypuses breed successfully to within 15 kilometres of downtown Melbourne.

MOST AUSTRALIANS WOULD not be surprised to encounter a Platypus (*Ornithorhynchus anatinus*) in a pristine river or the rocky pools of a remote mountain stream. Suggest that these remarkable animals might also be found in the rivers and creeks of a big city and you will probably be greeted with scepticism. However, a recent investigation of urban Platypus populations—the first such work to be undertaken in Australia—indicates that these distinctive monotremes can coexist with large numbers of people.

Early in 1995, biologists from the Australian Platypus Conservancy and Melbourne Water Corporation initiated surveys to find out if Platypuses live in urbanised parts of the Yarra River catchment. Helped by a keen band of community volunteers, pairs of eel (or fyke) nets were set along more than 80 kilometres of waterways around Melbourne, using methods previously tested in Platypus studies in the less trammelled reaches of the upper Yarra (see *Nature Aust.* Spring 1995).

Platypus biologists work mostly at night, when their study animals are more likely to be out and about. By notifying local residents of planned field work we hoped to prevent nervous neighbours mistaking the sight and sound of shadowy figures, splashing about with torches in the wee small hours, for signs of criminal activity. However, researchers in urban areas are themselves well advised to be wary. On one memorable occasion, two survey team members returned to their vehicle at 3 a.m. to find it occupied by four drunken youths intent on procuring a free ride home from the pub. Another time, a pair of nets was nearly obliterated by a trailer-load of rubbish that was tipped illegally from a bridge shortly after dark.

Nets were initially set over a four-month period along the Yarra River and adjoining segments of seven of its main tributary creeks. The study area stretched from Dight's Falls, a large man-made weir only a short distance upstream from the Melbourne Central Business District, to the outer fringes of the metropolitan area, 25–30 kilometres from the city centre. Habitats ranged from semi-rural creeks thickly flanked by blackberry bushes, to inner suburban waterways littered with hypodermic needles. To the surprise of many people, a total of 12 Platypuses were trapped along four of the seven tributary streams, including areas subject to heavy human disturbance. Four animals were encountered within 200 metres of busy highways. In addition, an adult male was caught swimming a few metres from the edge of a soccer field on which a noisy game was in progress under blazing floodlights! Along the Yarra

AUSTRALIAN PLATYPUS CONSERVANCY

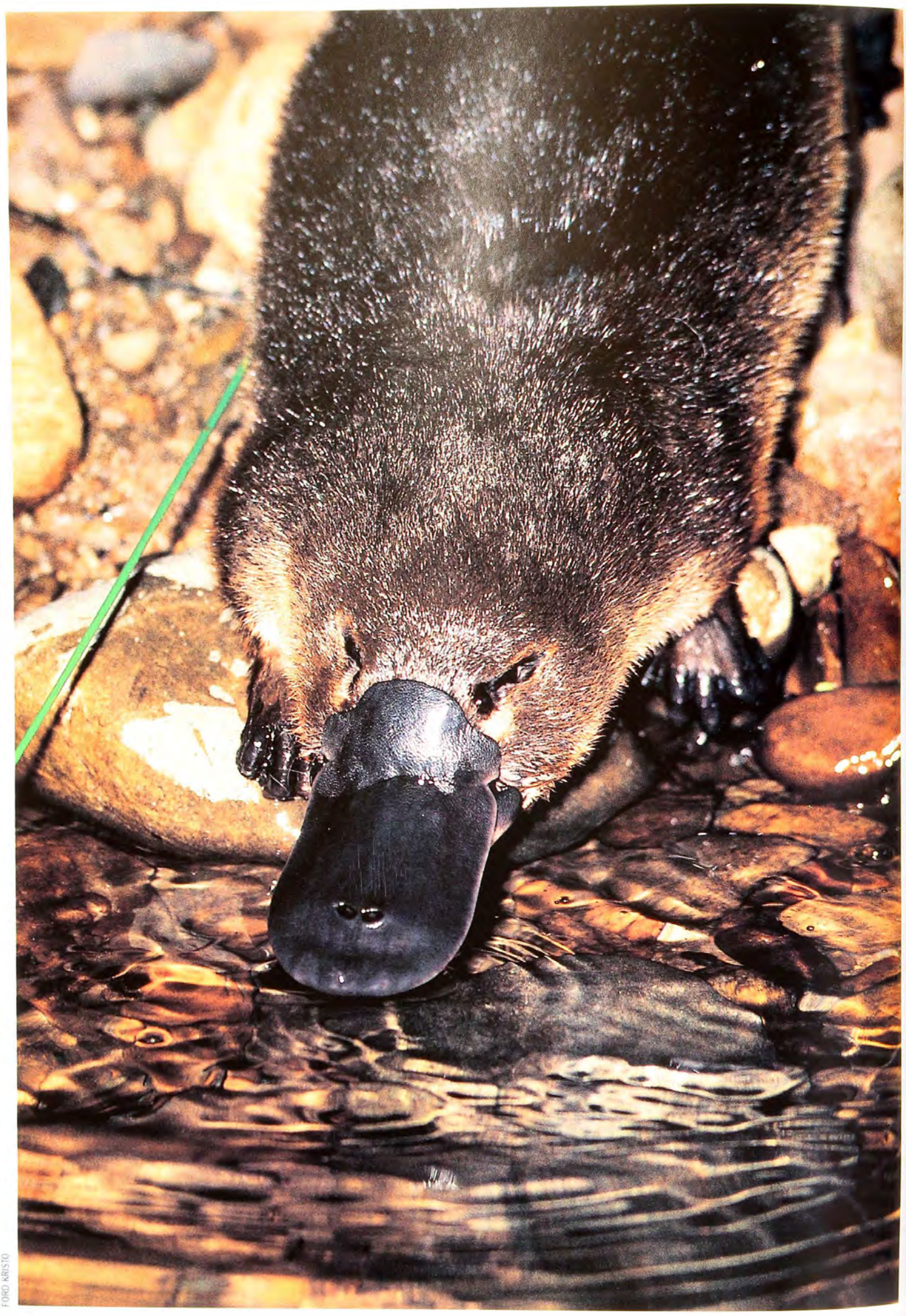
Platypus survey nets being set along the lower reaches of Mullum Mullum Creek, where three Platypuses were caught in two nights of trapping. This stretch of creek is a short distance downstream from the Templestowe Electricity Terminal Station in Melbourne's eastern suburbs, less than 14km from inner Melbourne.

itself, the capture of a juvenile female near the mouth of Diamond Creek in early March, shortly after young Platypuses first emerge from their nesting burrows in Victoria, indicated that Platypuses breed successfully to within 15 kilometres of downtown Melbourne.

The bad news was that Platypus numbers in suburban habitats were generally low compared to less disturbed waterways located in the upper reaches of the Yarra. No animals at all were encountered in the two streams sampled closest to the city centre—Merri Creek and Darebin Creek—suggesting that Platypus populations are missing entirely from this area. In short, while Platypuses can apparently live alongside humans, conditions for the animals appear to be far from ideal in much of the Melbourne metropolitan region.

THIS FIRST ROUND OF SURVEYS HAS PROvided a tantalising 'snapshot' of Platypus distribution in an urban area, but much more work is required to identify which factors are most important in limiting Platypus numbers in such habitats. To assist future research, each Platypus has been given a permanent identification mark, using the same type of silicon chip transponder commonly used to identify cats and dogs. This tiny cylindrical device, about the width of a pencil lead, is inserted just under the skin of the back and causes no discomfort to the Platypus. The code contained in the transponder can be easily deciphered with a scanner while an animal is held in a cloth bag and, with nearly a trillion combinations of numbers and letters available, there is no risk of misidentification.

In order to improve our understanding of Platypus conservation requirements, a variety of information is being collected in the course of the surveys. Along with standard measurements and weights, the physical condition of animals is assessed with respect to their level of body fat. Platypuses store nearly half of their total fat reserves in the tail, allowing condition to be graded on a five-point scale, using a 'squeeze test' to judge plumpness. An animal is given a score of 1 if the tail is so fat that its edges do not bend when pressed gently, whereas the tail of a starving Platypus



FORD KRISTO

TED DONELAN

Platypuses have their own specially adapted tick and the number of these ticks infesting each individual can be an indication of the animal's health.

(scored as a 5) is flaccid and strap-like. Interestingly, while urban individuals in the Yarra catchment are less numerous than their country cousins, they are just as fat, with both groups typically scoring 2 or 3 on this tail fat scale in summer.

Another potential clue to Platypus well-being is provided by noting the number of external parasites carried by the animals. While extended daily immersion in water appears to keep most skin parasites at bay, the Platypus has its own specially adapted species of tick (*Ixodes ornithorhynchi*), which in turn is suspected to be responsible for spreading at least two known types of intracellular blood parasites among Platypuses. These ticks mainly cluster on the lower hind legs—the one place that the Platypus cannot easily reach when grooming with the claws on its hind feet. The number of ticks on a given Platypus can vary greatly, from none to more than 600. As another facet of health investigation, any scars or signs of injury on the bill or body are carefully recorded. This information is being used to help assess whether urban Platypuses are being harmed by sharp or jagged pieces of rubbish in their environment, such as broken bottles.

The Platypus is proving to be far more tolerant of human habitation than previously thought.

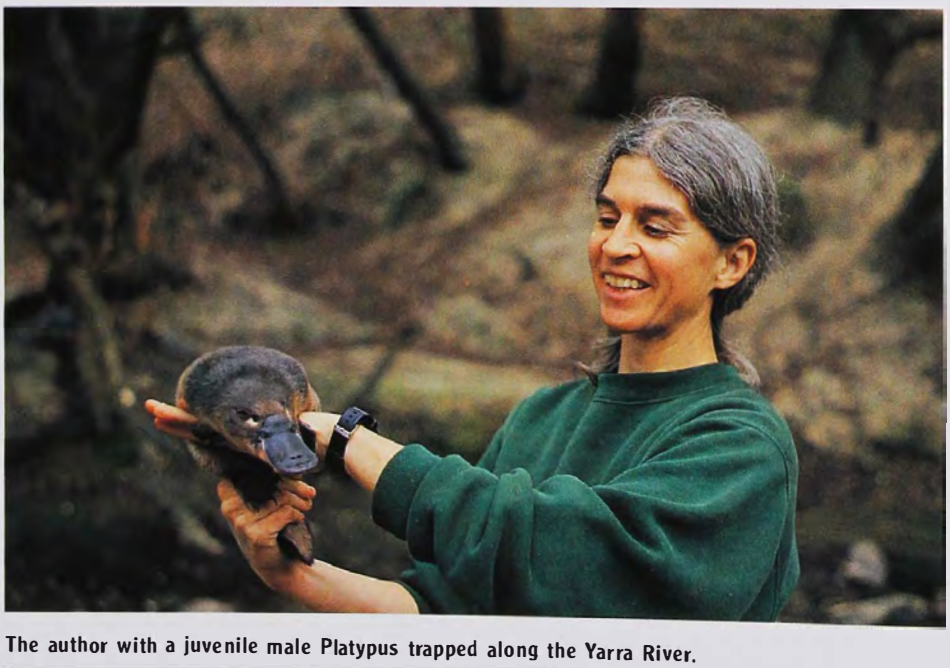
Experienced veterinarians on the research team lightly anaesthetise the Platypuses while they are being examined, thereby minimising any associated stress. This also makes it easier to collect small samples of blood, which are currently contributing to population genetic studies (at Monash University) and an investigation into seasonal variation in normal blood cell and biochemistry patterns (at Central Veterinary Diagnostic Laboratory in Melbourne). Platypus serum is also being analysed at Monash University to detect antibodies against leptospirosis—a water-borne bacterial disease transmitted via the urine of many animals, including cattle and pigs. Early results indicate that the majority of adult Platypuses in the study area have been exposed to this disease at some time in their life, although the number currently infected still needs to be assessed.

To provide information on Platypus diet in disturbed habitats, samples of food residues are obtained from the animals' cheek pouches, using a small cotton swab. Because Platypuses can remain under water for only a few minutes at a time, they temporarily store partially masticated prey in these pouches until returning to the surface to further chew and swallow their food. Analysis of the pouch contents therefore provides a good guide as to what the Platypus has been eating. The findings to date indicate that urban Platypuses, like their non-urban counterparts, are not fussy diners, consuming a variety of aquatic invertebrates down to the size of

These ticks mainly cluster on the lower hind legs—the one place that the Platypus cannot easily reach when grooming with the claws on its hind feet.

AUSTRALIAN PLATYPUS CONSERVANCY

A view of Mullum Mullum Creek near the farthest upstream point where an adult male Platypus was encountered. The fact that these animals can persist in such disturbed habitat is a tribute to their adaptability.



AUSTRALIAN PLATYPUS CONSERVANCY

The author with a juvenile male Platypus trapped along the Yarra River.

larval chironomid flies (or midges). This information is being linked to invertebrate surveys carried out by the Melbourne Water Corporation, providing a better understanding of Platypus food supplies in the metropolitan area.

Clearly, much remains to be discovered about the urban Platypus. Meanwhile, it is reasonable to assume that efforts to clean up waterways, stabilise and revegetate banks, reduce pollution and control feral pests are likely to benefit not only the Platypus but the many other native species that share its freshwater habitat. By accepting the challenge of restoring the quality of our urban waterways, there appears to be no inherent reason why residents of eastern Australia's large cities cannot enjoy having the Platypus, one of the world's most unusual animals, as a permanent neighbour. ■

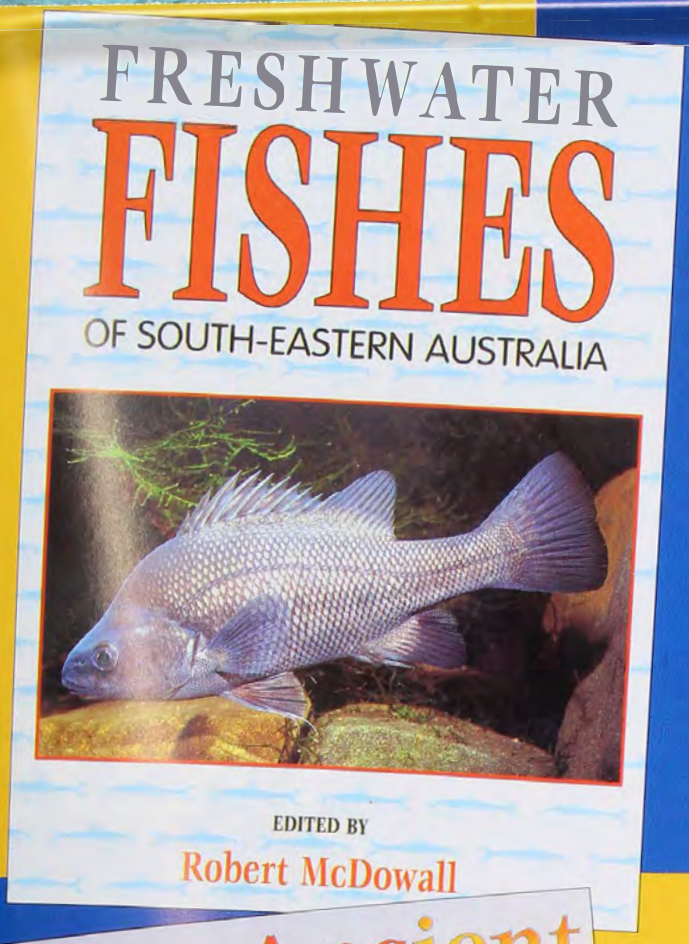
Further Reading

Gardner, J.L. & Serena, M., 1995. Spatial organisation and movement patterns of adult male platypus, *Ornithorhynchus anatinus* (Monotremata: Ornithorhynchidae). *Aust. J. Zool.* 43: 91–103.

Grant, T.R., 1992. The historical and current distribution of the platypus, *Ornithorhynchus anatinus*, in Australia. Pp. 232–254 in *Platypus and echidnas*, ed. by M.L. Augee. Royal Zoological Society of New South Wales: Mosman.

Grant, T.R., 1995. *The Platypus: a unique mammal.* (2nd ed.) New South Wales University Press: Kensington.

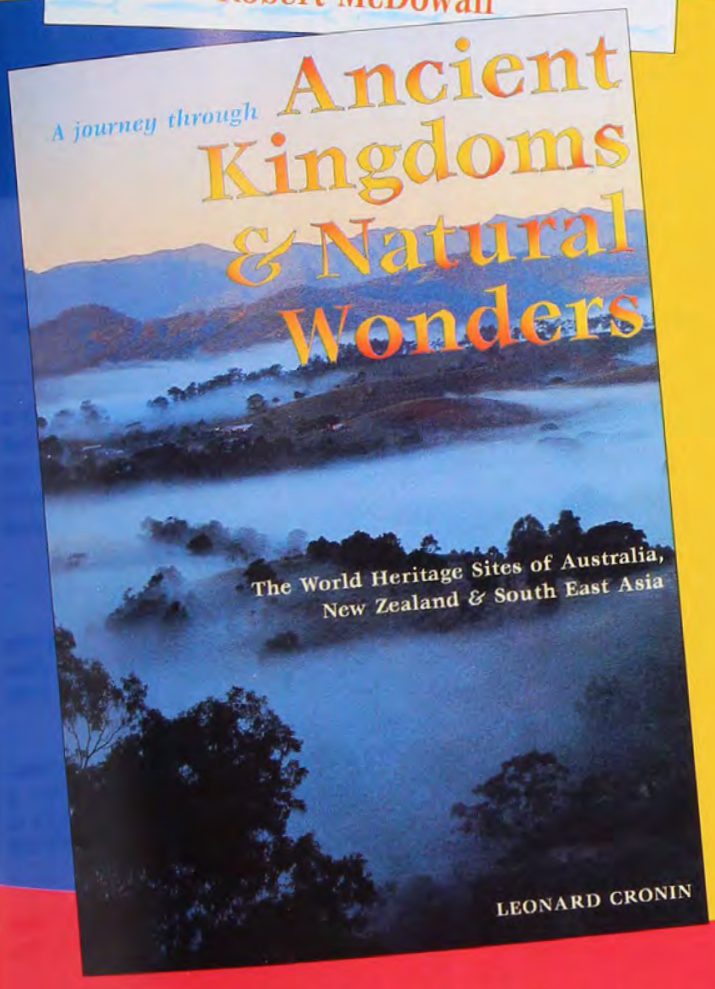
Melody Serena works as a conservation biologist with the Australian Platypus Conservancy, based at Toorourrong Reservoir Park at Whittlesea, near Melbourne.



FRESHWATER FISHES OF
SOUTH-EASTERN AUSTRALIA
Edited by Robert McDowall

Compiled for anglers, aquarists, fisheries biologists and enthusiastic amateur naturalists, this field guide provides comprehensive information on fishes in the huge Murray-Darling river system, those living in rivers draining to the coast from about Brisbane south and west to Adelaide, and those in the numerous rivers and lakes of Tasmania.

ISBN 0730104621, A REED BOOK, rrp $39.95



A JOURNEY THROUGH ANCIENT
KINGDOMS & NATURAL WONDERS
Leonard Cronin

Take the journey of a lifetime to the World Heritage sites of Australasia and South East Asia - through wilderness areas and wildlife sanctuaries, underwater ecosystems and coral gardens, glaciated mountain ranges and volcanic peaks, to the island home of the Komodo dragon, the temples of Borobodur and Prambanan, and the ancient Khmer city of Angkor.

ISBN 0730104885, A REED BOOK, rrp $34.95

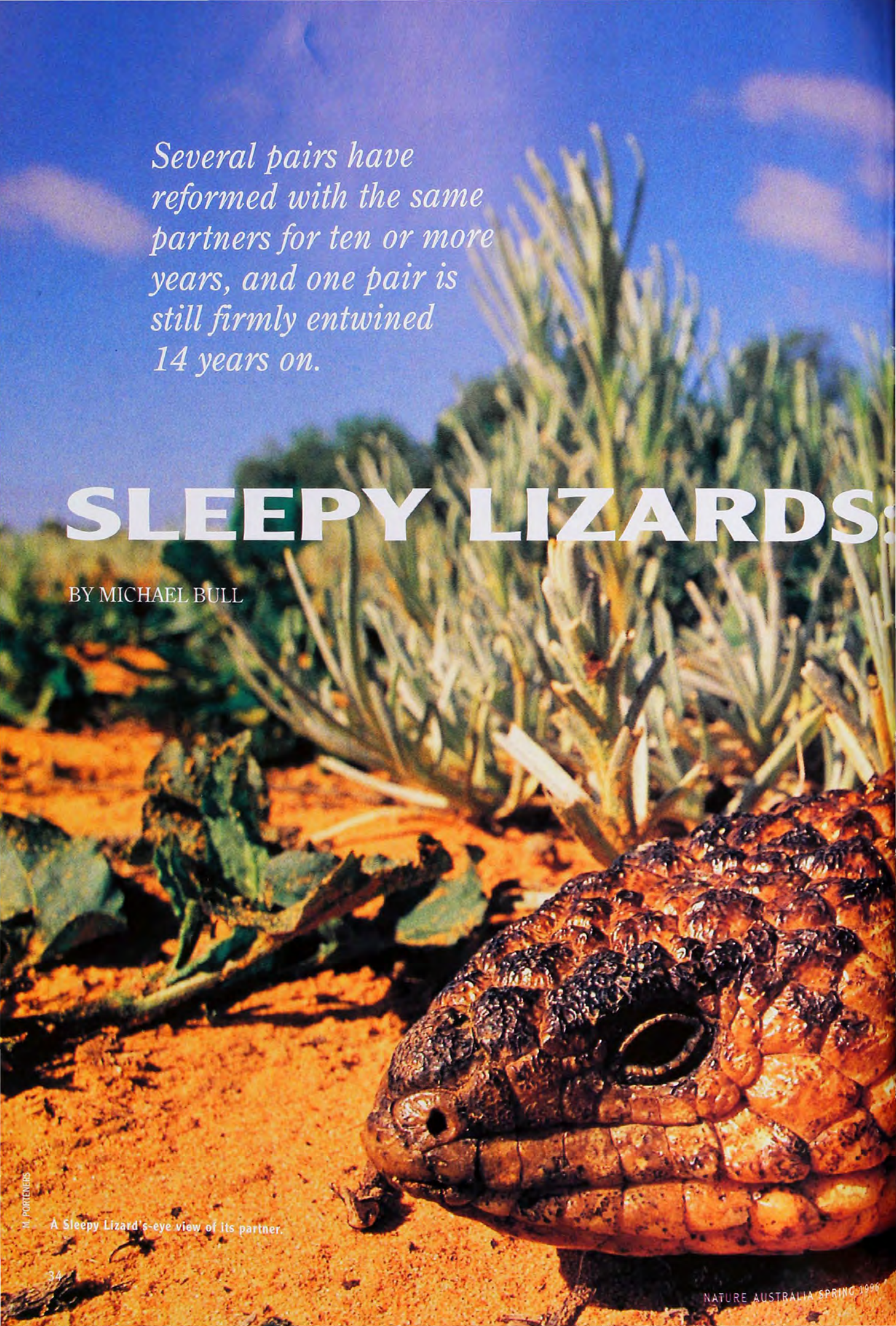
TO RECEIVE **10% DISCOUNT** OFF THE RECOMMENDED RETAIL PRICE,
INCLUDING P & H WITHIN AUSTRALIA, CALL TOLL FREE 1800 064 869
NOW AND HAVE CREDIT CARD DETAILS READY.

REED BOOKS

Several pairs have reformed with the same partners for ten or more years, and one pair is still firmly entwined 14 years on.

SLEEPY LIZARDS:

BY MICHAEL BULL



M. PORTENERS

A Sleepy Lizard's-eye view of its partner.

PAIRED FOR LIFE

NO LIZARD ANYWHERE IN THE world has ever before been reported to show pair fidelity. Pair fidelity is when a mating partnership is maintained over successive reproductive seasons. The same two individuals, one male and one female, get together repeatedly for mating. It's what humans do, or what we suppose they do. A host of mammal species, birds, and even fish show this behaviour, but no-one had ever found a lizard species that stays faithful...that is, until now.

The Sleepy Lizard (*Tiliqua rugosa*) is one of Australia's largest skinks. It occurs widely over the southern part of the country and goes under a variety of different names. In the west, they call it the Bobtail Goanna or, more affectionately, the Bobby. In South Australia, where I come from, we call it the Sleepy Lizard. Victorians call it the Stumpy Tail, in western New South Wales it is the Bog-eye, and in western Queensland, the Shingleback. In October 1830, when none of these names was in common parlance, Captain Collet Barker gave an unmistakable description of lizards that he called 'guanas' near the current city of Albany, Western Australia: "None of them offered to run away though I took one up. After being put down he still continued near, opening his mouth continually & making a kind of snap towards me. At last he moved slowly over my foot & crept under some long grass." No other Australian lizards combine this display of bravado and nonchalance. They had to be Sleepy Lizards. And when Barker reported how he found three of these lizards, "the first by itself, the two others together", he was describing lizard pairing, a phenomenon that is fascinating biologists today.

How individual animals associate with one another is a central question in animal social behaviour. In mammals and birds we know there are many forms of social grouping. Some species, like tigers, seem to work in isolation; others, like Australian Magpies or wolves, form small cohesive groups; and still others, like Budgerigars and sheep, form larger flocks or herds. Superimposed on these various social groupings, mammals and birds show a diversity of partnership relations. Some mate more or less haphazardly with whomever they encounter; in others, one sex, usually the male, will maintain exclusive access to a group of partners; and others, like most human societies, are largely monogamous. Even fish and insects show components of this rich behavioural diversity. But what about lizards?

The exciting thing is that this long-term pair fidelity in our Australian Sleepy Lizards has never been reported for any other reptile in the world.

For a long time there has been a general feeling that, when it comes to social behaviour, lizards are the simpletons of the animal kingdom. Some are known to form territories, and the brilliant colour patterns on some of Australia's agamid lizards, like the Painted Dragon (*Ctenophorus pictus*), are thought to be the visual signals they use to advertise and maintain those territories. But other species, like the secretive skinks, were thought of as mostly solitary and ethologically boring...until the discovery of pair fidelity in Sleepy Lizards.

LIKE MANY SCIENTIFIC DISCOVERIES, I came across this behaviour quite fortuitously. I was actually investigating the ticks that infest lizards. We were working in the flat Murray Plains region of South Australia. This is semi-arid bluebush country, north of a one-hotel town called Mt Mary (although the 'mount' must have got blown away after the town was named). Like Captain Barker in 1830, we frequently found pairs of Sleepy Lizards together in the spring time. They seemed to do every-

Pairs of Sleepy Lizards forage together on the growing tips of small plants. This pair has been disturbed while feeding.

KEN GRIFFITHS

KEN GRIFFITHS

Sleepy Lizards often avoid the midday heat by sheltering in convenient shade. During the spring, monogamous pairs seek shelter together and it is common to find them in physical contact like this pair.

thing together, often within a few centimetres of each other. They fed on the flowering roadside weeds together, they sheltered under bluebushes from the hot midday sun together and, when moving from one place to another, they wandered in tandem formation, with his nose closely following her tail.

Over our first spring, with the help of some discrete paint marks, we came to recognise many of the individual Sleepy Lizards in our site. And we were intrigued to discover that over a six- to eight-week period the partnerships remained intact. Partner swapping was a definite rarity.

The reward for this persistent pairing comes in late October or early November when the lizards mate. I have not often seen Sleepy Lizards mating, but those few occasions were rather special. The male comes from behind the female and gently bites along her flank. Successive bites are delivered closer and closer to her head, like a lover's kisses. Finally he clamps his massive jaws around her head (it must be hard to embrace in any other way when he needs his four legs for support), and she responds by straightening her hind legs, and raising her tail off the ground. It should be pointed out that the male attempts these precursors to mating, the courtship ritual, several times during the spring. If the female is not ready to mate, she simply moves away after the first 'kiss'. The male then resumes his patient pursuit, and eventually his perseverance pays off. When the female is willing to mate, he slides his body close to hers and twists around a little. Male lizards are equipped with two penises, or hemipenes as they are technically known, which can be extended sideways, so mounting is not needed. They just lie together, coupled in the warm sun for a few minutes. They separate, then amble off in different directions. They remain apart for the next ten months. By late November almost all of the lizards we find are solitary, and they stay that way until the following spring.

This monogamous pairing within one spring was interesting, but not unique. There are several other lizards species where it has been reported that one male stays with the same female for the whole mating season. But our next discovery was far more exciting.

In the second spring of our study we found pairs forming in exactly the same combinations as the first year. It was not a completely identical match-up, but over 80 per cent of the pairs were just as they had been, with the same male following the same female through the bluebushes. We have now been following our Sleepy Lizards for 14 years, and

SLEEPY LIZARD

Tiliqua rugosa

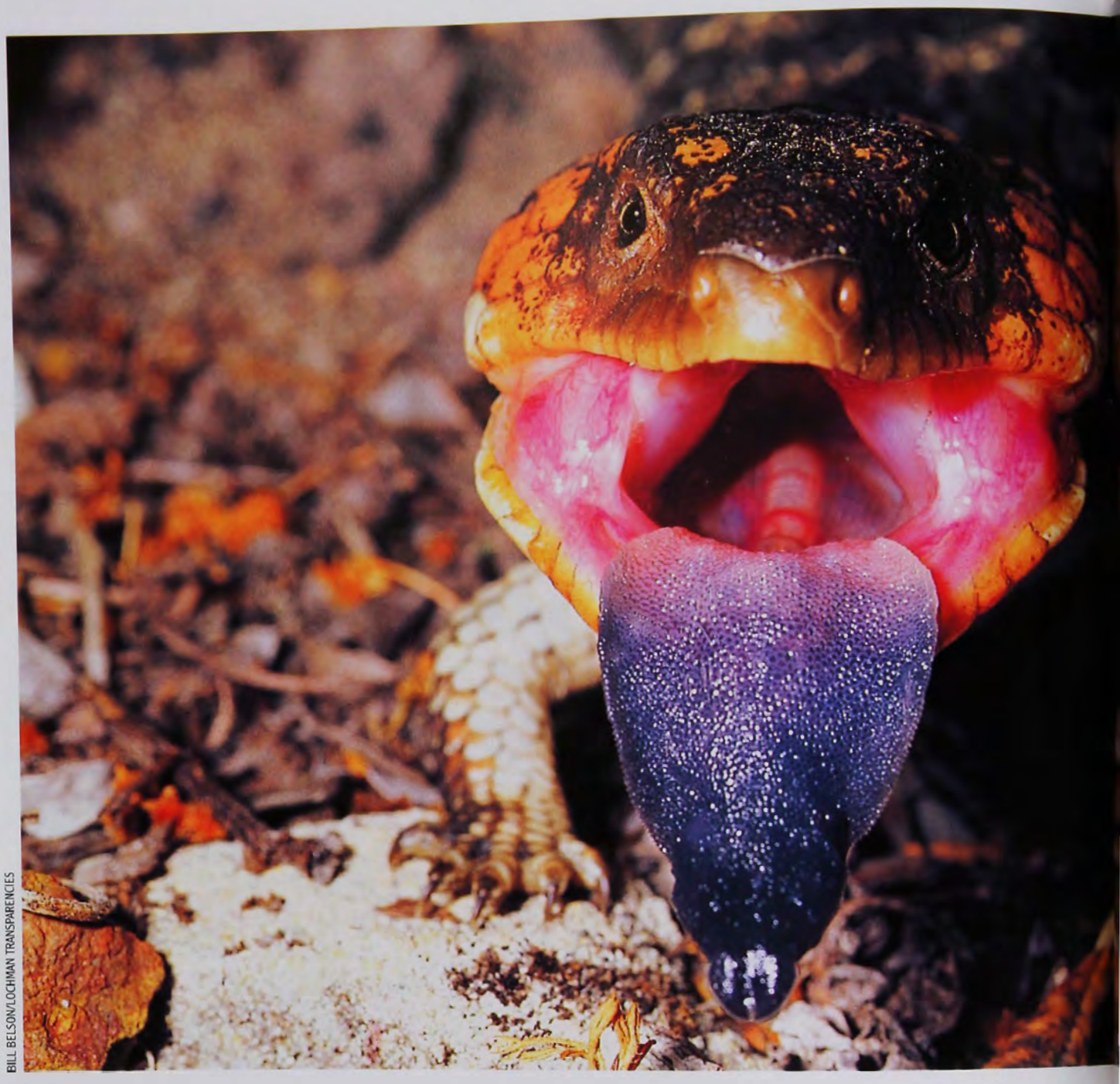
Classification
Class Reptilia; family Scincidae. Other common names include Shingleback, Stumpy Tail, Bobby, Bog-eye.

Identification
Blue tongue; large, thick scales on back (sometimes likened to a pine cone); large size, weighing up to 1 kg and commonly measuring up to 30 cm from snout to vent; variable body colour, from brown to grey to black, with variable blotching, usually in yellow (WA specimens often with orange or red head markings); tail usually short and blunt, but elongated and pointed in some specimens.

Distribution
Widespread in southern Australia, west of the Great Dividing Range.

Biology
Long-lived (up to 30 years); omnivorous diet with vegetation the major component.

Reproduction
Live bearing, one to four young per clutch, young born in late March or early April; the only reptile known to exhibit pair fidelity.



BILL BELSON/LOCHMAN TRANSPARENCIES

the pattern of fidelity turns up year after year. Several pairs have reformed with the same partners for ten or more years, and one pair that we recorded in our first season is still firmly entwined 14 years on. Of course the fidelity is not perfect (some lizards change partners after a run of several years); but then neither is the fidelity of 'monogamous' humans completely perfect. The exciting thing is that this long-term pair fidelity in our Australian Sleepy Lizards has never been reported for any other reptile in the world.

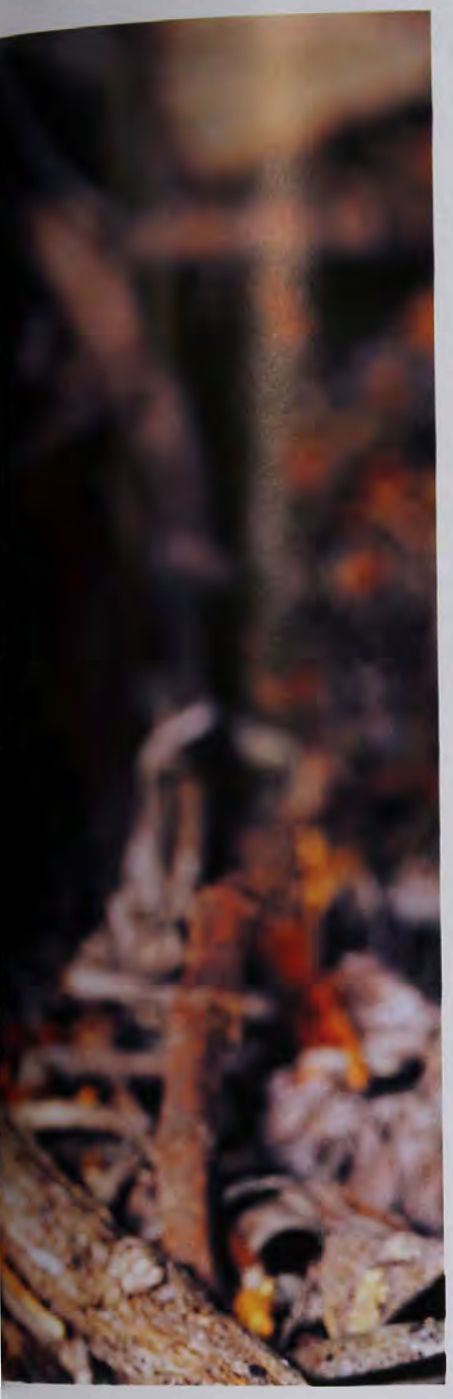
THIS DISCOVERY HAS ADDED A COMPLETELY new perspective to our understanding of lizard social behaviour. All of a sudden we have to envision a broad new range of social skills for this group: faithfulness to one partner, the ability to recognise different individuals from the crowd, and the retention of a memory, over most of the year, of which individual you were with last spring. But how do they find and recognise each other, and why do they bother?

The how questions are sometimes easier to answer. At our site we have been watching some pairs carefully as they go about their daily routines. They are not always together. On some days one partner wanders off alone, and ends up spending the night in a solitary refuge, up to 200 metres from its mate. Inevitably the two lizards find each other again within a day or two. This cannot be by visual searching because, being so low to the ground, their horizon must be very short. We have tried to copy this separation experimentally, by moving the partners a short distance apart. They easily relocate each other, and we think they use chemical signals, called pheromones. In other reptiles, chemicals for communication have been detected from skin secretions, from glands on the legs, and from the cloacal vent.

Our Sleepy Lizards have three ways of finding each. Sometimes they will follow the exact path their partner took previously, using their tongue to recognise their partner's trail on the ground. This method is not infallible because, when they come across the trail, there is no indication of which way it was laid. We have seen some lizards encounter their partner's trail, then follow it in the wrong direction, going away from their partner. They may be clever, but not that clever!

Lizards can also sense their partners by signals wafting in the air. If trail-following is unsuccessful, they lift their heads in the air, and flick their tongues in an attempt to sense their partner's smell. If the wind is in the right direction, this can lead to a quick reunion.

Finally they can use their memory of



Handle with care! Sleepy Lizards cannot run very fast, but they have an impressive defensive display that deters potential predators. Many humans are wary about picking them up and with good reason, as those powerful jaws can clamp onto a finger and cause significant pain.

past events. We saw one male looking for his partner. He headed for a patch of flowering plants where they had fed together on the previous day. We had seen his female partner feeding there again earlier that morning. She arrived and left using a route different from the one the male took. He circled the patch, ignoring the tempting flower heads that Sleepy Lizards gorge on in the spring. After the second circuit, he located her out-going trail. He followed the trail back to the bush where she was resting, and the pair was together again.

It seems that Sleepy Lizards have a sophisticated variety of strategies to ensure the partnership remains intact. Although we do not yet know the exact nature of the chemical signals, we assume that each lizard has a unique signal, and that partners can recognise each other and remember those signals from year to year.

The next question is why stay with the same partner? Any complex behaviour, where animals behave differently from random, can usually be explained by natural selection. Those individuals with the behaviour have some advantage over those without it. So what advantage is there for Sleepy Lizards choosing the same partner each year? I am afraid we do not know yet.

In mammals and birds there is a theory that familiar males and females know each other's various skills, and combine more efficiently than two strangers would to raise their young. For them, long-term fidelity is advantageous because more young are produced. But, as far as we know, lizards show little parental care, and the father has nothing to do with his offspring beyond fertilisation.

However it may still be advantageous to mate with a familiar partner. During the long spring courtship of Sleepy Lizards, females may need continual attention to make them receptive. That may happen faster with a male she recognises from last year.

Another theory about fidelity concerns disease control. The close association during partnership may lead to transmission of disease or parasites. If a lizard has avoided disease with a healthy partner one year, then it may be safest to stick with that partner the next year. That of course is exactly the strategy that health authorities are now advising humans to adopt, to avoid sexually transmitted diseases like AIDS.

Our research has already shown exciting and unexpectedly advanced social skills in these delightful Australian lizards. We hope that continuing work will help to reveal appropriate explanations. Perhaps other lizards have equally complex behaviours. We just need to take the time to look. ■

Further Reading

Bull, C.M., 1988. Mate fidelity in an Australian lizard *Trachydosaurus rugosus. Behav. Ecol. Sociobiol.* 23: 45–49.

Bull, C.M., 1990. Comparisons of displaced and retained partners in a monogamous lizard. *Aust. Wildl. Res.* 17: 135–140.

Bull, C.M., Bedford, G.S. & Schulz, B.A., 1993. How do sleepy lizards find each other? *Herpetologica* 49: 294–300.

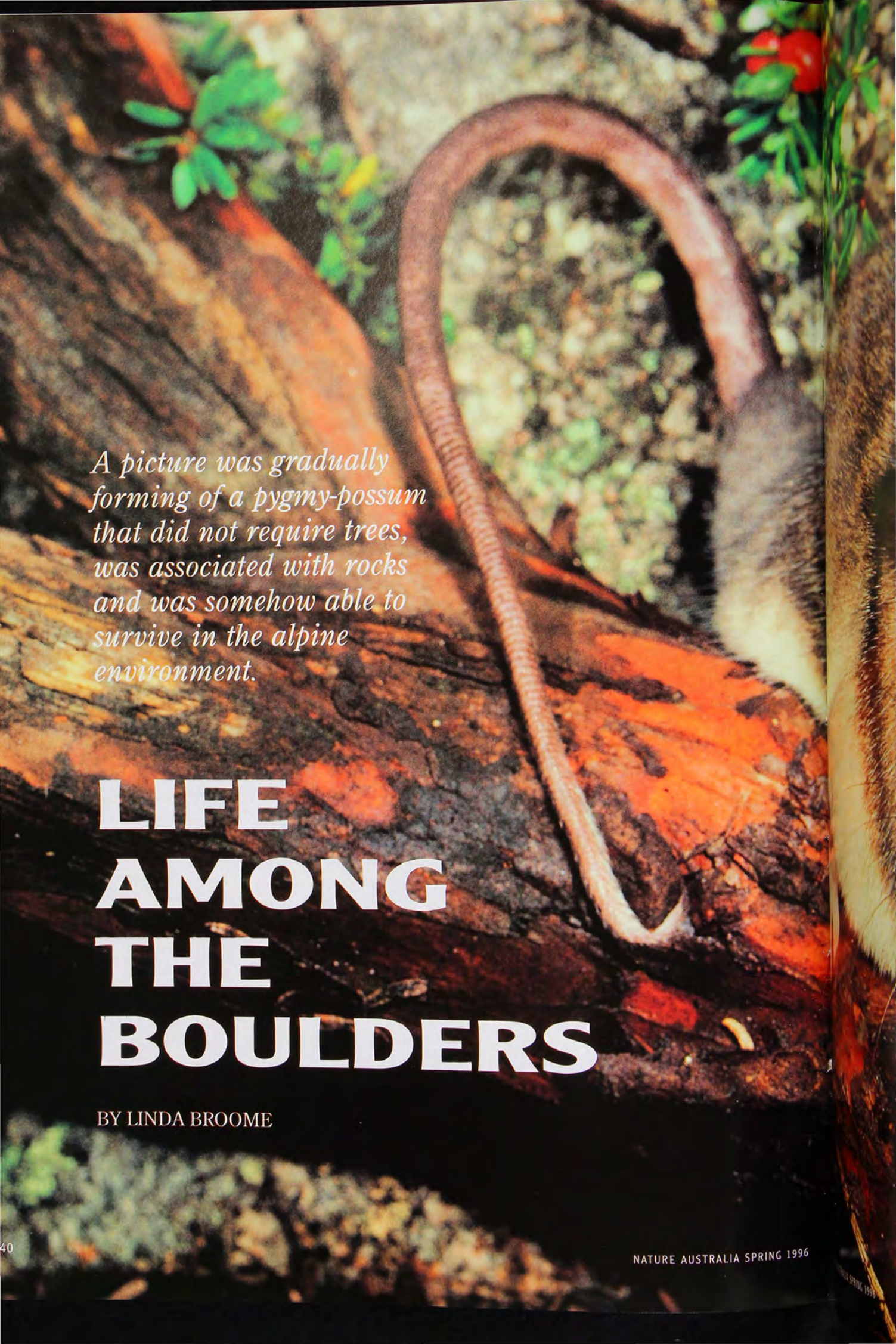
Bull, C.M., McNally, A. & Dubas, G., 1991. Asynchronous seasonal activity of male and female sleepy lizards, *Tiliqua rugosa. J. Herpetol.* 25: 436–441.

Mulvaney, J. & Green, N., 1992. *Commandant of solitude. The journals of Captain Collet Barker 1828–1831.* Melbourne University Press: Melbourne.

Michael Bull is Associate Professor in the School of Biological Sciences at Flinders University where he and his research group have been studying Sleepy Lizards at Mt Mary since 1982.

H. EHMANN

The reward for a season of faithfulness! In late spring a female will accept a male's approaches and allow mating. Here the male starts to bite gently along the female's flank, this activity being a prelude to mating.



A picture was gradually forming of a pygmy-possum that did not require trees, was associated with rocks and was somehow able to survive in the alpine environment.

LIFE AMONG THE BOULDERS

BY LINDA BROOME

Mountain pygmy-possums undertake the serious business of gaining weight in late summer and autumn, doubling their spring body weight in preparation for a winter spent in hibernation. This adult female is well on the way, weighing in at nearly 80 grams.

LINDA BROOME

IN 1894 A YOUNG SCOTTISH DOCTOR, Robert Broom, discovered a small pocket of fossil bone breccia at Wombeyan Caves in southern New South Wales. Along with the bones of other small marsupials and rodents was the jawbone of a previously undescribed marsupial. A striking feature of the tiny jawbone was the large, grooved premolar, which suggested to Broom that this was a small phalanger (possum) with characteristics similar to those of rat-kangaroos. Broom named the animal *Burramys parvus*. 'Burra burra' was the local Aboriginal word meaning 'place of rocks', *mys* was Greek for 'mouse' and *parvus* Latin for 'small'. Although this was a marsupial, and not a mouse ('marsupial' not being a word in common usage among the Greeks, Latins or indeed the Aborigines), the scientific name, literally 'small rock mouse', was prophetic.

Further fossil bone deposits were later found in other caves (in 1960 from Pyramids Cave near Buchan in Victoria and more recently at Jenolan Caves, New South Wales) which, like the Wombeyan Caves deposit, were attributed to owl predation. The bones were dated from around the late Pleistocene, 25–30,000 years ago, and *Burramys* was regarded as extinct—until 1966, when one was found in a ski lodge at Mt Hotham, Victoria. The animal, a male, aroused much publicity and scientific interest. By this time, *Burramys parvus* was well and truly recognised as a small non-gliding possum similar to pygmy-possums of the genus *Cercartetus*, and it subsequently gave its name to the collective family (Burramyidae). Since other small possums are arboreal (tree dwelling) and the immediate environment, being under several metres of snow at the time, was considered to be much too hostile to support such a small animal, it was hypothesised that the animal must have been brought up to the ski lodge from lower elevations in a load of firewood.

LINDA BROOME

Holding the red fruit-like receptacle of a Mountain Plum-pine (*Podocarpus lawrencei*) in one paw, a Mountain Pygmy-possum cracks the hard seed with its sharp premolar. Both the seed and fruit form an important part of the diet during autumn.

Nothing further was seen of *Burramys* until February 1970, when a female was trapped near Schlink Pass in Kosciusko National Park, at 1,784 metres elevation. A month later, another two individuals were caught 1.5 kilometres north-east of Guthega Dam (1,540 metres elevation). The natural environment at these sites consisted of rocky, granite outcrops with a thick shrub layer beneath Snow Gums

IAN MANSERGH

The author live-trapping Mountain Pygmy-possums in boulderfield habitat. Walnuts are used as bait, and the traps are lined with insulation and covered with a plastic bag to keep the animals warm and dry. Note the small ear tag used to identify each individual.

(*Eucalyptus pauciflora*). These discoveries directed attention back to Mt Hotham, where in February 1971, three individuals were trapped in rocky heathland near the ski lodge in which the first male had been found. In March 1972, 11 *Burramys* were trapped in granite boulderfields well above the tree-line near the summit of Mt Kosciusko, the highest peak on the Australian mainland (2,228 metres elevation). A picture was gradually forming of a pygmy-possum that did not require trees, was associated with rocks and was somehow able to survive in the alpine environment. Further trapping surveys in the late 1970s and early 1980s revealed that the Mountain Pygmy-possum, as it had become known, was confined to the alpine and subalpine areas of south-eastern Australia, at elevations above 1,400 metres.

In December 1985, while working at Utah State University in the United States, I received a phone call from Australia. "Would you like to conduct a study of the Mountain Pygmy-possum at Mt Blue Cow, in Kosciusko National Park?" I was asked. I had been radio-tracking deer mice (*Peromyscus* spp.) under the snow (at surface temperatures down to –40°C, not allowing for wind chill), so I thought why not; nothing could be worse than Wyoming at 2 a.m. in midwinter.

When I arrived at Mt Blue Cow in January 1986, my initial smugness was somewhat short-lived. It soon became clear that I would have to go into mountain goat mode. Over the next four years, with the help of many unsuspecting volunteer helpers, I was to trap and radio-track Mountain Pygmy-possums from the foot of the mountain near Perisher Creek to the summit of Mt Blue Cow and all the way across to Guthega and back, night after night in fog, blizzard, ice storm and gale. At times, when I had tramped half a dozen times from mountain peak to creek, or on one occasion when frightened out of my wits by strange, growling sounds coming out of a gully where I knew I had to get a location from one of the possums (it turned

FRITZ GEISER

A Mountain Pygmy-possum in its hibernating 'furry ball' position. This position allows for the maximum amount of heat retention by exposing the smallest possible surface area of the body to ambient temperatures. Here the animal has been turned over to show the position of its limbs.

out to be water entering a pipe but it did sound awfully threatening at 3 o'clock in the morning!), I did stop to ask myself "Why am I doing this?". But on still nights, when the "stars fairly blazed at midnight", or the moonlight shone through the knarled and twisted old Snow Gums and lit the snow so that I had no need for my headlamp, I felt a sense of peace and discovery that far outweighed any minor discomforts. I usually radio-tracked six or so possums at a time during each three-week-long tracking period. A number of times during the mild nights of summer, I woke to the flush of dawn, having curled up on a bed of snowgrass (*Poa* sp.) in between taking radio fixes.

I RADIO-TRACKED A TOTAL OF 42 MOUNTAIN Pygmy-possums during the snow-free season over the four years, and was continually amazed at how far the tiny animals with their radio-transmitter collars travelled. Weighing only around 40 grams in summer, it was nothing for females with large pouch young to travel from the base of the mountain to the peak, a straight-line distance of 900 metres (and 275 metres elevation), and back in a night. Adult males could quite easily do this twice in a night. One night, male 081 (I gave up giving them names after the first summer, instead referring to the individual numbers on their ear tags) led me on a 1.5-kilometre trek all the way to Guthega where, at dawn, I found him in a boulderfield nest site near the Parachute ski run and myself pushing through waist-high alpine heath in a swirling fog, my radio-receiving antenna clutched in hand. Subsequently I found that it was common practice for him and several other males to switch between daytime nest sites here and on the mountain peak, often travelling there and back again in a night.

Weighing only around 40 grams in summer, it was nothing for females with large pouch young to travel from the base of the mountain to the peak, a straight-line distance of 900 metres and back in a night.

These studies, along with work by Ian Mansergh (Conservation and Natural Resources) and colleagues near Mt Hotham and Judy Caughley (CSIRO) in the Kosciusko area, have shown that Mountain Pygmy-possums are largely restricted to periglacial blockstreams and blockfields. These are rivers of rock left by near-glacial conditions, or piles of boulders formed in depressions below mountain peaks. Collectively, we call them boulderfields. The animals are entirely terrestrial (ground dwelling) and radio-tracking has shown that they cross between boulderfields only where there is a dense cover of vegetation.

Analysis of their droppings has shown

A Mountain Pygmy-possum peeps out from a gap between granite boulders. The tiny pygmy-possums are capable of flattening their bodies much like lizards in order to squeeze through narrow cracks in their rocky habitat.

LINDA BROOME

LINDA BROOME

that 63 per cent of the diet is made up of arthropods (insects and other invertebrates), with the remainder being mainly seeds and fruits. In spring and summer a major component of the diet is the Bogong Moth (*Agrotis infusa*). This nondescript, small (three-centimetre body length), brown moth makes a remarkable annual migration from its breeding grounds on the western slopes and plains to spend the summer in aestivation (summer hibernation) among the rocks and boulderfields of the alpine peaks. The fat reserves of these moths can be up to 65 per cent of their body weight. On Mt Blue Cow, as on other areas, the highest numbers of moths were found on the mountain peak, hence the long-distance movements of the possums during summer. In late summer

Mountain Pygmy-possums and other small possums can be distinguished from rodents and marsupial mice by the fusion of their second and third toes below the first joint on each hind foot, a condition known as syndactyly. The prehensile tail (capable of curling and gripping) is another diagnostic feature.

Mt Blue Cow in December 1993, viewed from half way up the mountain at the loading station of the 'Summit' ski lift (1,795 metres elevation). This is prime Mountain Pygmy-possum habitat consisting of alpine heathland shrubs and overlaying boulders.

and autumn, the distance the possums travel becomes less as the moths leave. Then the seeds and fruits of alpine heathland shrubs, which grow among the boulders, become increasingly important in their diet.

At Mt Hotham, Ian Mansergh had shown that Mountain Pygmy-possums were untrappable from May to the time the snow melted in September–October. It was hypothesised that they hibernate during this time, although laboratory studies had been unable to show this. A gruelling winter of night-time radio-tracking at Mt Blue Cow in 1986 showed that the possums stayed under the snow, where temperatures remained at around 2°C, and seldom moved from their nest sites. Snow to a depth of a metre or more is a good insulator, with temperatures remaining relatively constant despite snow-surface temperatures as low as –20° C.

As in other fields of science, the ease of gaining information about animal behaviour and physiology increases as technological advances are made. By 1989, radio-transmitters that measured body temperature had been developed that were small enough to attach to the possums' collars. There followed a winter of relative ease on my part: strictly daytime ski tours, to check and retrieve data from the ten automated tracking units scattered around the mountain. With a radio-antenna in place of a ski pole, the only small price I had to pay were the gibes from larrikins on the ski lifts yelling out "Hey love, 'ave you lost ya TV?".

At the same time that I was traversing the snow at Mt Blue Cow, Fritz Geiser from the University of New England was measuring the metabolic rates and body temperatures of eight Mountain Pygmy-possums housed in his laboratory fridge at temperatures that simulated natural conditions. (They all survived quite happily and were released back on Mt Kosciusko in the following spring.) With further laboratory studies and continuing field studies by our colleague Gerhard Koertner (University of New England), we have shown that the Mountain Pygmy-possum is the only marsupial to exhibit prolonged seasonal (winter) hibernation, consisting of periodic torpor and short rapid warm-ups, as is characteristic of hibernating placental mammals from the Northern Hemisphere. Its hibernation pattern consists of gradually lengthening periods of torpor, which in midwinter can last up to 20 days, interspersed by short periods of arousal of usually less than one day. During torpor periods, body temperatures and metabolic rates are substantially reduced. We have found that the most efficient body temperature for a hibernating Mountain Pygmy-possum is about 2°C. Hibernating animals make substantial energy savings by not having to maintain their body temperatures above that of the surrounding environment.

By autumn, the possums are fat and placid. The heaviest animal I trapped, a furry little butter ball from the top of Mt Kosciusko, weighed in at an incredible 82 grams!

IN EARLY SPRING, WHEN THE POSSUMS emerge from hibernation, they weigh around 35 grams. After a period of feasting on Bogong Moths, and rapid production and development of their one litter of four young, all individuals set about the serious business of maximising weight gain for winter. Body weights are doubled by the time hibernation commences in March or April. This is necessary if they are to survive the period of winter cold and food shortage.

When breeding, the females in particular can be quite aggressive. By autumn, the possums are fat and placid. The heaviest animal I trapped, a furry little butter ball from the top of Mt Kosciusko,

MOUNTAIN PYGMY-POSSUM

Burramys parvus

Classification
Family Burramyidae (pygmy-possums)

Identification
The largest of the pygmy-possums, body length 10–12 cm, tail prehensile 13–16 cm, fur dense and short, grey above, cream to orange below and on flanks. Large, well-developed premolar used to crack hard shells of seeds and carapaces of arthropods. Weight varies throughout the year, averaging around 40 g. Maximum life span 5–12 years for females, 2–4 years for males.

Distribution and Status
Confined to alpine areas of south-eastern Australian mainland at elevations above 1,400 m. Habitat specialist, found in boulderfields with associated alpine shrubs. Total population estimated about 2,600 adults in good years but may drop to less than half this in drought years. Endangered.

Habits
Nocturnal. Females have overlapping home ranges and may share hibernacula (winter nesting sites) with daughters. Males visit female habitats to breed but both adults and young disperse in late summer and autumn to lower-quality habitats. Males may share nests and hibernacula.

Food
Arthropods (Bogong Moths, caterpillars, millipedes, beetles and spiders), seeds and fruits, depending on seasonal availability.

Breeding
One litter per year of 4 young, born when snow melts (late October to mid December). Rapid growth and development. Thirty-day pouch life, young remain in nest for another 30–35 days before weaning. Polygynous mating system, sex ratios often female biased.

TANIA BUBELA

Since the end of the last Pleistocene glacial period, which ended about 10,000 years ago, the range of the Mountain Pygmy-possum has been gradually shrinking with the retreating snowline.

weighed in at an incredible 82 grams! We have found that adults may hibernate for seven months, while young of the year are active for up to two months longer in the autumn, needing to gain sufficient fat stores to give them a chance of surviving the winter. In the laboratory, individuals were able to survive up to 185 days (6.6 months) without eating. Calculations suggest this period of fasting may last up to 240 days (8.6 months) in the wild. Mountain Pygmy-possums do show some food-caching behaviour but our studies suggest that fat storage and hibernation are the main strategies for winter survival. We have also shown that hibernating animals are very sensitive to changes in air temperatures in their winter retreats. This is a concern because any increases in environmental temperatures and loss of snow cover would expose animals to greater temperature fluctuations and probably increase winter mortality.

Like the environment it lives in, the Mountain Pygmy-possum is a very special relict from the Pleistocene ice ages. It does not occur below the winter snowline and is the only Australian mammal specialised to survive in the alpine environment. Since the end of the last Pleistocene glacial period, which ended about 10,000 years ago, the range of the Mountain Pygmy-possum has been gradually shrinking with the retreating snowline. It now occurs in five isolated populations within an approximate 10 x 50 square-kilometre area of Victoria and an 8 x 20 square-kilometre area of New South Wales. The total amount of boulderfield habitat, which is scattered throughout these areas, is less than ten square kilometres.

It is now over 100 years since the discovery of the 'small rock mouse' bones in Wombeyan Caves and 25 years since it was found to survive among the rocky outcrops of the Snowy Mountains and Victorian high country. The greatest threat to the continued survival of the Mountain Pygmy-possum is disturbance, destruction and loss of habitat. It is not coincidental that the best habitats—deep boulderfields at high elevations—are also areas favoured for ski resorts. These conditions result in the deepest, longest-lasting snow cover.

The author checking the location of a radio-collared Mountain Pygmy-possum. The antenna of an automated tracking unit, which measures the body temperature of the hibernating pygmy-possum every hour, can be seen in the left foreground.

Consequently three major populations occur on the ski slopes of Mt Hotham, Mt Blue Cow and Charlotte Pass ski resorts. A fourth, of yet unknown size, has just been discovered near Mt Buller. In the past, habitat loss and population stress has resulted from the construction and operation of these resorts. However we are becoming increasingly mindful of the need to reverse these trends, particularly since these areas are likely to become important refuge areas as the threat of global warming increases and habitat at lower elevations becomes unsuitable. The threat is not so much in higher summer temperatures, but in the loss of the insulating snow cover that protects hibernating possums from the extremes of winter temperatures. It has been predicted that in the next 50 years the annual mean temperature of the world may rise by 2°C. If this does in fact happen, the possum could become extinct. On the world scale of potential catastrophes, the possible retreat, metaphorically speaking, of *Burramys* off the top of the mountain may seem a relatively small thing. On a local level, though, it would be a tragedy. ■

Further Reading

Broome, L.S. & Geiser, F., 1995. Hibernation in free-living Mountain Pygmy-possums, *Burramys parvus* (Marsupialia: Burramyidae). *Aust. J. Zool.* 43: 373–379.

Geiser, F. & Broome, L.S., 1993. The effect of temperature on the pattern of torpor in a marsupial hibernator. *J. Comp. Physiol. B* 163: 133–137.

Mansergh, I. & Broome, L., 1994. *The Mountain Pygmy-possum of the Australian Alps.* New South Wales University Press: Kensington.

Mansergh, I. & Scotts, D., 1990. Aspects of the life history and breeding biology of the Mountain Pygmy-possum, *Burramys parvus*, (Marsupialia: Burramyidae) in alpine Victoria. *Aust. Mammal.* 13: 179–191.

Smith, A.P. & Broome, L., 1992. The effects of season, sex and habitat on the diet of the Mountain Pygmy-possum (*Burramys parvus*). *Wildl. Res.* 19: 755–768.

Dr Linda Broome is currently the Threatened Species Project Officer (fauna) with the New South Wales National Parks and Wildlife Service, Southern Zone. Her interests are in conservation biology. In addition to continuing research on the Mountain Pygmy-possum, she is conducting studies on other endangered species, including the Long-footed Potoroo and Smoky Mouse.

An adult female Mountain Pygmy-possum climbing on a Mountain Plum-pine branch. The long tail is used for balance and sometimes for gripping the branches.

LINDA BROOME

Stingless bees are also sometimes called sweat bees in the north because of their peculiar habit of collecting human sweat.

STINGLESS BEES

BY TIM HEARD

TIM LOW

Austroplebeia australis honey pots. Note the white patches, which are air bubbles in the sealed pots. Air bubbles in the honey pots of *Trigona carbonaria* are not visible because of their much thicker walls.

JEFFREY WILLMER

PRIOR TO THE ARRIVAL OF European Honey Bees (*Apis mellifera*), the lives of Australian Aborigines were sweetened with honey extracted from nests of stingless bees (*Trigona* and *Austroplebeia* species).

Although often simply called 'native bees' (and 'sugarbag' by Aborigines), the common name of 'stingless bees' is preferred because it distinguishes them from the 1,600 other species of bees native to Australia. As the name suggests, their stings are vestigial and useless in defence. Stingless bees are also sometimes called sweat bees in the north because of their peculiar habit of collecting human sweat, which is presumably used as a source of minerals.

Unlike most of the world's 20,000 species of bees, stingless bees represent a peak of insect social organisation, rivalled only by ants, termites, some wasps and Honey Bees. Like these they exhibit cooperative brood care and have different castes—queens, workers (infertile females) and drones (males). Stingless bees are the only bee species native to Australia that are social and store pollen and honey (basically dehydrated nectar). The other species are solitary and use what nectar they collect immediately for food for themselves or for preparing provisions for a brood cell. In their search for nectar and pollen, stingless bees are important pollinators for many species of flowering plants. In this way they share the same ecological role as Honey Bees.

Stingless bees may be encountered in all tropical and subtropical parts of the world except isolated islands. Australia has about 14 species, although a taxonomic revision in progress may alter this figure. The poor state of our understanding is partly due to the similar appearance of most species, which are small (about four millimetres long) and black. Like Honey Bees they have enlarged areas on their back legs for carrying pollen back to the nest. These are known as corbiculae or pollen baskets. Their hind legs therefore appear wide and hang low when in flight.

Most Australian species are found in the tropical north, although two species, *T. carbonaria* and *A. australis*, are common in subtropical eastern Australia and have been observed as far south as Bega in southern New South Wales.

DESPITE THE SIMILARITIES IN SOCIAL behaviour between stingless bees and Honey Bees, there are major differences that have led biologists to believe that their societies evolved separately. Each may have evolved from a common ancestor like bumblebees, which represent an intermediate stage of social evolution.

The major differences between stingless bees and Honey Bees relate to their nest architecture and propagation, and the way they communicate food sources to fellow workers.

The structure of the nest of stingless bees is complex and unique. The inner sanctum of the nest consists of a brood chamber, a grouping of cells containing the immature bees, surrounded by an insulating waxen envelope. Unlike Honey Bees, which continually feed their larvae, larvae of stingless bees are mass provisioned. Each brood cell is stocked almost to the brim with honey, pollen and glandular secretions, an egg is laid in the cell by the queen and then the cell is closed. Complete larval and pupal development occurs in the closed cell. When the adult bee emerges from the cell, the cell is destroyed. It is thus used only once, unlike Honey Bee cells

A *Trigona carbonaria* queen patrols the comb.

which are used many times. Surrounding the brood chamber are large egg-shaped pots of honey and pollen. This is in striking contrast to Honey Bee nests, with their vertical combs of regular hexagonal cells where brood, honey and pollen are all housed.

The nests of stingless bees may be useful in distinguishing species. For example, the presence of a projecting tube at the nest entrance of *A. australis* distinguishes it from *T. carbonaria* nests. The structure of the brood chamber of these two species also differs. The brood comb of *T. carbonaria* has a spiral arrangement, while that of *A. australis* forms a less organised cluster.

Stingless bee nests are made of cerumen, a material formed by mixing beeswax (a glandular secretion of worker bees) with propolis (resins of plant origin). Stingless bee workers may often be seen entering their nests carrying beads of clear resin in their pollen baskets. One northern Queensland species, *T. hockingsi*, has gained notoriety as a collector of wet paint, which it uses as a substitute for resin in nest construction. Honey Bees by contrast use pure wax for comb construction; they only rarely use resins.

The queens of highly social bees cannot live alone and new colonies are established by swarming. In Honey Bees the break is abrupt; a dense swarm of worker bees (known as a reproductive swarm) simply leaves the parent nest with the old queen, settles temporarily and starts looking for a new site. Immature queens are meanwhile developing in the parent nest and one of these will take over as the new queen. Stingless bee queens, on the other hand, are not transferred until the new nest has been fully prepared by workers. The reproductive swarms of stingless bees are therefore not as obvious as those of Honey Bees, and there is a lot of toing-and-froing between the old and new nests until the latter is ready. Furthermore, it is the new queen that makes the flight, with the old queen remaining in the parent nest.

Drones also swarm while waiting for the opportunity to mate with a new queen. These mating swarms occur around the old and new nests at the time the new queen makes her move. Mating usually takes place soon after the young queen has arrived at the new nest when she goes on a mating (nuptial) flight. Mating swarms also occur at established nests probably when the old queen has died and is being replaced by a young unmated one.

Another type of swarming occurs at *T. carbonaria* colonies, in which worker bees collide, grip onto each other, fall to the ground and fight to the death. This behaviour probably represents fighting between colonies. One such battle resulted in the death of 7,000 warriors, which I found in a tangled mass beneath the entrance to one of my hives. Although damaging to the populations of workers, the colonies nearly always recover from these scraps.

JEFFREY WILLMER

A colony of *Trigona carbonaria* established in an artificial wooden hive. The two halves of the box have been separated for display. The brood comb is centrally placed in a spiral arrangement surrounded by a multi-layered waxen sheath. Surrounding this are the pots of honey and pollen.

JEFFREY WILLMER

At the entrance to the nests of *Austroplebeia australis* is a projecting tube. Two foragers laden with pollen are approaching the nest from the upper right, while two others have already made their landing. In contrast, the entrance of *Trigona carbonaria* does not have a tube but is flush with the surface of the tree.

The dances of the Honey Bees, in which scout bees convey information regarding the direction and distance of flowers to hive mates, are well known. Stingless bees also direct nest mates to flowers, but by different means. Workers of some species merely jostle other hive bees to alert them to the presence of a rich food source but do not convey information as to distance and direction. Workers of other species lay scent trails (pheromones) on the ground or vegetation between the food source and the nest. Upon return to the nest they make zigzag runs and characteristic sounds that alert other bees to leave the nest and follow the trails. The method of recruitment is unknown for most Australian stingless bees, but for *T. carbonaria* it appears to involve the use of oral secretions.

The honey varies in quality depending on the species and the plants from which the nectar was collected.

Stingless bees are strong fliers. Although they are not able to reach the enormous ranges of Honey Bees, they can fly up to one kilometre. They will not fly any farther than they have to though; close resources are used in preference to ones farther away.

All Australian species nest in hollow trunks and branches of trees or in rock crevices. They may also be encountered in wall cavities and sometimes more unusual situations, such as old garbage bins. Where the cavity they are occupying is too large, they isolate their nest with a thick layer of resin and wax.

With care, colonies of stingless bees may be relocated from natural sites into wooden hives, a good idea when the natural nest site is in danger from land clearing. On the Gold Coast of Queensland, Peter Davenport saves many colonies this way and has them available for sale. He also markets his honey and earns a premium price for this rare product.

If the hive is constructed with the correct design, the colony, once established, can be split to form two hives. As

STINGLESS BEES

Classification
Family Apidae (bees), subfamily Meliponinae (stingless bees), 21 genera worldwide, 2 genera and about 14 spp. (5 *Trigona*, 9 *Austroplebeia*) in Australia.

Identification
About 4 mm long, black body, covered in microscopic hairs, enlarged areas on hind legs for carrying pollen and resin. Fewer veins on the wings than most other bees.

Distribution and Habitat
All tropical and subtropical parts of the world, except isolated islands. In Australia, they occur in the northern half, down the east coast to Bega and west coast to about the Hammersley Ranges. Most forest areas, including rainforest, eucalypt forest, mangroves, are suitable.

Biology
Highly social insects that live in large perennial colonies, nesting usually in tree cavities opening to the exterior through a small hole. Their social behaviour resembles Honey Bees in some respects, but is strikingly different in others.

Diet
Adults and young eat pollen and nectar, which they collect from flowers of both native and introduced species.

only one queen is present, the half that is queenless must make a new one. This is not usually a problem as a healthy hive continually produces new queens as witnessed by the presence of larger queen cells around the edge of the brood comb. The splitting process can be continued and eventually a large number of hives may be propagated from the original. The spiral brood architecture makes nest splitting straightforward for *T. carbonaria*, however no-one to my knowledge has successfully split hives of *A. australis*. Fortunately, nests of this latter species have been propagated by capturing reproductive swarms. In one case a swarm entered a nearby empty box and established itself there. In another case an empty box was positioned close by and the bees readily accepted it. Swarm capturing has never been performed for *T. carbonaria*.

The honey varies in quality depending on the species and the plants from which the nectar was collected. In general it is more liquid and more acidic than that of Honey Bees. Many people prefer the thicker, sweeter honey of *A. australis* to that of *T. carbonaria*. For both species it is aromatic from the plant resins used to build the pots in which the honey is stored. Usually less than 1.5 kilograms (one litre) of honey is produced by a hive in a year (compared to about 50 kilograms, or 75 litres, for a strong hive of Honey Bees). The structure of the nest also makes this honey difficult to extract. I prefer not to rob my hives of honey as the disruption to the nests slows down rates of colony growth. For me the value of these hives is more for conservation and pollination than honey production.

In summer, masses of small Cadagi (*Eucalyptus torelliana*) seeds collect at the entrance of many *T. carbonaria* nests. Helen Wallace, while at the University of Queensland, discovered that the bees enter the gumnuts of this plant in search of resins. Seeds in the gumnut stick to the bees and are carried back to the nest, from which they are often discarded. Cadagi seedlings are commonly found at the base of the hives. This plant appears to have become adapted for seed dispersal by stingless bees, the first example of seed dispersal by bees ever found. A down side of this behaviour is that the species is rapidly being dispersed outside of its native range of northern Queensland. This efficient seed dispersal enhances the weed potential of this plant.

Stingless bees are thought to be important pollinators of many Australian native plants and also many of the exciting new fruits, nuts, spices, vegetables and oil seeds gaining popularity in Australia. They are proven pollinators of macadamias, which benefit from cross-pollination. Huge numbers of worker bees, however, are needed to pollinate large orchards. This requires leaving extensive areas of adjacent forest. In areas where this vegetation has been removed, the bees need to be introduced. Now that the techniques to manage populations of stingless bees are available, we may see them joining the European Honey Bee as pollinators of macadamias and other crop plants. ■

Further Reading

Heard, T.A., 1988. Propagation of hives of the stingless bee *Trigona carbonaria*. *J. Aust. Entomol. Soc.* 27: 303–304.

Heard, T.A., 1994. Behaviour and pollinator efficiency of stingless bees and honey bees on macadamia flowers. *J. Apicultural Res.* 33: 191–198.

Wagner, A. & Dollin, L., 1983. Swarming in Australian native bees—help solve the mystery! *The Australas. Beekeeper* 84: 34–37.

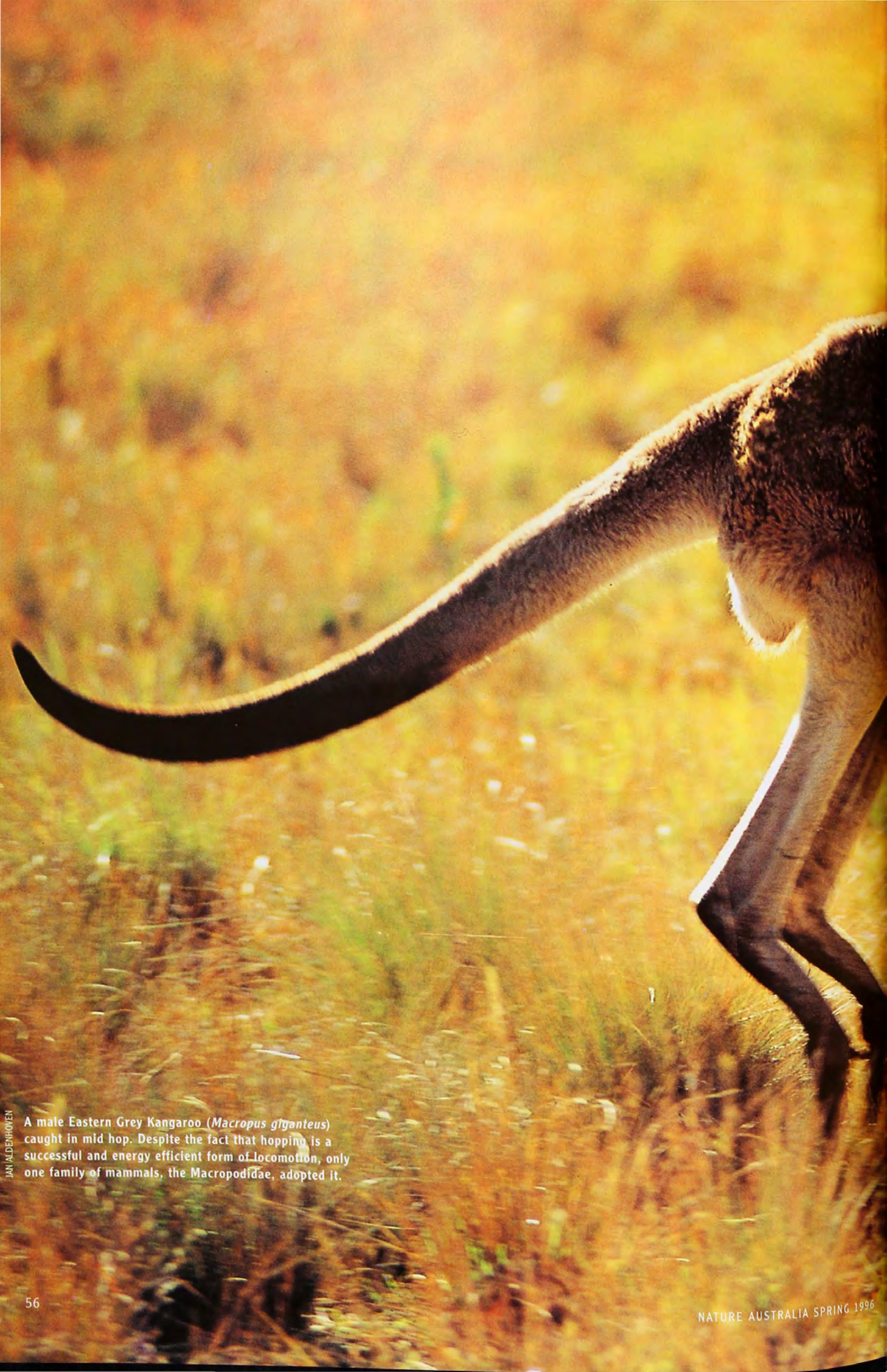
Wallace, H.M. & Trueman, S.J., 1995. Dispersal of *Eucalyptus torelliana* seeds by the resin-collecting stingless bee, *Trigona carbonaria*. *Oecologia* 104: 12–16.

Wille, A., 1983. Biology of the stingless bees. *Ann. Rev. Entomol.* 28: 41–64.

Dr Tim Heard is an entomologist with CSIRO in Brisbane. His interest in stingless bees began in 1985 while researching insect pollination of nut crops. He continues to dabble with stingless bees in his spare time. A hive design, and the techniques for relocating and splitting stingless bee hives, may be obtained by writing to the author.

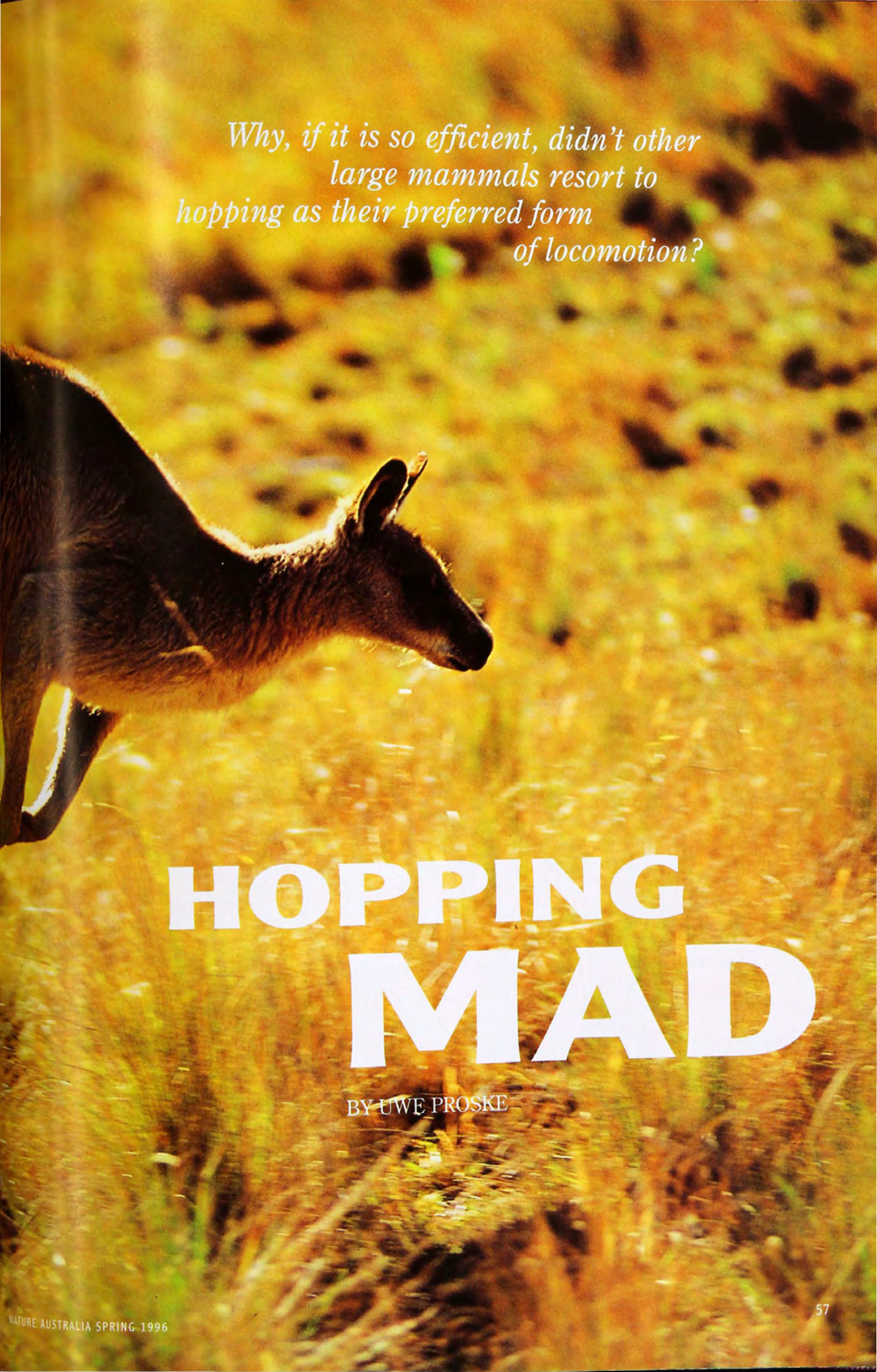
Stingless bee honey can be enjoyed without any fear of pain.

JEFFREY WILLMER



A male Eastern Grey Kangaroo (*Macropus giganteus*) caught in mid hop. Despite the fact that hopping is a successful and energy efficient form of locomotion, only one family of mammals, the Macropodidae, adopted it.

JAN ALDENHOVEN



Why, if it is so efficient, didn't other large mammals resort to hopping as their preferred form of locomotion?

HOPPING MAD

BY UWE PROSKE

I AM SURE WE HAVE ALL REFLECTED AT one time or another over the grace and elegance of a hopping kangaroo. Because hopping is such a simple gait, it has been the subject of a number of detailed studies, including one by our own group at Monash. Although researchers still don't know exactly how or why hopping evolved, as a form of locomotion it appears to have been a very successful development.

The family of hoppers, the Macropodidae, includes some 57 different species. These range in size from the one-and-a-half-kilogram Musky Rat-kangaroo (*Hypsiprymnodon moschatus*) that scuttles about the rainforest floor in Queensland, to the adult male Red Kangaroo (*Macropus rufus*) weighing 90 kilograms. All macropods hop but, at slower speeds, many of the smaller species move by quadrupedal (four-legged) running. Kangaroos with their large hind legs, their small forelimbs and the long tail are not able to run on all fours like the Musky Rat-kangaroo and, when they travel slowly, they resort to a rather unusual form of progression, called pentapedal locomotion. It is called pentapedal because it involves all four limbs plus the tail (penta = five). The animal moves forwards with a kind of creeping motion, keeping both its front and hind limbs together and using the tail as an additional prop. This kind of locomotion is obviously too awkward to use for travelling at speed so, when the kangaroo wants to go faster than about five to six kilometres per hour, it gets up onto its back legs and starts to hop.

One important observation, which is central to the question of the efficiency of hopping as a form of locomotion, concerns measurements of oxygen consumption by hopping kangaroos. These measurements were first carried out on Red Kangaroos by Terry Dawson and C. Richard Taylor at Harvard University. The amount of oxygen consumed is an indicator of energy expenditure and therefore the metabolic cost of locomotion. To measure oxygen consumption, kangaroos were trained to hop on a moving treadmill while wearing a mask through which the flow of oxygen was monitored, breath by breath. Hopping speed was controlled by altering the speed of the treadmill belt. The important observation made was that, above a hopping speed of six kilometres per hour, oxygen consumption no longer increased with speed. In fact it fell slightly so that it became energetically less costly for a kangaroo to hop at 20 kilometres per hour than at six kilometres per hour. In addition, at 20 kilometres per hour or faster, the energy used by the hopping kangaroo was less than that of a four-legged placental mammal of similar weight, running at the same speed.

Diagram of the calf muscle and its attachments in the kangaroo. At one end, muscle fibres attach to the femur (thigh bone); at the other to a broad, tendinous sheet, the aponeurosis, which becomes the Achilles tendon that attaches to the back of the heel.

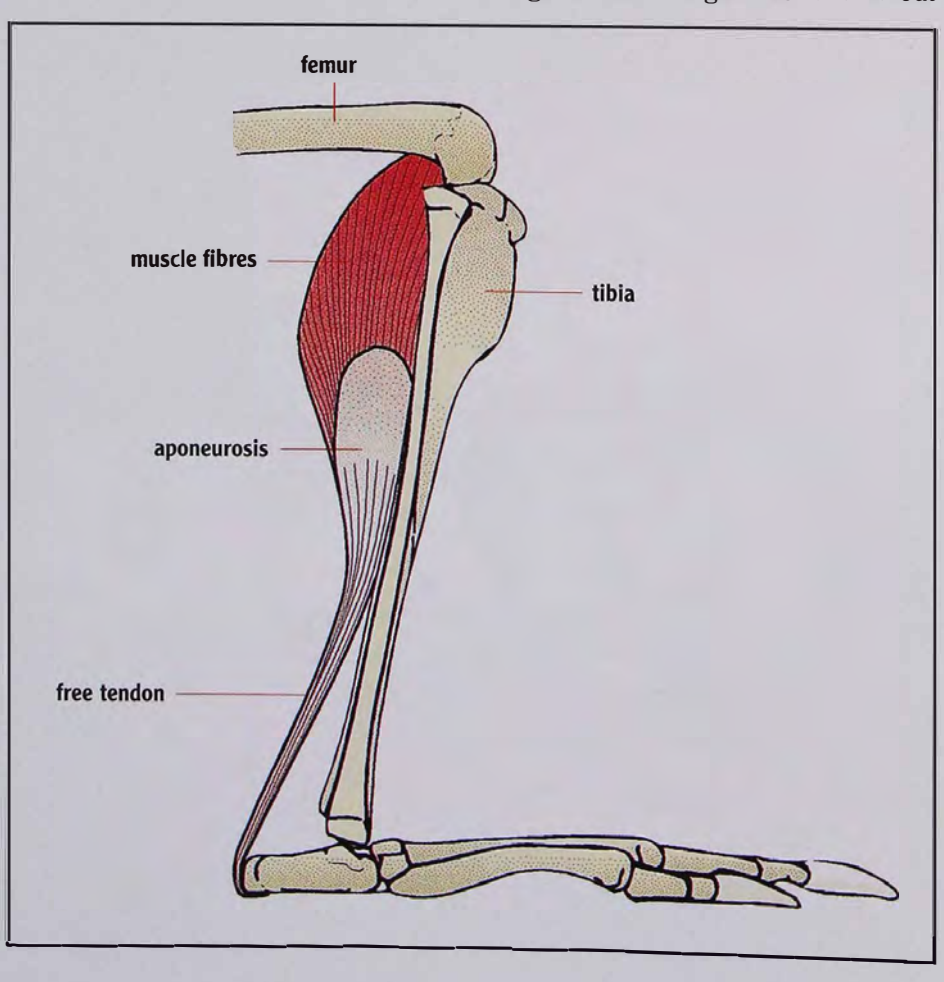


ILLUSTRATION BY FRANK GROENEVELD

HOW DO KANGAROOS MANAGE TO BE SO efficient? By storing elastic energy in their Achilles tendons, or at least that was the theory. The idea of conserving energy during locomotion by storing it in body parts has fascinated biologists for many years. Forms of motion believed to involve storage of elastic energy include examples as diverse as the jump of a flea, the swish of a shark's tail and the running athlete.

My colleagues Di Warren, David Morgan and I set out to directly test the proposal that the storage of elastic energy in tendons played a major role in the efficiency of hopping in kangaroos. But before describing our experiments, it is necessary to say something more general about the mechanical properties of muscles and tendons, and how they may be measured.

Muscles attach to the bones by means of tendons. Both muscles and tendons are elastic tissue. When they are stretched, they elongate and, if released from stretch, they tend to recoil to their original length. In mechanical terms, a muscle and its tendon can be modelled by two coiled springs linked together. The relative stiffnesses of the two springs (muscle and tendon) will determine how a stretch will be distributed over the system. If the muscle is relaxed,

Unlike quadrupedal mammals, large macropods like this Red Kangaroo are capable of keeping oxygen consumption (and therefore energy expenditure) constant when hopping at higher speeds.

AUSTRALIAN PICTURE LIBRARY . CARNEMOLLA

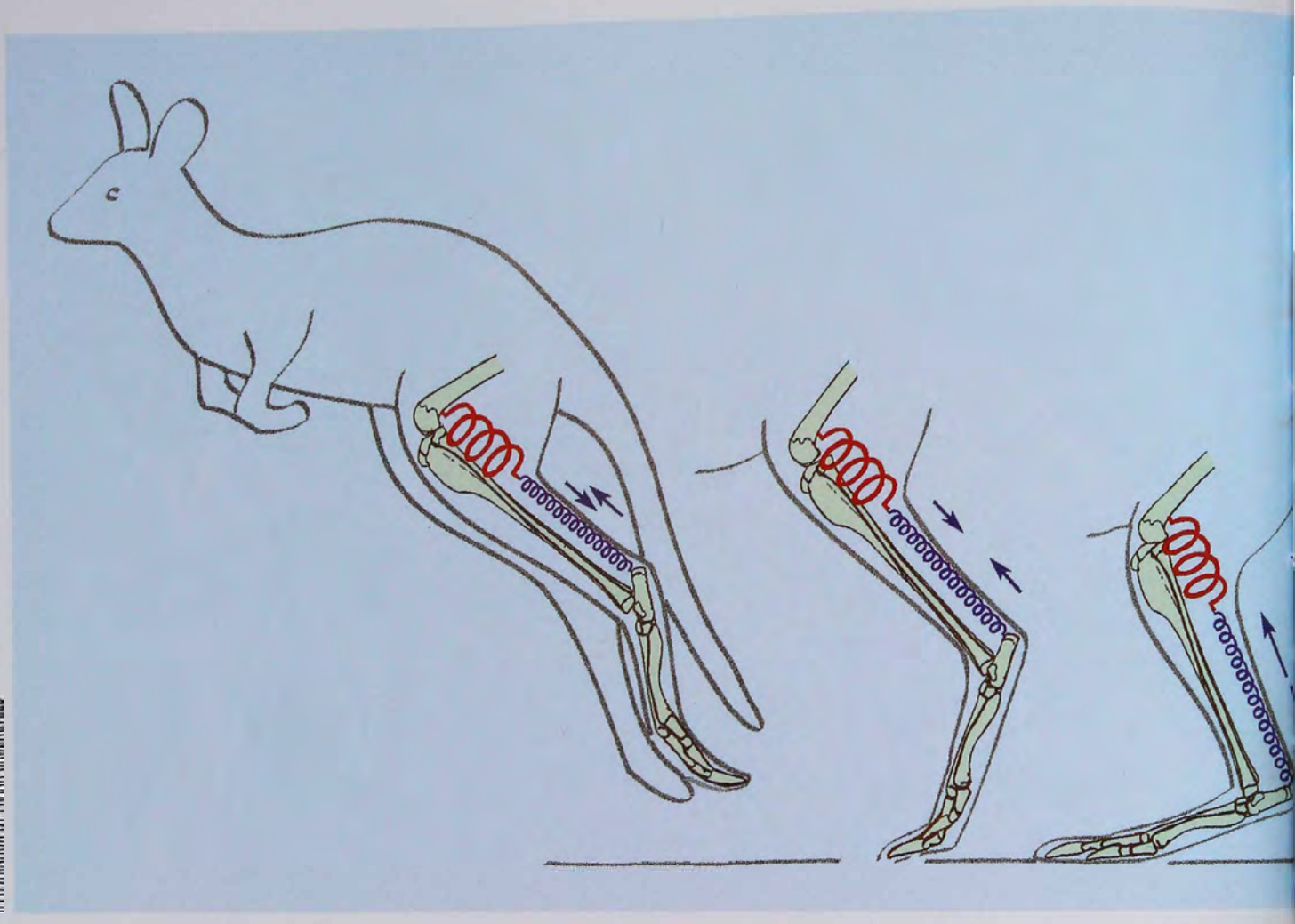


ILLUSTRATION BY FRANK GROENEVELD

Movements in the calf muscle and its tendon during hopping in a kangaroo. The large red spring represents the muscle; the smaller blue spring the Achilles tendon. The kangaroo lands from a hop, toes first. As the foot begins to bear the animal's weight, it is rotated about the ankle joint, stretching the muscle and its tendon. The recoil from stretch of the two springs (muscle and tendon) gives the animal extra lift during take-off for the next hop.

very little, if any, stretch will be taken up by the stiffer tendon. But once the muscle starts to contract it will resist a stretch with greater stiffness and, depending on how hard it is contracting, progressively more of the stretch will be taken up by the tendon. One other consideration is that the muscle spring is less truly elastic than the tendon spring. More of the energy put into stretch is recoverable from tendon than from muscle.

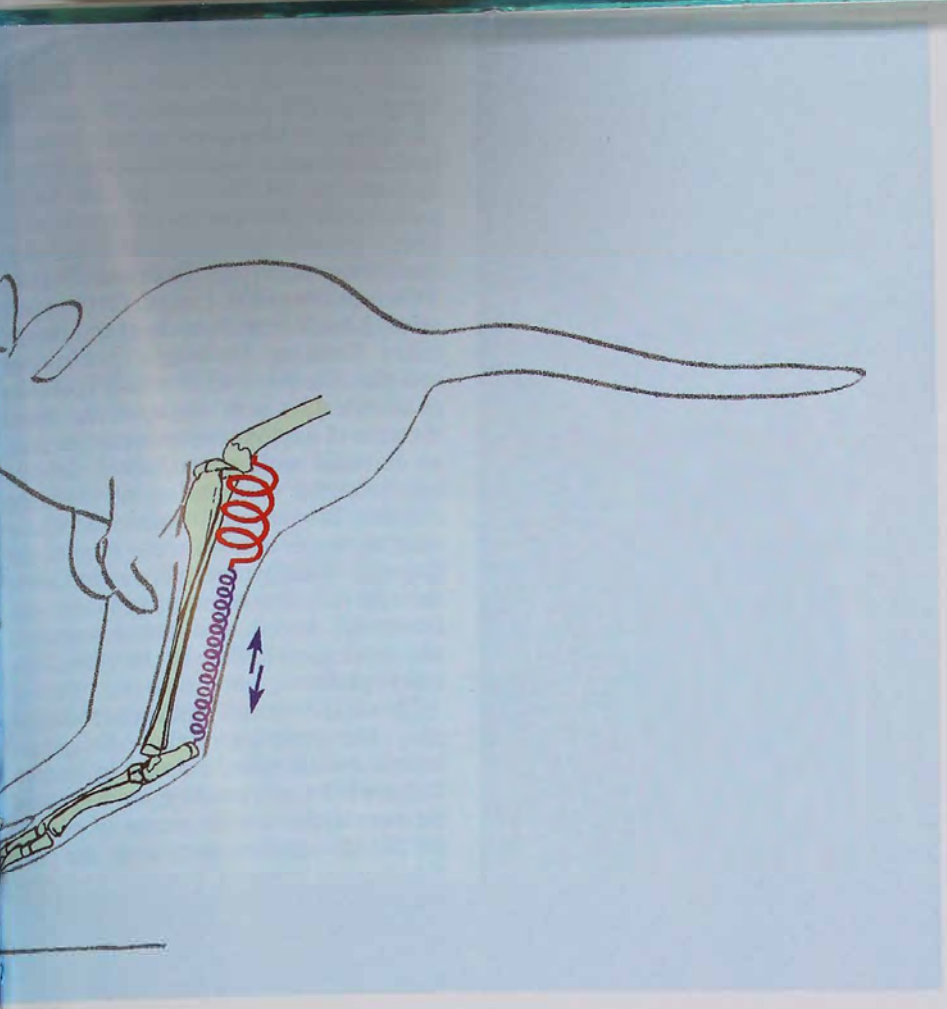
Kangaroos have large Achilles tendons, the tendons that attach calf muscles to the back of the heel. So the proposal was that a hopping kangaroo tensed its calf muscles each time it landed from a hop and the weight of the landing animal stretched the Achilles tendons, which then recoiled, helping the animal during the lift-off phase of the next hop. It is as though kangaroos are hopping on pairs of coiled springs—springs that are stretched on landing and that recoil during take-off, like inverted pogo-sticks.

The aim of our experiments was to measure the elastic properties of kangaroo leg muscles and tendons, and to determine whether sufficient energy could be stored in them to account for the low oxygen consumption during hopping. To do that turned out to be more difficult than we realised at the time.

Tendon properties have traditionally been measured by excising a piece of free tendon from the end of the muscle, clamping it in a stretching apparatus, and then stretching and shortening the tendon to see if it behaves like a spring. We did that with a piece of kangaroo Achilles tendon and established that it does indeed behave like a stiff spring, provided measurements were kept within the normal working range of the tendon. However we were left dissatisfied with our measurements because estimates of energy storage based on the free tendon might not apply to the whole tendon. A tendon, as it approaches the muscle, typically spreads out into a sheet, or aponeurosis, across the middle of the muscle. This is where the actual contacts with muscle fibres are made. In the case of the kangaroo Achilles tendon, only about half is free tendon. So mechanical measurements made on isolated tendon do not take into account the aponeurosis, nor the properties of the tendon–muscle fibre junctions.

It is as though kangaroos are hopping on pairs of coiled springs, like inverted pogo-sticks.

The only satisfactory way of measuring the elastic property of the whole tendon is to use a method that leaves the tendon intact, attached to the muscle. At the time of our experiments no such method existed, until my colleague David Morgan devised a new and ingenious technique. The method involves calculating the amount of movement during a stretch in muscle fibres and tendon, for contractions of different strengths. For this the assumption is made that tendon stiffness remains constant, while muscle stiffness is proportional to tension. The more the muscle contracts, the greater the stiffness with which it resists the stretch and therefore the larger the pro-



portion of stretch taken up by the tendon. The ratio of tendon stretch to muscle force gives the stiffness of the tendon.

We carried out experiments of this kind on the Tasmanian Pademelon (*Thylogale billardierii*). I remember well our first attempts at making the measurements. We had no idea how strong a kangaroo's calf muscles could be. Instead of just pulling on the strain gauge with which we were measuring muscle forces, the animal managed to move the whole experimental table! Eventually a successful series of measurements was achieved and we were able to estimate that, when calf muscles were contracting maximally and were then stretched, together with their full tendons, eight times as much of the stretch was taken up by the tendon as by the contracting muscle fibres. In addition, during repeated movements most of the energy put in during stretch, re-emerged during recoil.

This was an important result because it provided the necessary precondition for the tendon being the site of storage of elastic energy during hopping. But having an elastic tendon has both advantages and disadvantages. In general, when a muscle's tendon is short and stiff it provides for rapid and precisely controlled movements of the limb because the stiff, unyielding tendon rapidly and faithfully transmits the mus-

ESTHER BEATON/TERRA AUSTRALIS PHOTO AGENCY

The first experiments on the property of the calf muscle and Achilles tendon were carried out on the Tasmanian Pademelon.

GLEN CARRUTHERS

Kangaroos, like this male Eastern Grey, have large Achilles tendons in which they store much of the elastic energy needed for their efficient form of locomotion.

cle forces. The disadvantage is that there will be little opportunity for storage of elastic energy. Conversely, when a muscle's tendon is long and stretchy, it means energy storage is possible but this is achieved at the expense of accuracy and speed of the movements since the tendon must always be stiffened before the limb can be moved. It is like trying to move an object by pulling on it with a rubber band.

Since the time of our experiments other measurements have been made on hopping macropods, including implanting strain gauges on the tendons and measuring tendon forces using radiotelemetry in a free-ranging animal. The results all essentially confirm our findings, and the concept of storage of elastic energy in the Achilles tendon of kangaroos is now widely accepted.

That said, I don't want to leave the impression that the efficiency of hopping as a form of locomotion rests exclusively with the elasticity of the calf muscles and the Achilles tendons. Although no direct measurements are available yet, it is likely that other hind limb muscles and their tendons are also sites of elastic storage during hopping, involving a mechanism similar to that proposed for the calf muscles. Then there is the question of the role of the tail. It has a series of very large tendons running down its length and these too are likely to make some contribution, as the tail swings up and down during each hop. In addition, it has been speculated that the tail may help during the lift-off phase of a hop by acting like a cantilever. These are fascinating speculations that surely will provide the basis for future research.

THE ABILITY TO KEEP OXYGEN CONSUMPtion, and therefore energy expenditure, constant at higher hopping speeds appears to be limited to the larger macropods. The species for which it has been established include the Red Kangaroo and the Tammar Wallaby (*Macropus eugenii*). For smaller hoppers up to 1.5 kilograms, such as the Brush-tailed Bettong (*Bettongia penicillata*) and the Long-nosed Potoroo (*Potorous tridactylus*), which occasionally hops, the rate of oxygen consumption increases linearly with speed, as it does in quadrupedal mammals. Interestingly, for the Tasmanian Pademelon, whose weight range is similar to that of the Tammar Wallaby, there is a reduction in the rate of increase in oxygen consumption with speed, but not a complete uncoupling, as occurs in the other large macropods.

There are some other aspects of hopping that are interesting. Kangaroos increase their speed of travel by increasing stride length, not hopping frequency. So over quite a wide range of speeds, 10–35 kilometres per hour for Red Kangaroos, hopping frequency remains constant, at approximately two hops per second. A longer stride means that the animal's trajectory during each hop is flatter. It also means that the amount of time the animal spends in the air increases and ground contact time becomes proportionately less.

The energy required for hopping comes from the energy of motion (kinetic energy), and the amount of kinetic energy is determined by the mass of the kangaroo and its speed of travel. For a kangaroo taking off from a standing start, the first in a series of hops must be energetically more costly; as the animal gets up to speed, the energy stored on landing from one hop can be transferred to the next. Often startled animals will take off with several small, rapid hops in an attempt to get up to speed as quickly as possible.

There is yet another consideration. A hopping kangaroo can be modelled by a spring with a mass attached to it. Such a system has an optimal frequency where a minimum of force produces maximum stretching of the spring. This optimal or 'resonant' frequency depends on the mass and the stiffness of the spring. An increase in mass leads to a lower resonant frequency (in other words, the bigger the animal, the lower the hopping rate). When we observe a mob of kangaroos on the horizon, often the females are up in front and the larger males make up the rear. Because of their smaller mass, the females adopt a noticeably higher hopping frequency than the males. Each animal adjusts its stride length at the preferred frequency as it strives to maintain its place within the mob.

I have focussed this discussion on hopping in kangaroos—how it has become recognised as an energy-efficient form of locomotion. The ability to conserve energy by elastic storage probably allows kangaroos to travel long distances at relatively low energy cost in their search for new pastures or when escaping from bushfires. One question that remains is why, if it is so efficient, didn't other large mammals resort to hopping as their preferred form of locomotion?

We don't know the full answer, but one factor may be that it is not a very stable form of locomotion, given that it is bipedal and the feet are kept close together, making it easier to throw the animal off balance. I have often seen hopping kangaroos stumble, especially when covering uneven ground. Having said that, I recently watched with sadness and fascination a Red Kangaroo afflicted with the blindness that has recently spread among populations on the western plains. The animal was hopping in a wide circle, and running into bushes and fallen logs. I was astonished by the powerful correcting reflexes that allowed the animal to recover its posture each time its legs struck an unexpected obstacle. Some stability is probably provided by the rudder-like tail, which, as mentioned earlier, may also help during the lift-off phase of each hop. Another factor relevant to the evolution of hopping may relate to how kangaroos, as marsupials, carry their young in a pouch. Perhaps the posture adopted during hopping enables kangaroos to transport their joeys at speed. But these are probably not the only reasons for why more large mammals don't hop, and it remains for future studies to shed new light on this fascinating subject. ■

I was astonished by the powerful correcting reflexes that allowed the animal to recover its posture each time its legs struck an unexpected obstacle.

Further Reading

Alexander, R.McN., 1988. *Elastic mechanisms in animal movement.* Cambridge University Press: Cambridge.

Baudinette, R.V., 1994. Locomotion in macropodid marsupials: gaits, energetics and heat balance. *Aust. J. Zool.* 42: 103–123.

Dawson, T.J., 1977. Kangaroos. *Sci. Amer.* 237: 78–89.

Morgan, D.L., Proske, U. & Warren, D., 1978. Measurements of muscle stiffness and the mechanism of elastic storage of energy in hopping kangaroos. *J. Physiol.* 282: 253–261.

Proske, U., 1980. Energy conservation by elastic storage in kangaroos. *Endeavour New Ser.* 4(4): 148–153.

Uwe Proske is a Professor of Physiology at Monash University in Melbourne. He has been working for many years on the properties of muscle and muscle sense organs, but a particular interest has been muscle–tendon relations.

JAN ALDENHOVEN

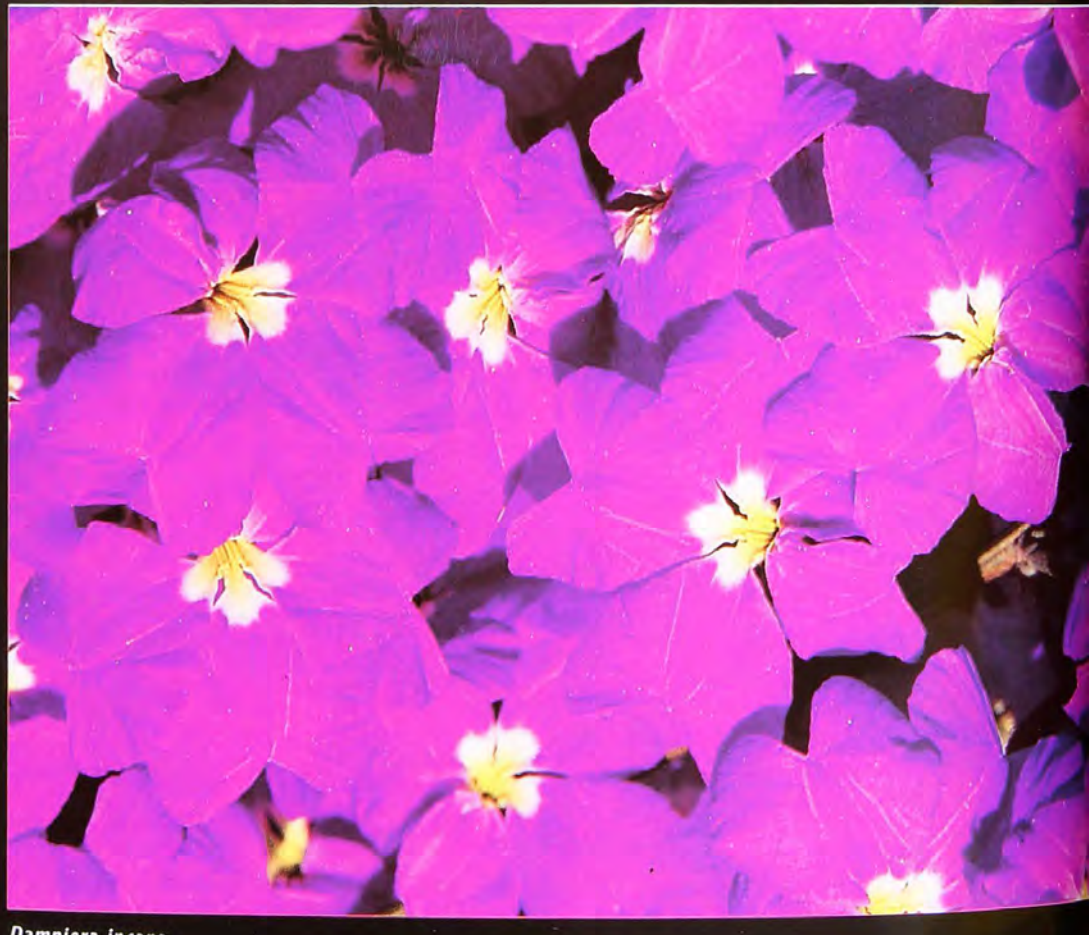
When kangaroos move slowly, they make use of their tail as if it were an extra limb. This unusual form of movement is known as pentapedal locomotion and is illustrated here by a male Eastern Grey Kangaroo following a female he is courting.

WILD FLOWERS

BY JIRI LOCHMAN/LOCHMAN TRANSPARANCIES

Grevillea eriostachya.

FLOWERS ATTRACT US MAINLY by their colours. In photography, however, it is not just the subject itself that matters, but also the background on which it is presented. That is why I prefer to use available light when photographing wild flowers, as it enables me to utilise the wide variety of naturally occurring colour tones of green, brown, yellow, blue or red. Naturally coloured backgrounds compliment the beauty of wild flowers much better than harsh black, which is so often the result of flash photography.

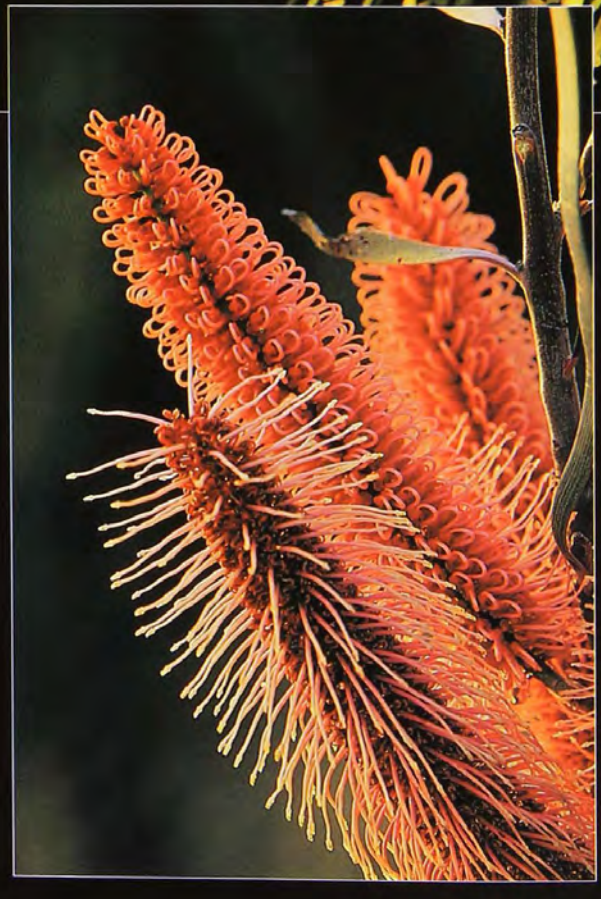


Dampiera incana.

Banksia menziesii.

Eucalyptus erythrocorys illyarrie.

WILD FLOWERS



Hakea coriaceae.

P H O T O A R T

Banksia attenuata.

Hakea laurina.

PHOTOART

Banksia ilicifolia.

WILD FLOWERS

Dryandra foliolata.

Could the modern story of the last mihirung provide a realistic image of a bird 40,000 years after the last individual speared feet-first into the mud?

EVOLUTION AFTER DEATH

BY MICHAEL ARCHER

THE GREAT BIRD'S DEATH STRUGgles sent jets of dust into the air, signals for help that only brought flies. Wandering across the mud-cracked claypan in search of things to eat, its heavy legs had burst through the treacherous surface into black, grasping mud beneath. Every thrust of its powerful legs had only punched it in farther. And there it had stayed, for two days, struggling and dehydrating in the heat of the sun. Metres away, shimmering in the heat, the bones of others whose legs had similarly failed them lay in unseemly heaps. In the distance, a human hunter watched from the shade of a wattle tree. He had seen these giant birds before, but not for a long time. When he was a boy and the land was drier, many had nested each year on these flats, laying large and delicious eggs. Although only a bit taller than emus, they had massive hind legs, smaller inner toes and much thicker, almost parrot-like jaws. When he returned to his family, he would tell this story of how the sucking mud had brought down this great bird—perhaps the last they would ever see.

In 1893, more than 40,000 years later, the bones, egg shells and even stomach stones of giant birds were discovered by staff members of the South Australian Museum in the fossil muds of Lake Callabonna, South Australia. The bird was later named *Genyornis newtoni*. Further studies revealed it to have been the last and smallest survivor of the Dromornithidae, an ancient family of flightless, herbivorous birds known only from Australia. Older kinds, such as *Dromornis stirtoni*, from eight-million-year-old deposits at Alcoota in the Northern Territory, were enormous. At nearly three metres in height and 500 kilograms in weight, *Dromornis stirtoni* was close to if not the largest bird that ever lived.

Because humans have been in Australia for at least 50,000 years, they probably overlapped with *Genyornis newtoni*, which is known from deposits as young as 40,000 years (at Callabonna; younger dates claimed, such as about 25–26,000 at Lancefield, Victoria, are now in doubt). Hence it is tempting to accept the interpretation of some prehistorians, such as noted dromornithid authority Patricia Rich (Monash University), that concepts like *mihirung paringmal*, which literally means 'giant emus' in the language of the Tjapwurong people of western Victoria, actually refer to memories of living *Genyornis newtoni*. On this assumption, Rich has popularised the common name of dromornithids as 'mihirungs'. Could an oral tradition of this kind survive more or less intact for 40,000 years?

A few long-dead cultures that had written languages have left tales, some nearly 4,000 years old, of battles, beasts and heroes, but commonly with embellishments or new interpretations added over the years by well-meaning translators. The epic battle known as the Trojan War, although a real event in perhaps the mid 1200s BC, made it into the modern world via the poems of Homer but here too only as a blend of superheroes, gods and miracles. That Troy was overrun by the Greeks is probably fact. But did Achilles really fall because an arrow hit the spot (his Achilles heel of course) that his Goddess mother Aphrodite held him by when she dipped him in an immortality brew? The accuracy of this bit of the historical story would seem to be open to significant doubt.

There are also arguments about whether or not rock paintings in some areas of Australia depict giant extinct Pleistocene animals. Josephine Flood (formerly of the Australian Heritage Commission in Canberra), for example, suggests that a 40,000-year-old rock painting from Panaramitee, South Australia, represents the head of an extinct *terrestrial* crocodile (species of *Quinkana*) in part because the drawing is too far from water to encourage the view that it represents a normal aquatic crocodile. Although the drawing does not really suggest anything in common with the extraordinary deep-headed quinkanine crocodiles, it could be a bad rendering of such a beast. In certain circumstances, such as the spectacular ice age galleries in European caves, reasonable drawings of now-extinct species certainly have persisted for perhaps 25,000 years, although the descendants of the people who made those drawings have long since lost contact with the art and its meaning.

But could cultural memories of prehistoric creatures stored as *stories*, mind pictures passed by each generation of storyteller to the next, remain unchanged for thousands of years? Could the modern story of the last mihirung provide a realistic image of a dromornithid bird 40,000 years after the last individual speared feet-first into the mud?

In 1972, Peter Dwyer (University of Queensland) was trapping small mammals around the Rofaifo village of Leu, in the Eastern Highlands of Papua New Guinea. Throughout his ten months of catching and buying mammals, he discussed with the local hunters the range of creatures he had accumulated, including several Grey-bellied Tree-mice (*Pogonomys sylvestris*) that he kept live in a cage in his house. According to the knowledgeable elder hunters, Peter had managed to catch all of the mammals they were familiar with—except one, which they called *hiongo lufi*, an animal that was once very common but had not been seen for many years. Although they did not recognise the tree-mice he kept in his house, they were certain that these were not *lufi*. Curious about his failure to catch *lufi*, Peter asked them to describe the missing beast. It was, they said, a very small burrowing mouse with tiny squinty eyes and a black mark on its nose—striking features that would be hard to overlook if he *had* caught one.

Puzzled, he wandered back to his house where he had another hard look at his live Grey-bellied Tree-mice. Like *lufi*, they were small creatures (although not as tiny as the Rofaifo claimed *lufi* to be), had small eyes (although not as tiny or squinty as *lufi* was said to have) and they were very common, like *lufi* was said to have been before it disappeared. Slowly, as he contrasted the legend and the creatures sitting at his feet, the penny dropped. They *were lufi*, but a *lufi* whose reality had departed from the ever-improving legend they had inspired. With the arrival of stores and

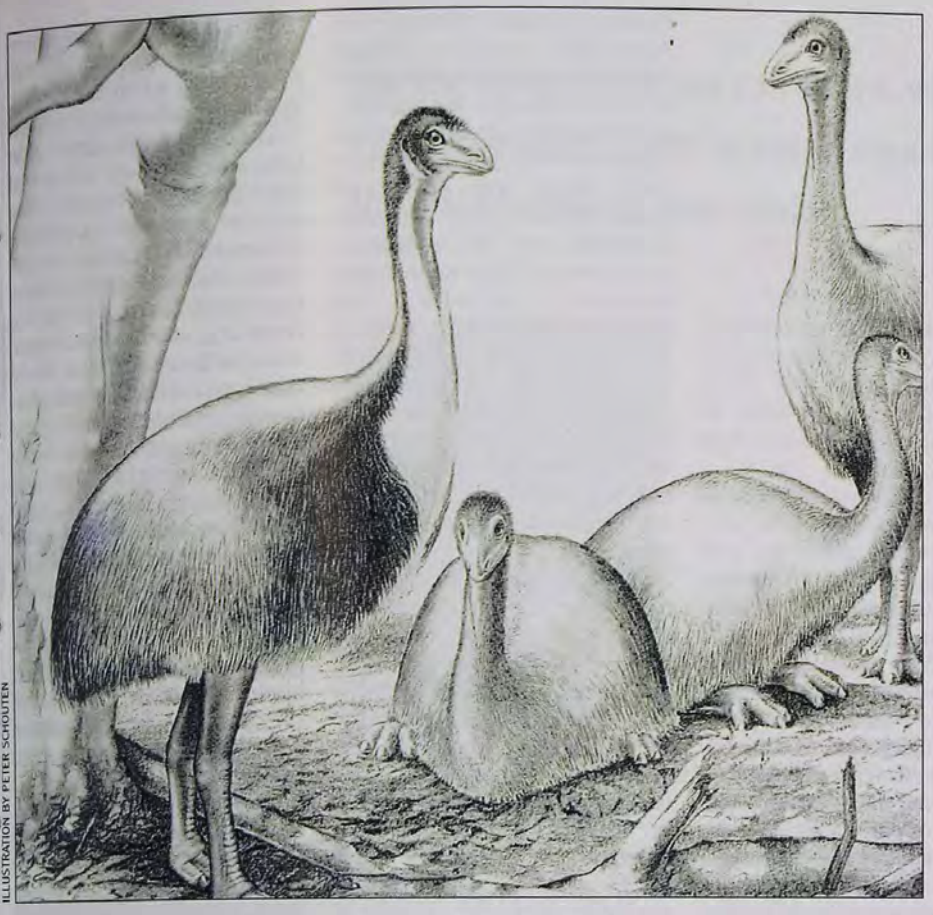


ILLUSTRATION BY PETER SCHOUTEN

***Genyornis newtoni*. Fossil remains of these birds have been found at Lake Callabonna, South Australia.**

easily bought foods, there had been a general decline in Rofaifo dependence on the smallest mammals of the area. No longer constrained by regular encounters with the actual creature, the legend of *lufi*, a cultural story barely one generation old, had become so exaggerated in the telling from one person to another that no-one recognised the source of the legend even when its wriggling whiskers were tickling their face. In a paper entitled "The rediscovery of Lufi" (*Nature Aust.** Autumn 1976, Peter concluded that *lufi* had "...vanished at the fireside. The small mammals of the bush had parted company with those of the mind. One by one and irrevocably they were going extinct."

Everyone who has played the party game 'Chinese Whispers' has discovered the impossibility of having even a single sentence survive retelling in a circle of ten people. Each listener interprets what they hear, exaggerating the features that most impress them, forgetting ones they don't understand. The continuously retold tale evolves into something unrecognisable within ten minutes.

Should we expect to find, in verbally transmitted stories, reliable accounts of creatures last seen nearly 40,000 years ago? To transmit a word picture of an extinct animal, such as the 'mihirung' bird, over this period of time, the legend would have to have been retold between 2,000 (once per generation) and 40,000 (annual recital) times, which is two billion times longer than the average game of 'Chinese Whispers'. In terms of 'lost *lufi* intervals' of perhaps 40 years, a story-based account transmitted for this long would probably have transformed into something totally unrecognisable.

Perhaps it would be more reasonable and respectful to allow stories told of ancient creatures to stand as found, without the need for another culture's interpretation to give them scientific credibility. The lesson of *lufi* is surely that cultural stories no matter how soundly based at the start, like language and life itself, inevitably and marvellously evolve with time. ■

*Previously *ANH*

Further Reading

Dwyer, P., 1976. The rediscovery of Lufi. *Aust. Nat. Hist.* 18(9): 317–323.

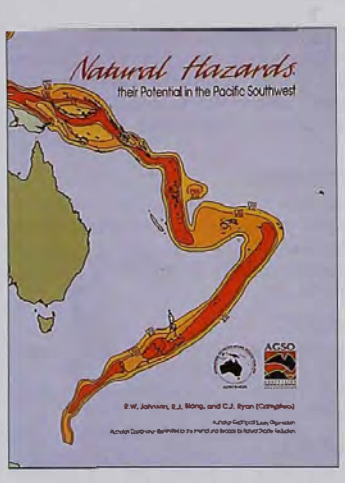
Flood, J., 1995. *Archaeology of the Dreamtime.* Angus & Robertson: Sydney.

Rich, P.V. & van Tets, G.F. (eds), 1985. *Kadimakara: extinct vertebrates of Australia.* Pioneer Design Studio: Melbourne.

Sutton, P., 1988. Myth as history, history as myth. Pp. 251–268 in *Being black: Aboriginal cultures in 'settled' Australia,* ed. by I. Keen. Aboriginal Studies Press: Canberra.

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.

REVIEWS



Natural Hazards: Their Potential in the Pacific Southwest

By R.W. Johnson, R.J. Blong and C.J. Ryan. Australian Geological Survey Organisation, Canberra, 1995, 60pp. plus map. $35.00rrp.

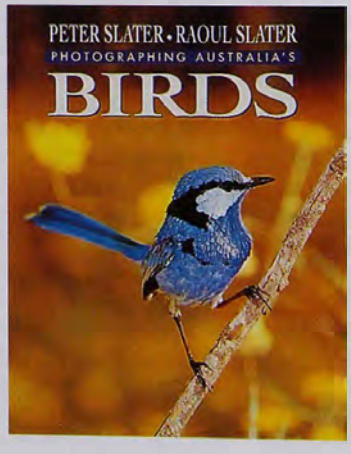
This is a welcome addition to the diverse literature on environmental themes. Unlike the majority of environmental texts this booklet does not deal with fauna, flora, landscapes or undersea scenes; rather, it presents meteorological and geological events that pose hazards in the South-west Pacific. It discusses the impact the environment has on humans, rather than the other way around. The area covered is the south-western quadrant of the Pacific region, extending to the Indian Ocean westwards, South-East Asia northwards and Antarctica southwards. Australia, New Zealand and island arcs to the north form the central part of this region. The authors have included a discussion on the uneven nature and limitation in the data they use to assess the potential hazards within the region. They put this data to good use in providing a map of potential natural hazards in the Pacific south-west.

The booklet sets the scene with a general discussion of the hazards, the meteorological and geological framework, the Natural Hazards Potential Map, global and regional views of the hazards, and interactions between hazards and effects. Then follows successive chapters discussing each of the 12 selected hazards. The first groups cover hazards that can be assessed across the whole region. Cyclone frequency and intensity maps clearly show northern Australia as a hazardous area, but bring out the high vulnerability of the Philippines to cyclones (called typhoons there). An earthquake intensity map illustrates the dramatic increase in this hazard in countries fringing Australia, but also shows small pockets of earthquake hazards in Australia. The volcanoes section shows that landslips can often result from other hazards such as volcanoes and earthquakes and can even create further hazards such as tsunamis. The tsunami section includes an eye-opener for Australians who live beside the sea as there is evidence for prehistoric tsunamis that today would devastate a populated coast.

The next group of hazards concentrates heavily on the Australian region, where the most detailed information is available. Sections on severe thunderstorms, floods, droughts and bush fires all have particular relevance to Australian readers. Maps depicting potential intensities of these hazards are particularly revealing and hold some surprises—such as the relatively large area of severe thunderstorms over Western Australia and the relatively small area of high to extreme bushfire potential in Australia. The last group of hazards on wave heights and ice are the least important, except for high-latitude shipping. The booklet concludes with thoughts on future assessment of hazards, acknowledgments and references.

The booklet is well illustrated with graphic pictures and clear maps, and includes some spectacular satellite and aerial views. The accompanying Natural Hazards Potential Map is a valuable synthesis for regional planners and all those interested in the environments of the region. The compilers have not hidden the unevenness of available data and provide a thought-provoking summary. I recommend this publication to anyone with environmental interests.

—Lin Sutherland
Australian Museum



Photographing Australia's Birds

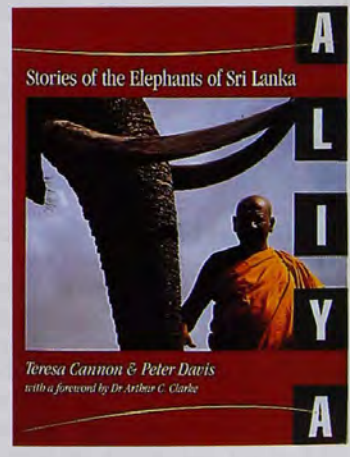
By Peter Slater and Raoul Slater. Steve Parish Publishing, Qld, 1995, 160pp. $24.95rrp.

Wow! This is the sort of book that makes me want to leave my job, load up the truck with camera gear and hit the road. But it is also more than just a beautiful and compelling picture book that is hard to put down until you have savoured every page. I found myself comparing their techniques to those that I have used when attempting to photograph birds.

The technical data contained in this book will prove very useful for anyone who decides they want to try and photograph animals in the wild. The authors highlight the need for discipline in recording details like exposure, as there will be a lot of trial and error before you develop the sixth sense needed when shooting in the field. Another essential is to use the longest lens you can afford, especially if you don't want to spend days inching a hide closer to your subject.

Whether you are a complete novice or have a background in photography this book will inspire you to push the boundaries and take a closer look at the world around you.

—Kate Lowe
Australian Museum



Aliya: Stories of the Elephants of Sri Lanka

By Teresa Cannon and Peter Davies. Airavata Press, Melbourne, 1995, 180pp. $60.00rrp.

This superbly written and illustrated book gives the reader a detailed insight into the natural and life history of the Sri Lankan Elephant (*Elephas maximus maximus*), a subspecies of Asian Elephant (*Elephas maximus*). Its seven chapters take one through the significant role that elephants play in Sri Lankan mythology, religion, culture and history.

Throughout the book, the authors have highlighted the continual struggle between an ever-ballooning human population, and the rapidly

dwindling wild elephant population. With humans continually encroaching on shrinking elephant habitat, conflict with elephants is all too frequent.

The book also describes in simple terms some of the unique anatomical, physiological and behavioural characteristics of elephants, and covers the difference between the African Elephant (*Loxodonta africana*) and the Asian Elephant. The authors also point out the significant differences between *E. maximus maximus* and other Asian Elephants. A brief insight is given into the life of a mahout (elephant driver) and the care of elephants in captivity. The detailed and fascinating anecdotes highlight how elephants have been exploited, persecuted, revered and worshipped by humans.

Although much of the book describes elephants in very anthropomorphic terms, the authors have pointed out that it is often difficult to describe these creatures in any other way, and to do so may belittle their magnificence.

One is continually reminded of the desperate need to conserve elephants, and we can only hope that a book such as this will increase our awareness of their plight. Elephants are a flagship species and their demise can only mean the demise of many others.

—Larry Vogelnest
Taronga Zoo

Use the longest lens you can afford, especially if you don't want to spend days inching a hide closer to your subject.

Australian Frogs: Amazing Amphibians

By Jill Morris and Lynne Tracey. Greater Glider Productions, Qld, 1995, 48pp. $17.95rrp.

This would be both an excellent book for introducing children to the world of frogs and a prized gift for one already initiated. The text by Jill Morris is informative without being too detailed or technical. It is also backed up by a short poem (accompanying the illustration) that details some aspects of the life history of the particular frog shown, and a description is given of the frog's call. The result is a neatly encapsulated piece of information I suspect children will relish.

Lynne Tracey's illustrations enhance the information, showing not only the frog itself but also the environment in which it lives and some of the other inhabitants that share it. The introductory chapter is well written and easily understood.

The book appears accurate throughout; in fact the only problems I had were one or two cases of potentially ambiguous wording. We are told, for example, that *Litoria aurea* means 'golden beach frog'. This is true but, without explanation, the unaware reader might think that *Litoria* means 'golden' and *aurea* means 'beach (frog)'. Similarly, predators defined as "creatures living on others" is open to several interpretations.

The book runs to 48 pages including glossary and index. It sells for an affordable $17.95 and is highly recommended.

—Martyn Robinson
Australian Museum

OTHER NEW TITLES...

The Taipan: the world's most dangerous snake
By Paul Masci/Philip Kendall. Kangaroo Press, NSW, 1995. $19.95rrp.

Native plants of the Ravensthorpe region
By Gillian F. Craig. Ravensthorpe Wildflower Show, WA, 1995. $12.95rrp.

Mosses and liverworts of rainforest in Tasmania and south-eastern Australia
By S.J. Jarman and B.A. Fuhrer. CSIRO Publications, Vic., 1995. $24.95rrp.

A photographic guide to snakes & other reptiles of Australia
By Gerry Swan. New Holland, NSW, 1995. $14.95rrp. Others in the series: **Mammals** *by Ronald Strahan and* **Birds** *by Peter Rowland.*

Wildlight: images of Australia
By Philip Quirk, Grenville Turner, Mark Lang and Peter Jarver. William Heinemann Australia, Vic., 1995. $45.00rrp.

Banksias and Bilbies: seasons of Australia
Gould League of Victoria, 1995. $15.95rrp.

Endangered fauna of western New South Wales
Edited by Danielle Ayers. NSW National Parks and Wildlife Service, NSW, 1995. $50.00rrp plus $5.00p/h.

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. *NATURE AUSTRALIA* is pleased to help promote the following societies:

BIRDS

ABSA Australian Bird Study Assoc. Inc.
PO Box A313, Sth Sydney, NSW 2000. Ph: (02) 231 8166
Contact: Alan Leishman, Secretary

Membership Fee: $35.00

Avicultural Society of SA Inc.
PO Box 3234, Rundle Mall, Adelaide, SA 5000.
Ph: (08) 264 3295
Contact: Neroll & Bill Price, Contact Officers

Membership Fee: $33.00

Cumberland Bird Observers Club Inc.
PO Box 550, Baulkham Hills, NSW 2153. Ph: (02) 264 7703 (w); 872 4185 (h)
Contact: Frances Czwalinna, Hon. Secretary

Membership Fee: $15.00

NSW Field Ornithologists Club
PO Box Q277, QVB Post Office, NSW 2000. Ph: (02) 807 6828
Contact: Sheila Witt, Hon. Secretary

Membership Fee: $35.00

Victorian Ornithological Research Group
PO Box 1000, Blind Bight, Vic. 3980. Ph: (059) 987 996
Contact: Arnis Dzedins, Secretary

Membership Fees: $15.00 (single); $20.00 (family)

Are you a Club Secretary?

NATURE AUSTRALIA's Associate Society Scheme is designed to help your club or society with free publicity, funds and member benefits. Contact *Nature Australia* for more details.

CONSERVATION

Australian Trust for Conservation Volunteers
PO Box 423, Ballarat, Vic. 3353.
Ph: (008) 032 501
Contact: Colin Jackson, Director

Membership Fee: $25.00

Friends of the Platypus
c/- Australian Platypus Conservancy, PO Box 84, Whittlesea, Vic. 3757.
Ph: (03) 9716 1626
Contact: Geoff Williams, President

Membership Fees: $30.00 (single); $45.00 (family); $20.00 (full-time student)

National Parks Foundation of SA Inc.
GPO Box 759, Adelaide, SA 5001. Ph: (08) 231 0016
Contact: Helen Jaensch, Secretary of Council

Membership Fee: donation (tax deductible)

Orangutan Fund Australia
PO Box 447, St Leonards, NSW 2065. Ph: (02) 489 6341
Contact: Jenny Katauskas, Secretary

Membership Fee: $25.00

Victorian National Parks Association Inc.
10 Parliament Place, Melbourne, Vic. 3002.
Ph: (03) 9650 8296;
F: (03) 9654 6843
Contact: Doug Humann, Director

Membership Fee: $36.00

EARTH SCIENCES

Dinosaur Club (NSW)
Australian Museum, 6 College Street, Sydney, NSW 2000.
Ph: (02) 320 6236
Contact: Jenny Nancarrow, Margery Phair

Membership Fee: $12.00 (single); $20 (family/group)

Dinosaur Club (Qld)
Qld Museum Assoc., PO Box 3300, Sth Brisbane, Qld 4101.
Ph: (07) 3840 7555 or 3840 7641
Contact: Donna Miles

Membership Fees: $12.00; (senior/junior); $20.00 (group); plus $5.00 (overseas)

Dinosaur Club (Vic.)
Earth Sciences Dept, Monash University, Clayton, Vic. 3168.
Ph: (03) 9905 1370
Contact: Jennifer Monaghan

Membership Fee: $12.00 (single); $20.00 (group)

EDUCATION

CSIRO's Double Helix Science Club
PO Box 225, Dickson, ACT 2602. Ph: (06) 276 6643
Contact: Lynn Pulford, Membership Secretary

Membership fee: $26.00

SA Science Teachers Assoc. Inc.
SASTA Office, c/- Plympton High School, Errington Street, Plympton, SA 5038.
Ph: (08) 293 2733
Contact: Judy Morton, Office

Membership Fees: $70.00 (secondary); $59.00 (primary); $99.00 (schools/inst.)

MUSEUM

Friends of the Qld Museum
PO Box 3300, Sth Brisbane, Qld 4101. Ph: (07) 3840 7641
Contact: Sandra Mann, Exec. Officer

Membership Fees: $25.00 (single); $30.00 (family); $20.00 (student/country)

TAMS, The Australian Museum Society
Australian Museum, 6 College Street, Sydney, NSW 2000.
Ph: (02) 320 6225;
F: (02) 320 6051
Contact: Carole Bibby, Exec. Officer

Membership fee: $50.00 (single); $65.00 (family/joint)

The Waterhouse Club
SA Museum, North Terrace, Adelaide, SA 5000.
Ph: (08) 2077 389
Contact: Mary Lou Simpson, Exec. Coordinator

Membership fee: $50.00 (single); $70.00 (family)

NATURAL HISTORY

Field Naturalists Club of Vic.
1 Gardenia St, Blackburn, Vic. 3130.
Contact: Geoffrey Paterson, Secretary

Membership Fee: $45.00 (single)

REPTILES

Victorian Herpetological Society Inc.
16 Suspension St, Ardeer, Vic. 3022. Ph: (03) 9363 6841 (pm); F: (03) 9360 5704
Contact: Brian Barnett, President

Membership Fees: $25.00–$38.00

SCIENTIFIC RESEARCH

ANZSES, Australian & New Zealand Scientific Exploration Society Inc.
PO Box 174, Albert Park, Vic. 3206. Ph: (03) 9866 8699
Contact: Colleen Lazenby, Executive Director

Membership Fees: $30.00; $50.00 (with Nature Australia*)*

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

The Guide

WELCOME TO THE GUIDE, *Nature Australia's* marketplace for over 100,000 people who now read every issue of the magazine. As a *Nature Australia* reader you are part of a very special group – a large and growing band of enthusiasts with a real interest in Australia's nature. *Nature Australia* is read in homes, universities, colleges, schools, libraries and other institutions across Australia and overseas.

***Advertisers can reach this very special group for a surprisingly low cost in* The Guide.**

Call (02) 339 8179 for full details.

Q&A

Flying termite nymphs leave an existing colony during the rainy season in the Tanami Desert, Northern Territory.

REG MORRISON/AUSCAPE INTERNATIONAL

Flying Frenzy

Q: *I have noticed how some insects are attracted to lights in such numbers that they seem to form a solid ball, and by morning discarded wings can be banked up centimetres deep against walls. I understand that what we are witnessing is the movement of the winged phase of the (usually wingless) termite. Are all 'flying ants' termites?*

—Lana Little
Chillagoe, Qld

A: Termites are often mistakenly referred to as 'white ants' or 'flying ants', but in fact termites are not related to ants at all. The termites you are witnessing are the virgin, flying adult males and females. They are leaving an existing colony to mate and start new colonies. There are two obvious features that distinguish a termite from an ant in the adult stage: colour and form of the antennae. Termites are white or off-white and have straight, bead-like antennae, whereas ants range from pale orange to dark brown or black and have antennae elbowed at right angles in the middle. Although thousands of flying termites may congregate around your light source at night, giving the impression of being in plague proportions, most will die of dehydration and possibly only one pair will go on to reproduce and start a new colony.

—Max Moulds
Australian Museum

Strange Bird Behaviour

Q: *In my garden recently I noticed a magpie exhibiting some very strange behaviour. It was lying on its chest, wings and tail fanned out and with the side of its face up against the wall of my house. It did not seem distressed in any way. Could you please explain why this bird might have been doing this?*

—H.W. Kinnersly
Lindfield, NSW

A: This odd behaviour catches the attention of many people, who often express concern that the bird is suffering in some way. In fact, it is a voluntary action, a type of comfort behaviour known as 'sunning', or more specifically, 'sun-exposure'.

This behaviour has been observed in many species. It usually takes place in an exposed location, at the hottest time of the day, with the sun high in the sky. A number of possible functions has been suggested, almost all to do with some form of feather maintenance. Most of these are still speculative, but there is observational evidence from some vultures that this exposure helps restore the original shape of wing and tail feathers deformed during flight. Another possibility that has been raised is that the light and heat increases the flow of preen oil, used in maintaining the condition of the feathers, or it could increase the activity of ectoparasites so that they leave areas that are inaccessible to beaks and feet and thus are more likely to be removed during preening. Sun-exposure might also aid vitamin synthesis or have some other benefits to the skin.

Sunning birds adopt a variety of postures, ranging from

An Australian Magpie takes in the sun.

COURTESY H.W. KINNERSLY

a simple pose with the wings drooped and the feathers fluffed up, through to more elaborate ones, in which the wings are extended, the tail spread, and the feathers of the head and neck raised, much like your Australian Magpie. In some instances, a bird may lean to one side, with the uppermost wing lifted vertically. Sometimes the bird positions itself next to a reflecting surface, such as the side of your house, presumably to increase the exposure.

While performing these actions, the bird may suffer some heat stress, which it combats by gaping, panting and feather-fluffing to allow heat to escape from the body.

A related behaviour is sun-basking. This appears to serve a thermoregulatory function. It permits a bird to maintain a high body temperature, while reducing the bird's own metabolic requirements. Sun-basking is characteristically seen during cold weather.

—Walter E. Boles
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 $20 gift voucher for the Museum Shop Book Catalogue. Winter's Pic Teaser was a leaf-tailed gecko (*Saltuarius swaini*) from Queensland.

AUSTRALIAN MUSEUM

Answers to Quiz in Nature Strips (page 20)

1. Little or Fairy Penguin
2. Types of fungi
3. False
4. *The lost world*
5. Tasmania
6. A New Zealand parrot
7. The asteroid belt
8. Penicillin
9. Torres Strait
10. Giant Squid

On hearing the name 'rat', the crowd, previously empathetic, would reel back in disgust.

RATS, REVENUE & RECONCILIATION

BY RICHARD BRAITHWAITE

OFTEN WHEN I WAS WORKING in the lyrebird enclosure at the Healesville Fauna Park near Melbourne, clearing my traps and releasing numbers of the Swamp Rat (*Rattus lutreolus*), a crowd of curious visitors would slowly accumulate. When the interest level had reached a certain point, I would break off from my task and explain to the people what I was doing, at the same time allowing the children to stroke the animal's attractive brown fur. Inevitably at the end of the performance one of the crowd would ask the name of the species. But on hearing the name 'rat', the crowd, previously empathetic, would reel back in disgust. I explored this reaction many dozens of times. Had I given the animal a more attractive name, such as the Aboriginal word Koota, the crowd's reaction would no doubt have been different.

The Australian native rodents have had a raw deal. They have received little study in comparison with the glamorous marsupials and have fared particularly badly since settlement, with 12 per cent now extinct and a further 20 per cent classed as critically endangered, endangered or vulnerable.

The professional marketers tell us of the importance of names for the associations they draw. If you want people to feel good about a product, they need to feel good about the name. A perfume manufacturer does not saddle a perfume with a name like "Dog's Breath". But this is, in fact, what we have done with much of our fauna. We have followed the 19th-century tradition of ignorant newcomers to Australia. With the 61 native rodents, we used the words 'rat' and 'mouse' as the noun for their common names. It is not just that Australians do not feel good about this component of their native fauna, but it inadvertently contributes to their extinction. While I was on the Scientific Advisory Committee of the World Wide Fund for Nature (Australia), approved projects on rodents were unable to attract funding. The fund-raisers found that potential corporate sponsors were unwilling to have their names associated with names like False Water-rat and Big-eared Hopping-mouse. So funding did not eventuate and projects were not carried out. Other groups, like bats and insects, have suffered similarly.

But it is not just about fund-raising. It is also about reconciliation. When Europeans arrived on this continent they introduced the mainstays of European imperialism (sheep, cattle, pigs, wheat etc.) at the expense, we now realise, of soil erosion, salinisation and species extinctions. We were insensitive to what was here. We failed to recognise how Aboriginal people had, for thousands of years, successfully adapted themselves to the continent. We arrogantly assumed we knew best, refusing to see the validity of their knowledge. By doing this, we rejected their worth as people. Reconciliation is about making amends for this.

This raises the question of what common names native rodents should be given. A list of hundreds of alternative Aboriginal names from around the country for all species of native rodents has now been published. From this list, my colleagues and I came up with a set of recommended names that originate from near the centre of the geographic range for each species. They also tended to be shorter and easier to pronounce than some of the alternatives. The Kimberley name Garrawal, for example, was chosen for the Golden-backed Tree-rat (*Mesembryiomys macrurus*); Rakali, which comes from the Murray River area of South Australia, was selected out of a total of 54 for the Water-rat (*Hydromys chrysogaster*); Yirrkoo, from the Kakadu region, was chosen for the False Water-rat (*Xeromys myoides*); and Mayaroo for the Long-haired Rat (*Rattus villosissimus*). In a few cases where no name was clearly associated with a species, a more general name was applied. The Arnhem Land Pebble-mound Mouse (*Pseudomys calabyi*), for example, was given the name Pinti, which is a Jawoyn name for small mice from the south of Kakadu National Park, where this rodent is virtually restricted.

By adopting more attractive Aboriginal names for our fauna, we would be doing something not only for conservation, but for community cohesion as well. We would also be participating in the process of developing a more appropriate cultural identity, one more in harmony with the continent we live on. We would be helping to make Australia a better place. ■

G. HOYE/NATURE FOCUS

The unfairly named Swamp Rat.

Further Reading

Braithwaite, R.W., Morton, S.R., Burbidge, A.A. & Calaby, J.H., 1995. *Australian names for Australian rodents*. Australian Nature Conservation Agency: Canberra.

Dr Richard Braithwaite is a Senior Principal Research Scientist with CSIRO Division of Wildlife and Ecology in Darwin.

BACK ISSUES AND SUPPLEMENTS

23/6

23/7

23/9

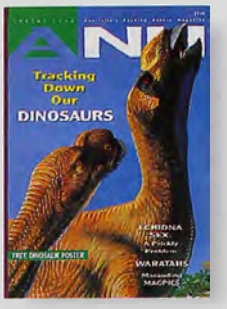
23/11

24/1

24/2

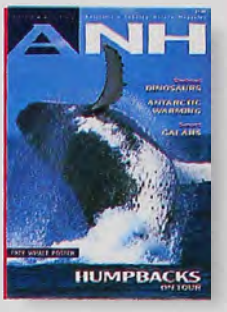
24/4

24/5

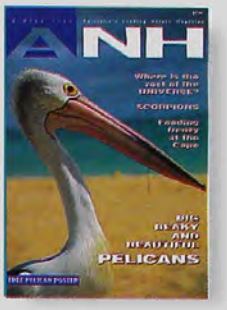


24/6

24/7



24/8

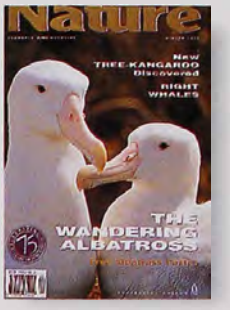


24/9

24/10

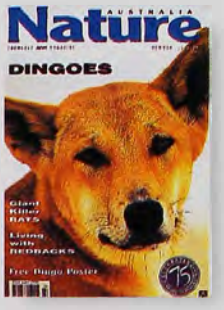
24/11

24/12



25/1

25/2

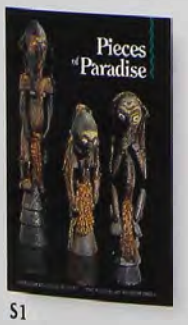


25/3

25/4

25/5

SUPPLEMENTS



S1
Pieces of Paradise

S2
Tracks through Time

SPECIAL OFFER

Library box holds 12 issues of the magazine. Finished in durable, dark green PVC. It will ensure your copies remain in mint condition.

To order use the form opposite

Discover Australia's natural beauty.

Discover the unique natural beauty of Australia in two spectacular books. *Australian World Heritage*, features a diverse range of Australian landscape included on the World Heritage list. Magnificent sites such as Kakadu and Lord Howe Island, all listed for their natural or cultural significance, are brought to life in stunning photographs.

In the second book, *Nature of Australia*, homage is paid to the incredible variety of natural environments found in Australia. The unique flora and fauna is elegantly captured in a host of habitats, from lush coastal regions to the arid deserts. Each book includes a bonus souvenir stamp product.

Australia Post

Stamps

Australian World Heritage is available from 14 March and *Nature of Australia* from 9 May for 14^{95} each, at your Post Office or Australia Post Shop. To order by credit card, simply phone during business hours on **Freecall 1800 331 794.**

APS 607 NA