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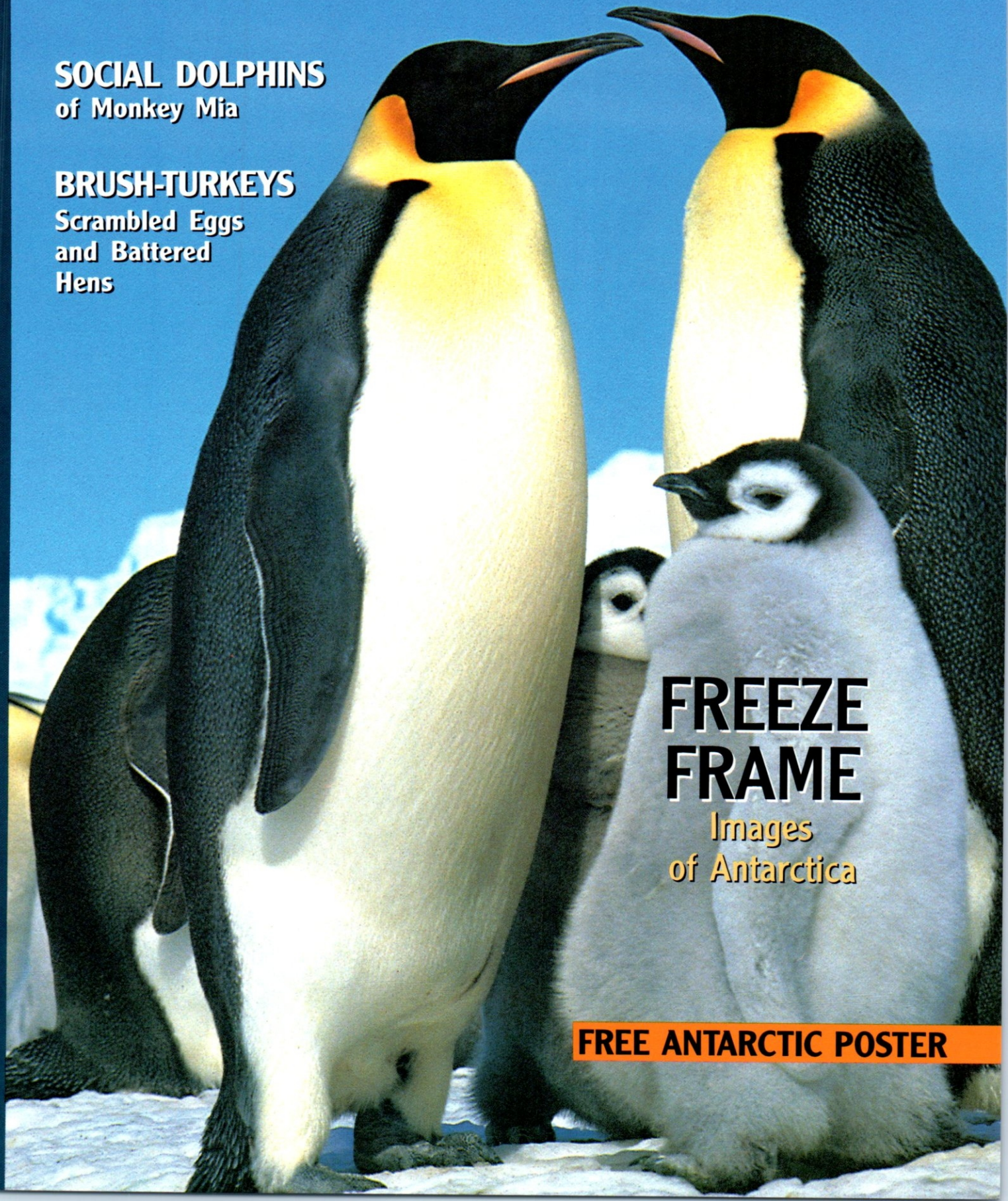
of Monkey Mia

BRUSH-TURKEYS
Scrambled Eggs and Battered Hens



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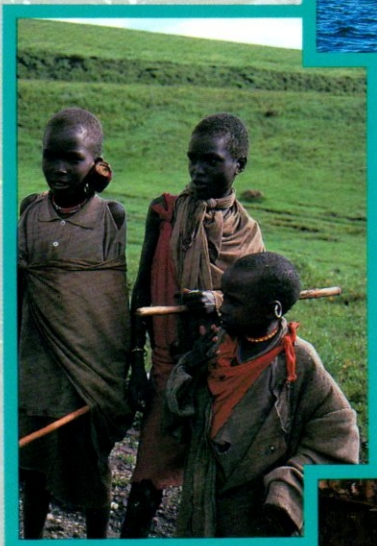

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Up Front

JONATHAN CHESTER

Antarctic photographer Jonathan Chester.

Antarctica is a place of ethereal beauty—Jonathan Chester's exceptional photographs have captured the essence of this vast continent in Photoart and on our cover and poster. Interestingly, people who overwinter in Antarctica's harsh climate have been found to have fewer health problems in later life (see Quips, Quotes & Curios).

RICHARD CONNOR

Dolphin researcher Rachel Smolker.

Being belted over the head and pecked repeatedly may not sound like good sex—but it works for the Australian Brush-turkey. And if the females' subjection to brutality sounds rough, life as a male is not much better: he spends most of his time building mounds to incubate eggs that may not even be his own. But there is reasoning behind this madness, as you will learn.

Unusual encounters can be had at the beach at Monkey Mia, Western Australia, where dolphins come in to visit people and be fed. But how much do you know about the extraordinarily intricate social lives these creatures lead? From the female 'social butterflies' to the solitary sponge-carriers, their relationships make fascinating reading.

Also in this issue intrepid writer Tim Flannery investigates the strange phenomenon of why our animals—bar humans and wombats—have shrunk over time. We discover how Steve Van Dyck almost poisoned his family; why people either love or hate flying-foxes; and how to discover the traditional Aboriginal way of life in the Northern Territory.

KATHIE ATKINSON

Hand-rearing an orphaned flying-fox.

ANH

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Front Cover
Emperor Penguins at Auster Rookery, Antarctica. This icy continent is Mecca for the serious nature photographer. See more of Jonathan Chester's exceptional photographs in Photoart.

Articles

Regular Features

Columns

LETTERS

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

Population Pays Principle

The 'polluter pays principle' discussed in "One world: the science and the politics" (ANH Winter 1992) indeed has its merits. However it must be linked with a control in human numbers to discourage 'trade' in population increase for income of carbon dioxide credits.

As well as pollution debits there must be demerit points scored against communities that do not bring their numbers down, over time, in accordance with some pre-arranged formula or timetable. Population, landmass area, and the ability of each community's environment to handle those people in harmony with nature's rights all have to be balanced.

Any system based on today's national populations alone only takes into account the human and carbon dioxide factors. It ignores the needs and rights of all the other passengers on our planet.

—Guillaume Tabuteau
Broken Hill, NSW

Mirrored Earth

North does not *have* to be placed at the top of every map; that we usually put it there is merely a convention. There is much to be said for viewing maps of the surface of the Earth in different orientations, simply because it shakes us out of our conventional view of our home and literally gets us to look at things differently. But I doubt if there is anything to be gained by showing satellite views of the Earth's surface as mirror images of how they really appear from above. It took me a little time to place that part of the Earth's surface portrayed in Jonathon Porritt's article "One world: the science and the politics" (ANH Winter 1992). It is a mirror image of North Africa, the Mediterranean and the Middle East. Presumably it would appear like this if viewed from underneath, but who can possibly see it like this?

—Nigel Wace
Australian National University, ACT

I was interested by Jonathon Porritt's article "One world: the science and the politics" (ANH Winter 1992). I was mildly put out, however, to see that the one world pictured on page 34 is not our one. It became somewhat more recognisable when viewed in the mirror.

—Andrew Bryant
Ashfield, NSW

Inconsistent Principles

It has been most interesting to learn from recent contributors (ANH Summer 1991–92 and Autumn 1991) that the Japanese addiction to whaling springs from their adoption of Buddhism in the sixth century, and their (then) misapprehension that whales were lawfully edible because they were fish. Others shared this error into the 19th century; now we know better, and so do the Japanese. The Japanese of today are not noticeably clinging to other Buddhist principles, particularly the ideal of renunciation of worldly riches: why are they so keen on this one? I suggest it has very little to do with tradition, and a lot to do with the fact that owners of whaling fleets make a great deal of money. In this case there is no cultural excuse for their persistence in an industry the rest of the world considers reprehensible.

—Douglas Newton, New York

Get Well Soon!

I read with interest the QQC article "Feeling crook" (ANH Spring 1992) in which a Dr Sapolsky was reported as suggesting that treating fever during infections may not be such a good thing to do. But the situation is even more complex and interesting than indicated.

Interleukin-1 (IL-1) is a product of the body's acute response to infection or other damage. The raising of body temperature to produce a fever is indeed one of IL-1's functions and it seems that animals do survive longer if allowed to raise their body temperature during experimentally induced fever.

However, other factors may also be involved, possibly through changes in concentrations of substances such as iron circulating in the blood. Some bacteria appear to like a culture medium rich in iron. Iron disappears rapidly from the circulation during experimentally induced fever, while total body iron is unaffected.

During fever, the iron becomes unavailable to both the invading organism and the host. It has been suggested that this may help to inhibit the multiplication of disease-producing microorganisms, however, iron disappears even if bacteria are not involved.

Not all changes associated with fever and inflammation appear to be beneficial in the long term. Inflammation may result in weight loss (muscle breakdown) and, if it continues for long enough, growth retardation in children and anaemia (loss of available iron for production of red blood cells).

Overall it does appear that,

Population needs to be included in the 'polluter pays principle'.

MALCOLM RICKETTS

in principle, fever as a response to inflammation is associated with beneficial effects, at least in the short term. That it may be counterproductive to use drug treatment to reduce fever is not, however, an inevitable conclusion. Fever is only one aspect of the acute inflammatory response.

'Inflammation' is part of the body's non-specific response to injury or infection. It is a complex process, which includes fever and other processes that appear to be contradictory and not immediately identifiable as being beneficial. For example, IL-1 may indeed be stimulating the production of CRF (corticotrophin-releasing factor). But if, as stated in the article, CRF is diverting energy to muscles, IL-1 will be busy breaking down muscle protein (another of its known effects).

Sapolsky raises the character-building option of toughing it out. It is unlikely, however, that this confers any real benefits as far as the patient is concerned. Indeed there may even be metabolic gains to be made by treating the fever. In the management of real patients we must be constantly alert to differentiate between the intellectual curiosity and the functional response to treatment.

What then are the implications of treating fever during acute illness? Here again the situation is not simple (at least in theory) as the effects differ depending on the drug used.

Drugs that interfere with 'prostaglandins' will reduce fever, inhibit breakdown of muscle protein and, at least in juvenile rats, prevent growth retardation. Aspirin is such a substance. Unfortunately aspirin is no longer recommended for treatment of fever in children due to its association with Reye's Syndrome (a severe form of liver disease) particularly during influenza and chickenpox. On the other hand, paracetamol is safe and effective in treating fever but lacks the anti-inflammatory effects of aspirin and so is unlikely to affect either muscle protein breakdown or growth retardation.

Raising body temperature during infections and the associated changes must have had a potent influence for survival in our evolutionary history as evidenced by its presence throughout the phylogenetic tree—in reptiles, fish, birds and mammals. At the risk of repeating myself, the acute inflammatory response is, however, a bit of a blunderbuss and fever is only one aspect of a complex response to an invading organism and there are clearly trade-offs in the long term.

The bottom line seems to be that, yes, fever may be good for you but treating it does no harm. Not treating fever certainly increases the sum of human misery, as those of us who have gone to our sick children in the middle of the night might well know. Pain is the forgotten symptom in children and drugs that may incidentally reduce a fever are eminently suitable for this.

This 'short note' has developed a life of its own! In an attempt to curry favour with the editorial staff, may I say that this family subscribes to a number of well-known educational, glossy publications and your awards for 'Best Periodical' are more than justified; ANH is stimulating and great fun.

—Dr David MacKintosh
Northmead, NSW

Huskies in Antarctica

In his rather emotional plea for the retention of the huskies in Antarctica, Patrick Moonie asks the question, "What is the price of a human life?".

No doubt another Antarctic veteran, the Ancient Mariner of Coleridge's famous poem would be able to give a definite answer. I think he would reason this way: if there are at least four billion humans on Earth and only twenty thousand tigers, one human life is worth .00002 of a tiger's life.

His experience was that the

How many humans equal a dog?

200 men on his ship died because he killed one albatross, or that one human life then was worth .02 of an albatross.

Perhaps Mr Moonie should be more objective if his argument is going to carry weight. Even some Christians believe, like The Ancient Mariner, that "the dear God who loveth us, He made and loveth all."

—D.H. Crakanthorp
Moruya, NSW

Art is Wild

After reading the Q & A "Wild art" (ANH Winter 1992) I wish to advise readers of three societies actively involved in wildlife art. All have annual exhibitions and produce a number of newsletters. These societies are:

- The Wildlife Art Society of Australasia; P.O. Box 284, Canterbury, Victoria 3126.

- The Wildlife Art Society of Queensland; P.O. Box 5591, West End, Queensland 4104.

- The Wildlife Art Society of South Australia; contact Pam Thoday at the Enchanted Bush Gallery, Birdwood, South Australia 5234.

—Colleen Werner
Birdwood, NSW

ANH 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 gift voucher from the Museum catalogue. The winner this issue is Douglas Newton.

JIRI LOCHMAN / LOCHMAN TRANSPARENCIES

QUOTES & CURIOS

QUIPS

COMPILED BY GEORGINA HICKEY

Dolphin Bumps

The scientific literature widely refers to the skin of dolphins and related small whales as 'smooth'. However, a new study by Drs Pat Shoemaker and Sam Ridgway, scientists with the Naval Ocean Systems Centre in San Diego, suggests that 'bumpy' skin is in fact a widespread trait within the toothed whales (or odontocetes).

Shoemaker and Ridgway observed faint, shallow corrugations on the skin of a number of odontocete species and, using a quick-drying epoxy resin, took impressions of the ridges from seven of these species.

Less than two millimetres wide and ranging between 10 and 120 thousandths of a millimetre deep, the ridges were found to resemble the fingerprint contours of the human hand. Size and distribution of the ridges appeared to be fairly consistent among members of the same species regardless of sex. They were generally distributed over most of the body and tended to run around the body circumference at approximate right angles to swimming direction.

While the researchers acknowledged that more work was needed to determine the function of the ridges, they speculated that they might somehow contribute to swimming efficiency. Perhaps they play a role in the tactile senses by helping to convey detailed information about water movements close to the animal's body? Or they might somehow influence the hydrodynamic characteristics of the animal. Support for this comes from anecdotal accounts by Sea World trainers that the ridges on individual Killer Whales become more pronounced as the speed of the animal increases. It remains unclear, however, whether the ridges do influence speed and, if they do, how.

—K.McG.

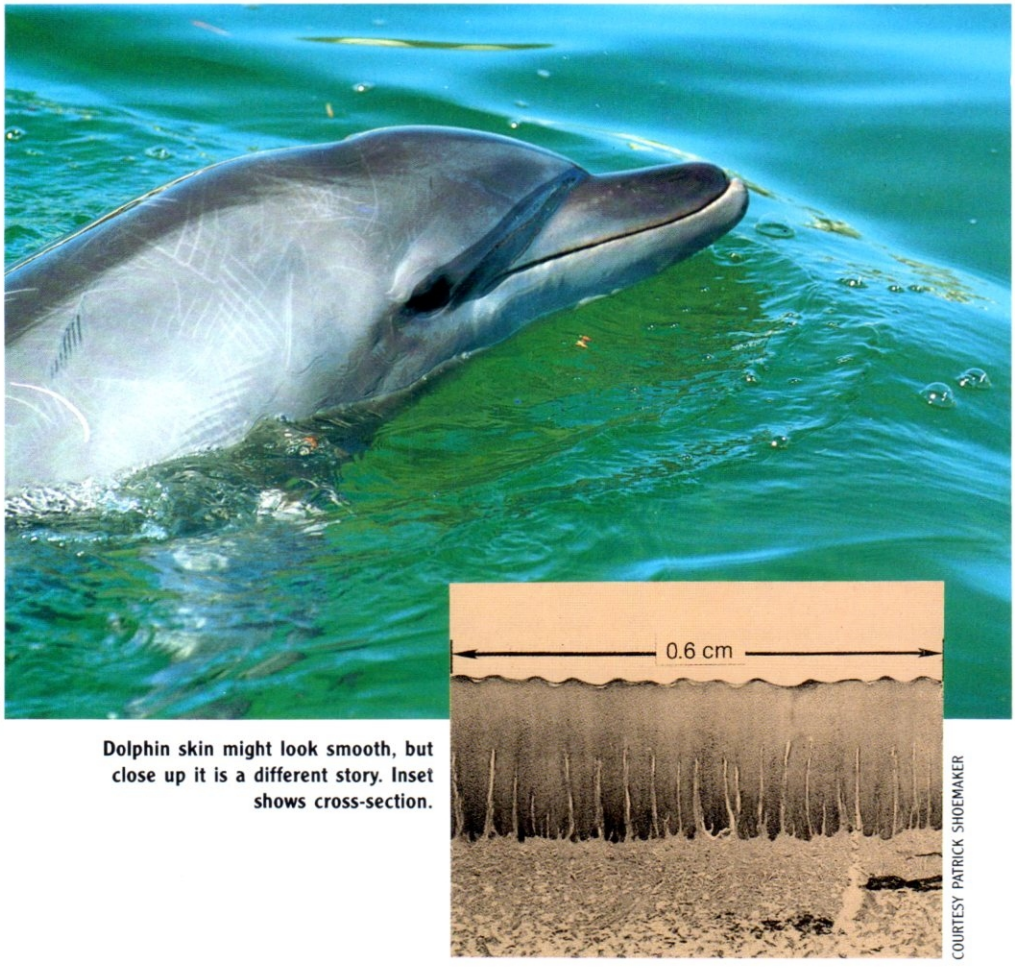


PHOTO INDEX

COURTESY PATRICK SHOEMAKER

Dolphin skin might look smooth, but close up it is a different story. Inset shows cross-section.

Return of the Quagga

Extinction is forever, it's true. But a group of researchers in South Africa have embarked on an ambitious project to stage the return of a population of animals called 'Quaggas' that were hunted to extinction in the late 1800s. The last individual died in Amsterdam Zoo in 1883.

The Quagga is a member of the horse genus *Equus*, a kind of zebra but brown coloured and only partly striped. It was once a common animal in southern Africa.

By studying the DNA from preserved Quagga skins, a team led by American molecular biologist Russel Higuchi established that the Quagga was not a separate species of zebra but a subspecies of the common Plains Zebra. Plains Zebras of East Africa have distinct black and white markings over their whole body. They become browner and less striped the further south they live. The Quagga represents the southernmost of the Plains Zebra groups.

The genes for Quagga colouring are probably not lost forever . . . only diluted.

The genes for Quagga colouring are probably not lost forever. They are most likely only diluted and spread among living Plains Zebras. Because they belong to the same species, it should be possible to

Soon the Quagga may not be just a thing of the past, thanks to selective breeding.

selectively breed Quaggas from the extant southern populations.

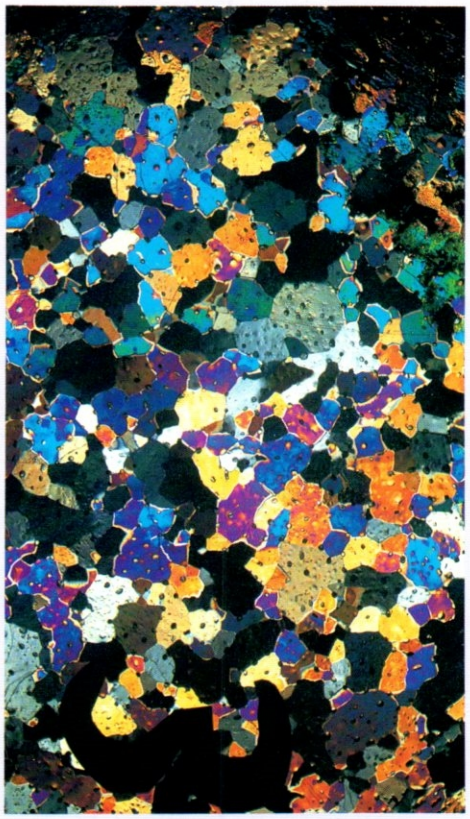
Among the ten foals born so far, some are more similar to the Quagga than their parents are. If researchers can produce animals with the right markings over several generations, they will be justified in calling them Quaggas.

Reinhold Rau of the South African Museum and cofounder of the Quagga Breeding Project wants it made clear that he and his coworkers are not recreating a whole species. They are simply trying to correct the tragic mistakes made when this subspecies was hunted to extinction. Extinction of a species really is forever.

—C.A.

Carrie Arkinstall (education officer at the Australian Museum), Dr Suzanne Hand (biologist at the University of NSW) and Karen McGhee (freelance science writer living in Newcastle) are regular contributors to QQC.

COURTESY R. RAU



AUSTRALIAN ANTARTIC DIVISION

COOL PHOTOGRAPHY

What would you say if I were to drop this in your drink? Probably 'thanks': this photo is of ice. When sliced thinly and viewed through crossed polaroid filters, as here, ice looks very different from the cubes taken from your freezer. Such photographs are an important tool used by glaciologists to study the complex mechanical processes that go on inside the massive (in some places three kilometres thick) Antarctic ice sheet as it deforms and spreads under its own weight.

Ice core samples are taken from different depths in the Antarctic ice sheet, and compared with laboratory samples. Each coloured shape is a separate ice crystal, making it easy to measure crystal size. The forces within the ice determine the size, shape and orientation of these crystals. If, by deforming samples of ice in the laboratory, we can create the same crystallographic changes that occur in the ice sheet samples, then the chances are very good that what we are doing to the ice in the laboratory replicates what happens in the natural ice mass.

By understanding the physics of the ice flow within the Antarctic ice sheet—in other words, by knowing how the ice crystals deform under their own weight—it is possible to trace an ice core sample back to its original position and to date it.

The dots in the photo are bubbles of air that were trapped between the ice crystals when they originally fell as snow. The trapped gases can be analysed and, by knowing the age of the samples from which they originated, we can determine the composition of the atmosphere in the past and make relevant comparisons (such as for greenhouse gases) with modern-day samples.

—Jo Jacka
Australian Antarctic Division

MALCOLM RICKETTS

Toughing it out through an Antarctic winter has long-term benefits.

Antarctic Benefits

Antarctica in winter is a bitter and lonely place. The weather is dry, cold and windy; the nights are extraordinarily long; the air is thin. And life in the isolated research stations is disturbingly repetitive.

The short-term deleterious effects on those who endure this harsh environment are many and well documented. They range from dry skin, changes in thyroid function and disruptions to the body's circadian rhythms, to immunosuppression associated with life in a germ-free environment and lowered blood pressure. But research now suggests that, in the longer term, life back in the 'real world' after the hardships of an Antarctic winter may actually be better for the experience.

Dr Lawrence Palinkas, an anthropologist from the University of California at San Diego, investigated the health and well-being of 358 enlisted US Navy personnel for 15 years after they over-wintered in Antarctica between 1964 and 1974. He compared his findings with the medical records of 2,396 enlisted Navy men who had volunteered for Antarctic duty along with the 358 but were assigned elsewhere because of limited number of available positions. All men in both groups were deemed medically and psychologically suitable for Antarctic service.

The study found that, after a return to normal living, the Antarctic group had a significantly lower hospitalisation rate than the control group. More specifically, a lower rate of men in the Antarctic group succumbed to common 20th-century ills such as cancers, diabetes and osteoarthritis.

Within the Antarctic group, Dr Palinkas found those who were based at the harshest stations suffered less of the symptoms associated with the notorious 'Winter-Over Syndrome' (such as insomnia and depression) and lower long-term hospital admission rates than those assigned to stations with mild conditions. In other words, the more severe the hardship, the more beneficial it appears to be.

Dr Palinkas concluded that "adaptation to extreme social and physical environments may provide long-term health benefits for certain individuals". Perhaps surviving an Antarctic winter puts a different perspective on everyday life, promoting a sense of well-being that sustains good health.

—K.McG.

Cave-dwelling Coelacanths

Thought to be extinct for 50 million years before its discovery in 1938 off the coast of South Africa, the Coelacanth *(Latimeria chalumnae)* is one of the world's most enigmatic creatures. This one- to two-metre-long, deepwater fish is known from few specimens and fewer live observations, and is the only living member of an ancient group that lays claim to a key position in the problem of vertebrate transition from water to land and the origin of the tetrapods (that is, amphibians, reptiles, birds and mammals). Traditionally, extinct lobe-finned fishes called rhipidistians have been regarded as the closest relatives of the tetrapods. But among *living* fish, the Coelacanth, lungfishes and, to a lesser extent, bony fish (teleosts) have each been considered to be the sister-group of the tetrapods.

Now, a study of amino acid sequences in Coelacanth haemoglobin by Thomas Gorr, Traute Kleinschmidt and Hans Fricke of the Max Planck Institutes of Biochemistry and Vertebrate Physiology, indicates that the Coelacanth is the closest living relative of the tetrapods. This supports the traditional view based on palaeontological research but conflicts with the conclusions of some recent anatomical and molecular studies.

> They remained almost motionless in a variety of orientations—belly-up, head down or tail stands.

Genealogies aside, the first observations of Coelacanth social behaviour in the wild suggest that its natural history will prove to be every bit as interesting as its pedigree. Using a submersible with a depth capability of 400 metres, Hans Fricke and German and French colleagues have studied small groups of Coelacanths at around 200 metres depth in

The Coelacanth is probably the oldest living relative of four-legged land animals.

the volcanic Comoro Archipelago of the western Pacific.

Groups of up to ten Coelacanths were observed sheltering during the day in two- to three-metre-deep lava caves where they remained almost motionless, floating 10–20 centimetres above the cave floor in a variety of orientations—belly up, head down, tail stands or any oblique position. The fleshy paired fins controlled body position by slight movements but never rested on the bottom. After sunset, the fish left the caves and drifted alone slowly across the lava cliffs, presumably to feed. At dawn they returned to the nearest cave.

Although these Coelacanths spent the day in close proximity to each other, they avoided body contact except for very brief (less than 40 milliseconds) fin contacts. Because Coelacanths have individual markings and aggregate in small peaceful groups, it is probable that cave occupants recognise each other individually. Sensitive electroceptors have been found on the Coelacanth's snout and the authors suggest that electric communication may play a major role in behaviour, perhaps explaining the scarcity of visible social interactions.

How Coelacanths find their way around the topographically complicated lava cliffs at night remains one of the most interesting unanswered questions of the study.

—S.H.

Taken for a Ride

In 1979, a small bobtail squid *(Euprymna morsei)* was collected and preserved by Shirley Slack-Smith, a curator of molluscs at the Western Australian Museum. The 60-millimetre adult specimen was part of a catch trawled off the Dampier Archipelago in north-western Australia by the CSIRO's research vessel *Soela*. On her return to Perth, Mrs Slack-Smith noticed an unusual feature in this particular specimen: it appeared to have a small fish tail projecting from its gill cavity. Not being able to remove it with forceps, she dissected open the chamber, and found a 15-millimetre specimen of a fish. It was jammed head-first in a depression near the squid's gills and was obviously too large for the available space. The rear part of the fish's body appeared to be deformed, the tail fin and its base being bent upwards. In addition, the normally straight, downward-directed spines and rays of the anal fin curled around and up the side of the fish's body. Shirley was curious to discover more about this extraordinary interloper, so she passed the specimen to the Museum's fish department for identification.

Examination of the fish revealed it to be a small juvenile of the Deepsea Jewfish *(Glaucosoma buergeri)*, a close relative of the Pearl Perch *(G. scapulare)* and West Australian Jewfish *(G. hebraicum)*. The

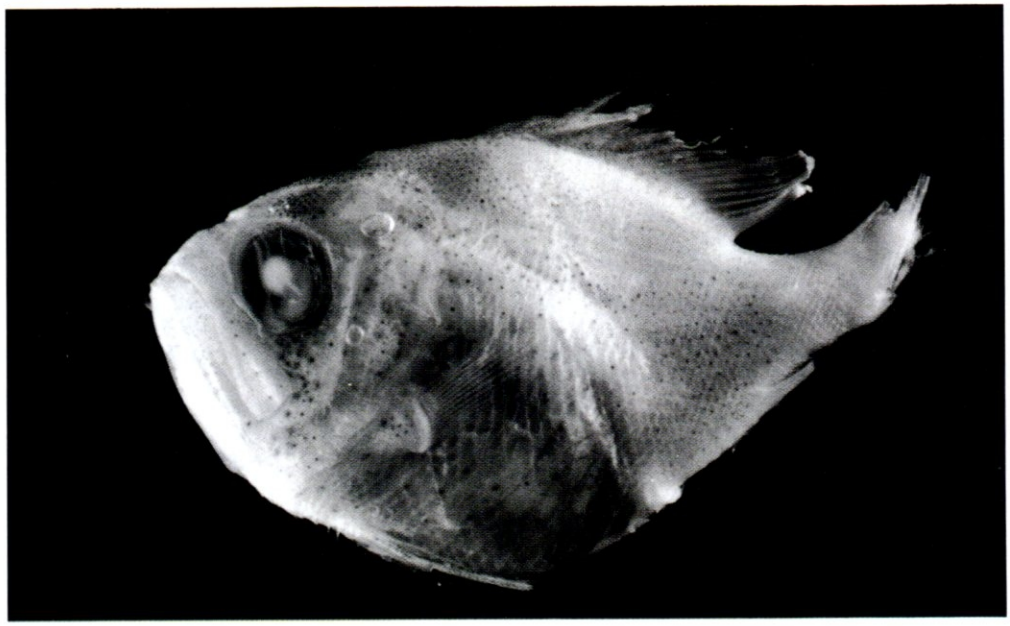
L. SCHAUER / © HANS FRICKE

fish had obviously spent some time with the squid rather than simply ending up in the gill cavity during their capture by the trawl net. There are several reasons for this assumption. First, the fish is larger than the gill opening and could not have entered it except when much smaller. Second, the abnormal depression in the squid's gill cavity fitted perfectly around the body of the fish. It had obviously been formed by the fish feeding on the squid's gills and gonad (sex organ)—there is no corresponding depression on the other side of the gill cavity. And third, the distortion to the tail and anal fin could only have resulted from growth that occurred after the fish became trapped (the abnormally curved shape of the anal fin spines is particularly significant).

The abnormal depression had been formed by the fish feeding on the squid's gills and sex organ.

This evidence suggests that the fish had entered the gill cavity of the squid when very small, perhaps to avoid being eaten by this carnivore, or maybe accidentally as the squid inhaled. Either way, it had obviously become trapped as it grew in size. The fish, which normally grows to about 450 millimetres, probably survived initially by feeding from the plankton-rich water that was drawn in by the breathing actions of the squid. However, as the fish grew and its appetite increased it was eventually forced to feed on the host itself. Had the squid not been caught, there seems little doubt that this relationship would soon have ended—the fish would have quickly outgrown the available space, resulting in the death of both animals.

—Barry Hutchins
Western Australian Museum



Cramped living conditions deformed this juvenile Deepsea Jewfish.

BARRY HUTCHINS

Why are Kiwis' Eggs so Large?

Kiwis (*Apteryx* spp.) are New Zealand ratites—non-flying birds, including the Emu, Ostrich, cassowaries, rheas and the extinct moas. At about the size of a domestic hen, they are the smallest living ratites. They also produce the largest eggs in relation to body size for any bird. Eggs of the Brown Kiwi weigh between 400 and 435 grams (up to 25 per cent of their body weight). This compares with the usual 55 to 100 grams for birds of similar size.

One explanation for the large size of kiwi eggs is that they confer some advantage to the species' survival (the larger hatchlings have a greater chance of fending for themselves), and thus were selected, through Darwinian selection, for this trait. But, as Stephen Jay Gould from Harvard University has pointed out in his latest collection of essays, this line of reasoning is not always the best. Just because some trait is of benefit now does not mean that it evolved for that purpose in the past.

Gould prefers the interpretation first proposed by William A. Calder of the University of Arizona, that kiwis lay large eggs because they are descended from much larger birds. In other words, the size of the eggs didn't increase over time, it's just that the size of the birds decreased.

Evidence for this interpretation comes from allometric studies in which the relationship between egg and body weights in birds were examined. For different bird species, as body weight increases, egg weight increases only two-thirds as fast. Put another way, as body weight decreases, egg weight decreases more slowly, and so smaller birds have relatively heavier eggs. But, still, kiwi eggs are much larger than expected for birds of that size.

The relationship of egg and body weights within a species, however, tells a different story. For domestic fowl, as body weight increases, egg weight increases not by two-thirds (as

The egg of a kiwi can be up to 25 per cent of its body weight.

it does in studies *between* species), but by much less—only 15 per cent as much. (Again, this means as body weight decreases, egg weight decreases *even more* slowly.) It is a general rule that the rate of increase of a particular character (in relation to increase in body size) is much less in studies *within* a species than among species. So it might reasonably be assumed that the same applies to kiwis.

If kiwis did evolve from larger, moa-sized ancestors, according to the relationship of egg and body weights among species, egg size would have decreased at two-thirds the rate of body size. But, if natural selection continually favoured the smaller adults *within* a population (with egg size decreasing at a much lower rate than would be expected between species), then a marked size decrease would produce individuals with apparently oversized eggs, thus explaining the paradox.

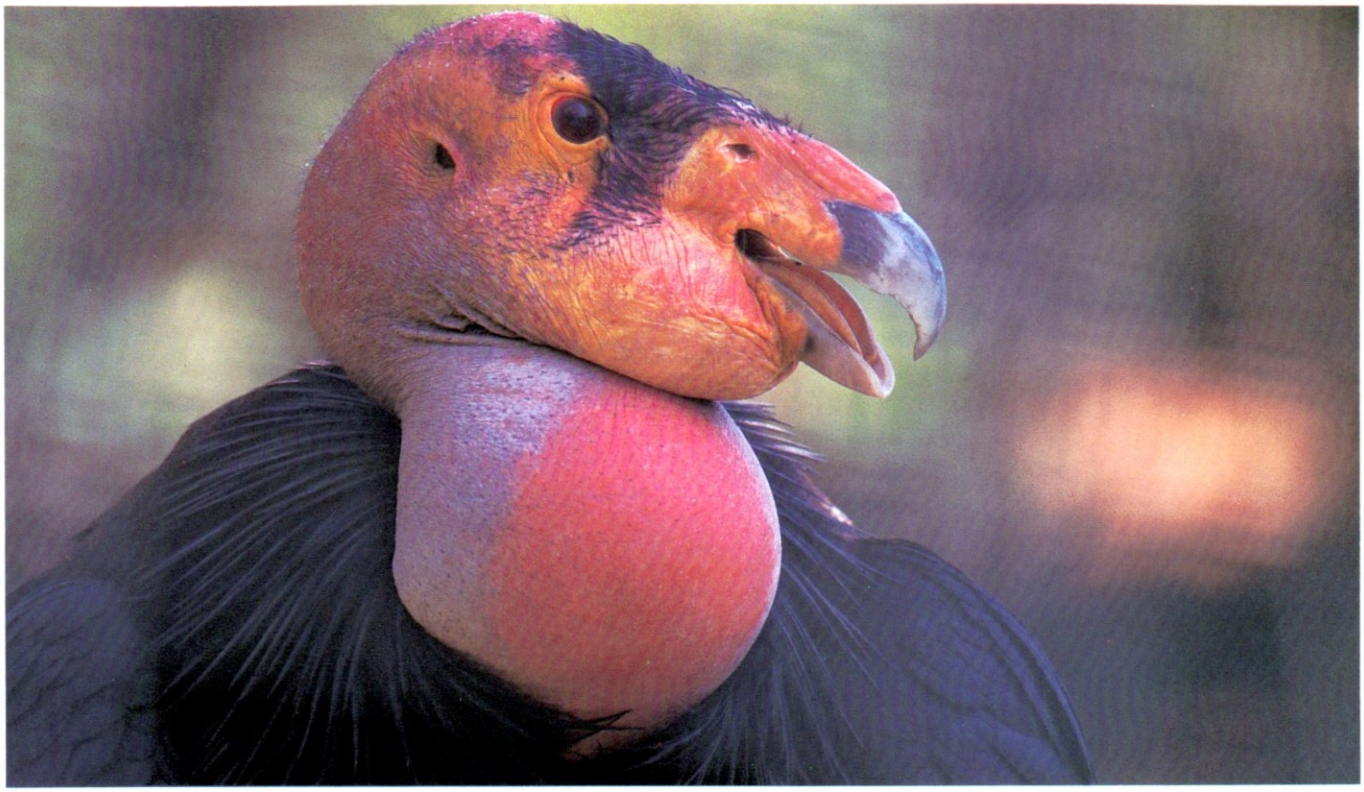
As Gould emphasises throughout his essay, we must not fall into the all-too-easy trap of assuming that current function of a feature reflects the reason for its origin. It may just as likely have been developed for a different purpose and later put to its present use. Kiwi eggs, it seems, are so large because kiwis are dwarfed descendants of much larger birds and their eggs followed standard principles of allometric scaling during their evolution. Just because the large eggs confer considerable advantages today does not mean they were selected for their large size in the first place.

—G.H.

QUICK QUIZ

1. What is another common name for Banteng?
2. Name the Pacific island famous for its many large monolithic statues of human heads.
3. To the nearest million, how many people live in Australia?
4. What does IUCN stand for?
5. Who is the Chairman of the Commission for the Future?
6. Who wrote the book *Save the Earth*, published in 1991?
7. Which elephant has the wrinkliest skin: the African or Indian Elephant?
8. What is the name of the world's largest living land crab?
9. What is a tektite?
10. Why is the Comb-crested Jacana or Lotus-bird sometimes called the 'Jesus bird'?

Answers in the Questions & Answers Section



FRANCOIS COHIER / ARDEA LONDON

High hopes for the California Condor.

The Rise of the Condor

For more than a million years, across the vastness of North America, thousands of California Condors *(Gymnogyps californianus)* soared on majestic wings. But by the mid 1970s, their habitat was decimated, save for a small region in the mountains of south-central California.

Early attempts to protect condors by establishing sanctuaries were insufficient to eliminate all hazards to such free-roaming animals. By the early 1980s, fewer than 25 birds remained in the wild. Certainly these magnificent birds were tempting targets for hunters, and they probably also fed on coyotes and rodents poisoned by ranchers. But it was lead poisoning from ingesting bullet fragments while scavenging on large carcasses that was the prime factor for the demise of the California Condor population.

Then, in 1982, a biologist witnessed a scuffle between a condor pair that resulted in inadvertent destruction of the single egg. Within weeks, to everyone's surprise, the pair had laid a second egg. For captive breeding, the implications of this double-clutching were enormous. Beginning the following year, in a bold and hotly contested move, biologists scrambled through nearly impenetrable bush and scaled precipitous cliffs to abduct eggs, forcing pairs to nest again while the first egg was incubated in captivity. Over the next three years, 13 chicks hatched under the care of zoo biologists, but this was sharply contrasted by tragically high mortality in the wild. By 1986, only five condors remained and the painful decision to capture the last free birds could not be prolonged. On Easter Sunday 1987, a day many hope is symbolic of the ultimate restoration of condors to the

Biologists scrambled through bush and scaled cliffs to abduct eggs.

ANH

THE ADAPTABLE HOUSE SPARROW

The House Sparrow *(Passer domesticus)* is one of nature's great opportunists. Randall and Margaret Breitwisch, biologists from the University of Dayton in Ohio, were recent witnesses to a display of the sparrow's uncanny ability to adapt its behaviour to suit the situation.

One December morning, in 1990, they were waiting at an intercity bus station in the New Zealand town of Hamilton when they noticed sparrows flying back and forth through a pair of automatic sliding glass doors into the station cafe. They appeared to deliberately open the doors, by flying slowly past the infrared sensor, hovering in front of it, or landing on top of the control box and leaning forward. The birds would then fly through the open doorway, scavenging crumbs and scraps from the cafe, and fly back outside when they had finished.

The Breitwischs watched male sparrows open the doors at least 16 times in the morning and several more times when they returned that afternoon. Female sparrows, on the other hand, tended to wait for people to activate the doors and then flew through behind them. According to the station's traffic supervisor, the sparrows had learned to open the doors very quickly after they had been installed just two months previously.

—K.McG.

BRIAN CHUDLEIGH / ANT PHOTO LIBRARY

wilderness, the last California Condor was taken from the wild.

Over the next few years, effective breeding programs at both the Los Angeles Zoo and the San Diego Wild Animal Park nearly doubled the captive population size to 52. And so it was decided, in October 1991, to transfer two gawky, immature condors–Chocuyens and Xewe (pronounced Gay-wee)–into the rugged mountains of the Sespe Condor Sanctuary, 120 kilometres north-west of Los Angeles. Because young condors seem to thrive better in groups, they have been temporarily chaperoned by two female Andean Condors, whose surrogate use in the breeding-and-release programs have proved invaluable.

At the Sespe release site, the condors were kept in a large netted enclosure that allowed them to become accustomed to their environment, while protecting them from predators. The birds fed on uncontaminated calf carcasses backpacked in by keepers who were careful never to reveal themselves to the birds.

Two gawky, immature condors were transferred into the rugged mountains of the Sespe Condor Sanctuary.

Finally, in January 1992, the net was spirited away. The California Condor graced the skies once again.

The arduous project is far from over. Scientists will constantly track the released birds, each of which is wearing a radio transmitter. Uncontaminated carcasses may be provided indefinitely, and these will be carried even further into the rugged interior with the help of two young Llamas, in the hope of getting the birds to move further from human interference.

Unfortunately, since this story was written, Xewe and Chocuyens have not fared well. One of them has already died of lead poisoning and the other is now known to have dangerously high levels of lead. Not to be deterred, however, the Condor Recovery Team has just transported a further six young California Condors to the Sespe release site, where they will remain in the netted enclosure until their release at a later time. Breeding success in captivity remains high, as do hopes for the ultimate success of the captive breeding-release program.

—Sandie M. Degnan
University of California
Santa Barbara, USA

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The fish bound for the pan were toadfish and the family bound for the grave was my own.

FISHING FOR THE LAST SUPPER?

BY STEVE VAN DYCK

BY THE END OF THE '50s my brother and I were notching up our first decade of school holidays, none of which had ever been spent east of the Great Divide. We may have been ace dag-pickers in the shearing shed, and crackerjack udder-spongers in the dairy, but when it came to surf and sea, we were wet behind the ears. It was with some misgivings, therefore, that family tradition was broken with the promise that a Christmas spent at the beach might prove a change better than a holiday.

So, with uncanny polar perspicacity, Father Christmas made an early visit, the Holden was stuffed with new beach paraphernalia and fishing gear, and we took off in a slick of coconut oil towards Bateau Bay.

The prebooked holiday mansion turned out to be a defunct fish-and-chips shop with living quarters out the rear, and from the moment we moved in until my father's hiatus hernia burst in rage, tourists bashed on the front door night and day wanting everything from Chicko rolls to gar guts.

The holiday wasn't going exactly as planned until we tried our hands at angling off the rocks. Here, it quickly became apparent, we'd chanced upon an untapped fishery. As soon as the bait was tossed into the sea a fish could be pulled in . . . not terribly large, but what they lacked in pounds they made up for in persistence.

There were two kinds, a seven-centimetre tiddler with black and yellowy stripes ('Stripeys', *Microcanthus strigatus*) and the other a most peculiar odd-bod, more skinned than scaled, more puffball than Pisces. Once out of the water (or whenever jabbed) the latter, which was slightly larger and more pear-shaped, with penetrating green pupils encircled in fiery orange, would immediately inflate itself to look like an enormous profiterole, grunting while it did so.

This was all very amusing, but a meal was a meal and six of each were selected for the frying pan and taken back to justify the existence of the besieged grease shop.

We scaled and filleted the stripy fish and watched them shrivel up to ropey knots in the pan. But the bug-eyed blimps were a worry when it came to preparation: did you scrape them or skin them or drop them in whole? And the prospect of them performing some posthumous inflation trick and then exploding in the fat didn't bear thinking about. So I took them next door in the hope of getting some cooking hints from the locals.

Talk about out of the frying pan and into the fire! The instructions that were screamed in unison at me could have been heard on the wheat belt. The overriding messages coming through the shrieks seemed to be ones of caution and derision. Caution indeed! The fish bound for the pan were toadfish or toadoes (most likely *Torquigener pleurogramma*); and the family bound for the grave was my own.

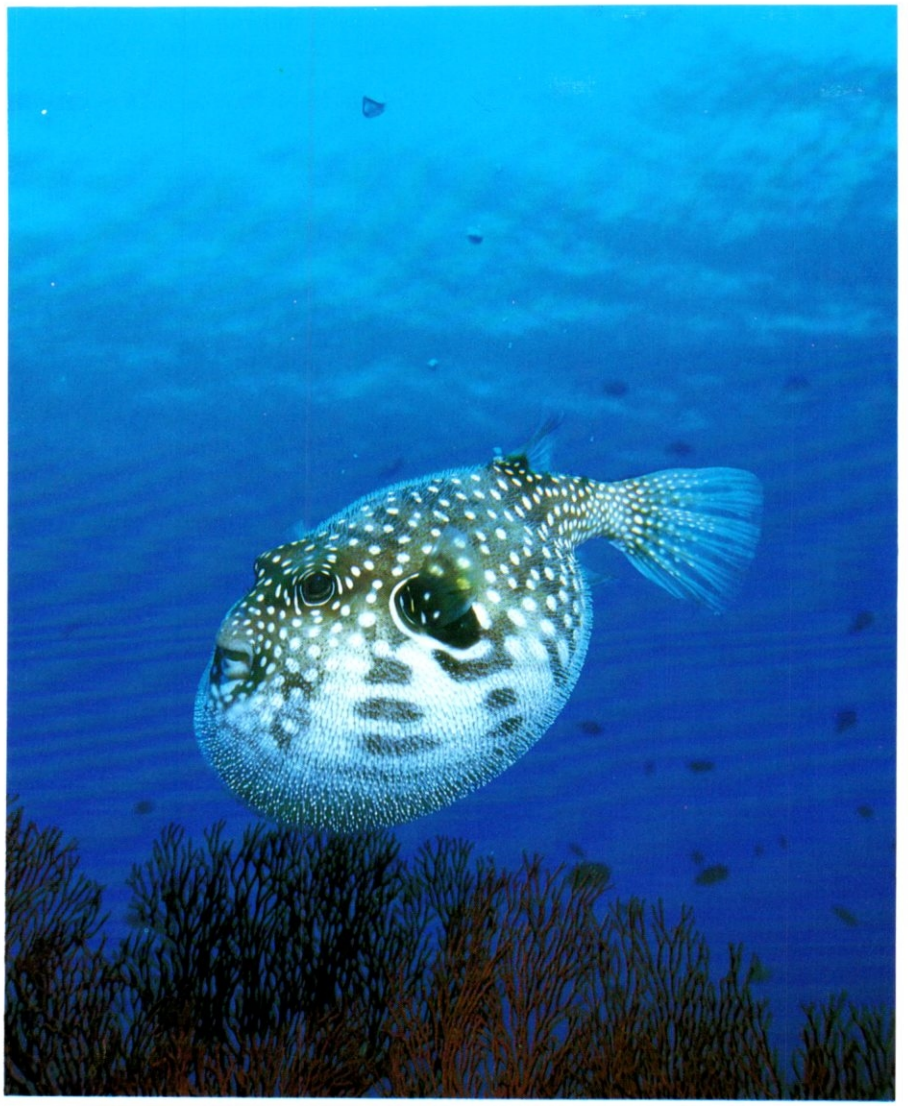
Without the Japanese licence to serve it and the know-how regarding the safe preparation of such pufferfish flesh, or *fugu* as it is known to Japanese connoisseurs, ingestion of as little as a tenth of a gram of ill-treated flesh may be sufficient to kill a person within 20 minutes. Even today in Japan, 100 poisonings occur each year among devotees who tempt fate by eating pufferfish that is prepared either at home or in unlicensed restaurants. About 50 of these annual poisonings prove fatal.

Many deaths have also been recorded from Australia, and considering the commonness of toadoes that pick around piers and puddle in warm pools left by the falling tide, it is surprising that more tragedies don't occur in their name. What is not so surprising is the number of family pets that die distressing deaths after eating shrivelled toadoes left high and dry at favourite fishing spots.

The poison in pufferfish is known as tetraodontoxin and, like curare used on the tips of arrows, causes paralysis, loss of consciousness and eventually death through respiratory failure. Right to the late stages of intoxication victims can hear, comprehend and feel sensation, while being totally unable to respond. For these reasons, diplomacy and gentleness

Tasty but toxic? The Blackspotted Pufferfish *(Arothron nigropunctatus)*.

KEVIN DEACON / AUSCAPE INTERNATIONAL



APL / VOLVOX

Beware the Stars and Stripes Toadfish *(Arothron hispidus)*.

are the order of the day when dealing with an apparently unconscious pufferfish victim. As there are no anti-sera against tetraodontoxin, treatment can only be made according to symptoms, but respiratory stimulants and a ventilator are usually called for.

The taste of expertly prepared toado is said to be delicate and comparable to a good, crisp white burgundy. According to clinical physiologist Ichiro Matsubara, "Sometimes one feels slight numbness at the tip of one's tongue after having eaten the viscera. Such numbness, although worrying, enhances the delicacy of the dish. After all the idea of sharing a potentially mortal risk with friends makes the whole evening exciting."

Fortunately not everyone dies from even severe poisoning. Captain Cook and his crew recovered after eating such a meal in New Caledonia in 1774. But the classic and earliest account of toadfish ingestion comes courtesy of G.P. Whitley who in 1953 unearthed this 1690 Japanese quote (which also contains one of the first records of toxin adsorption by charcoal): "People that by some long and tedious sickness are grown weary of their lives . . . chuse this poisonous Fish, instead of a knife or halter, to make away with themselves. A neighbour of my servant . . . being so strongly infected with the Pox, that his nose was ready to drop off, . . . bought a good quantity of this poisonous Fish, cut it into pieces, boil'd it, and in order as he thought to make the poison still stronger, he took soot from the thatch'd roof of his house, and mix'd it with the rest. After dinner he laid himself down to die, and soon falling mortally sick, he brought up not only the poison he had taken, but a large quantity of viscid, sharp, nasty matter, probably not the least cause of his distemper, and by this means found life and health, in what he sought for death, for he recovered, and was well afterwards." ■

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Steve Van Dyck is in charge of the Mammal Section of the Queensland Museum where he has worked since 1975.

KATHIE ATKINSON

The Smooth Toadfish *(Tetractenos glaber)*— a highly toxic feast!

The species is particularly prone to the impact of prolonged dry weather, such as has occurred in the last decade.

THE CORROBOREE FROG

BY WILLIAM S. OSBORNE

A SMALL, RARE FROG found high in the mountains of south-eastern New South Wales and the Australian Capital Territory is arguably one of Australia's most attractive frog species. Its common name, Corroboree Frog, was given to it because of the resemblance of its striking pattern of yellow and black stripes to Aborigines painted for ceremonies. This brilliant colour pattern easily distinguishes it from all other Australian frogs.

Like other members of its genus, the Corroboree Frog *(Pseudophryne corroboree)* generally moves by crawling rather than hopping. *Pseudophryne* species inhabit regions of reliable rainfall in the temperate zone of the continent, and differ from most other Australian frogs in that they breed in late summer and autumn, and lay their eggs in terrestrial situations that become flooded following seasonal rainfall in winter. The Corroboree Frog occupies the moistest and coldest part of the continent, being confined to areas above 1,000 metres in the Snowy Mountains and associated ranges.

Although its geographic range is small, the Corroboree Frog was once quite abundant, and occurred in large numbers at breeding sites during the summer. However, recent surveys have confirmed that the species has suffered a considerable decline in abundance in many areas; to the extent that its geographic range has contracted substantially. The distinctive Snowy Mountains population appears to have been most affected, with numbers at many remaining breeding sites still declining or remaining perilously low. This population has also experienced the greatest human influence with livestock grazing seriously damaging mountain catchments in the first half of this century and, more recently, hydro-electric and ski resort developments impacting on many local populations.

Although human activities have contributed to the loss of Corroboree Frog habitat, the overall decline cannot be attributed to these localised processes. Instead the main feature that correlates with the dramatic decrease in the size of adult breeding groups in the Snowy Mountains is an increase in summer droughts during the period 1978 to 1984. To understand the serious effects of drought on this species, it is necessary to consider aspects of its ecology and breeding behaviour.

Such a specialised life history may increase the susceptibility of these frogs to the impact of environmental change.

The Corroboree Frog is found in high-altitude environments that are cold and wet and usually covered by snow for a period during winter. Although such harsh conditions impose severe conditions on animal and plant life, the life history of the Corroboree Frog is ideally suited to surviving in these areas. Corroboree Frog males move into their breeding sites in sphagnum bogs and seepages in mid-summer where they call from hidden positions in moss or other dense bog vegetation. These calling sites are usually within a few centimetres of the edge of a shallow pool. When the female is ready, she moves to a suitable calling male, and lays a clutch of between 16 and 38 eggs.

After fertilisation the embryos develop to an advanced tadpole stage inside the egg jelly. Unlike tadpoles of most other frogs, their hatching is delayed for many weeks until the nest site floods with the onset of winter rain. In fact, tadpoles frequently remain in the egg jelly for up to six months until melting snow in spring fills the pools and floods the nests. As summer approaches the tadpoles grow slowly in the pools, and by late December and early January, almost one year after fertilisation, the juvenile frogs emerge from the pools.

Such a rigid and specialised life history may increase the susceptibility of the frogs to the impact of environmental change. The number of eggs laid by each female Corroboree Frog is small compared to that of most other species of Australian frogs, which lay eggs in clutches of hundreds, or even thousands. With their small clutch size, and with such a lengthy dependence of the tadpoles on a reliable supply of water in the breeding pools, the species is particularly prone to the impact of prolonged dry weather, such as has occurred in the last decade.

Concerns about changes in the world climate have particular significance for the conservation of cool-adapted species such as the Corroboree Frog. If present trends in the warming of the atmosphere continue, then the predicted 2–4°C rise in mean annual air temperature early next century would virtually eliminate the alpine climate of the Snowy Mountains, greatly reducing the area available for this species. The present contraction in the range of the Corroboree Frog may herald the beginning of such a change, and careful monitoring is required for this and other species with fragmented high-altitude distributions. ■

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Dr William S. Osborne is currently employed as a senior wildlife ecologist with the ACT Parks and Conservation Service. He has undertaken a number of zoological consultancies, including a study of the conservation of Corroboree Frogs in Kosciusko National Park.

JEAN-PAUL FERRERO / AUSCAPE INTERNATIONAL

Australians were remarkably imaginative in their attempts to exploit their native resources.

FROM THE AGE OF MUSEUMS

BY TIM LOW

IF YOU WANDER DOWN THE MUSTY corridors of Calcutta's Indian Museum, past the stuffed walrus, pickled baby in a bottle, and eight-legged baby goat, you come to a vast hall titled "Plants in the Service of Man". Inside lies what is probably the last of the British Empire's great 19th-century economic botany displays. In polished timber and glass cases stand jars of spices and resins, coils of fibre, and bottles of pickled tomatoes and other fruits and vegetables, bleached white by the passage of time. Lining the walls are timber samples and jars of plant medicines–dried leaves and roots, thistle flowers, even blocks of hashish.

In the 19th century, displays of this kind graced exhibition halls throughout the Western world. The displays expressed the optimism of an empire, when the colonies served as sources of new and improved products for the enrichment and advancement of European civilisation. More than mere entertainment, the displays were a serious attempt to inform traders, manufacturers, farmers and entrepreneurs of promising new foods, medicines, fibres and timbers. Some were part of permanent displays in museums; many were temporary exhibits in International Expositions.

Sydney had a permanent plant display in the Technological, Industrial and Sanitary Museum of New South Wales–the forerunner to the Powerhouse Museum. The museum plant catalogue, by botanist Joseph Maiden, was later enlarged into his classic work, *The useful native plants of Australia (including Tasmania)*, published in 1889. The most important book on Australian economic botany, it provides a wealth of information about edible, medicinal, fibre and timber plants. In Brisbane, economic botany merited its own Museum of Economic Botany, curated by the eminent Frederick Manson Bailey. Other technological museums were located in Melbourne and other cities, and even in country towns. Such was their popularity that Maiden published a guide for exhibitors in 1890.

Plant (and animal) exhibits were included in temporary exhibitions held in Melbourne (1861, 1866, 1880, 1888), Sydney (1870, 1879) and Adelaide (1877). As well, Australian plant products were flaunted as part of international exhibitions in London, Paris, Vienna, Dublin, Amsterdam, Philadelphia, Dunedin and Calcutta. The catalogues to these exhibits, preserved in old libraries, show that Australians were remarkably imaginative in attempts to exploit their native resources.

Seeds of the Peanut Tree *(Sterculia quadrifida)* featured in an Aboriginal food exhibit in Melbourne in 1866–1867.

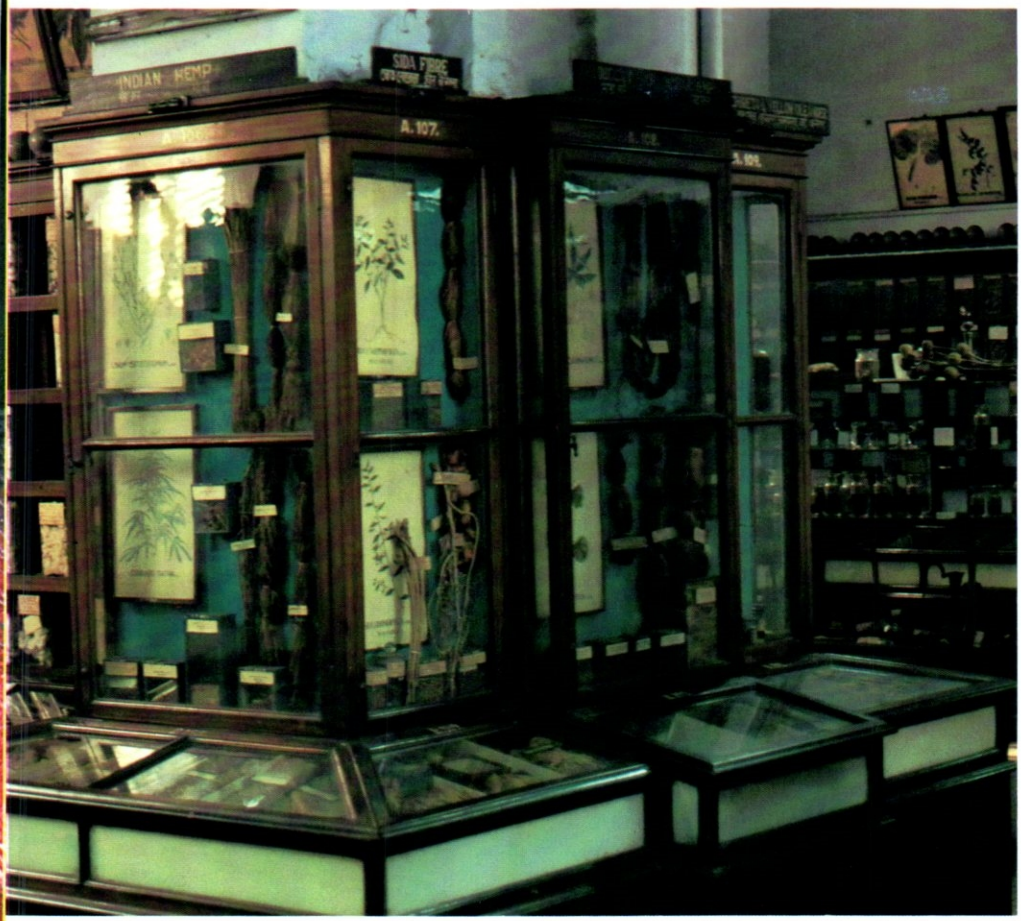
Displays included such items as she-oak paper, Cabbage Tree Palm (*Livistonia australis*) hats, snuff made from Spreading Sneezeweed (*Centipeda minima*), tea-tree oil, barks for tanning, grasstree resin, medicinal barks, Helidon Spa mineral water, Aboriginal narcotics, Dugong ointment, and kangaroo sinews "applicable as Sutures in surgical operations".

The Melbourne Intercolonial Exhibition of 1866–1867 featured two Aboriginal food displays, one from the Wimmera, Victoria, another from northern Queensland. Although the exhibits have long since crumbled to dust, the catalogue notes survive as a precious record of Aboriginal diet, including what is apparently the only record of Aborigines eating the roots of Mud Dock (*Rumex bidens*).

Plant fibres often featured in the displays, as sources of cloth, string, rope or paper. In the 19th century, paper could be made only from leaves, stems and bark, not wood pulp as it is today (hence the destruction of so many of our forests). Experimental paper was made in Australia from sedges, eucalypt barks, native bananas *(Musa banksii)*, even swamp algae.

One of the fibre plants often displayed in exhibitions was Sidratusa or Paddy's Lucerne *(Sida rhombifolia)*, a cosmopolitan weed in the hibiscus family (Malvaceae). In northern New South Wales and southern Queensland this plant be-

PHOTOS: TIM LOW



Calcutta's Indian Museum features an aging display of plant fibres, including sheafs of Cannabis and Sidratusa.

Many elderly Australians remember chewing the leaves of Sidratusa as a folk remedy for diarrhoea.

came a horrendous pest of pastures, and the stem fibre was exhibited abroad in the hope of turning an invidious weed into a profitable crop. An example of how international exhibitions encouraged new trade can be found in the 1873 Annual Report of Queensland Colonial Botanist, Walter Hill, referring to this plant, which he called 'Queensland hemp': "A sample of the material manufactured from this plant was exhibited at the International Exhibition held in London in 1862, and commanded great attention. The sum of 35 pounds per ton was offered for it in large quantities . . . A sample of the fibre was also shown at the London International Exhibition last year, and since then I have been inundated with letters on the subject."

Unfortunately, nothing came of the enquiries, partly because Australian labour costs were too high. But the fibre was for a time exported to London from India, as one of the 'Indian hemps'. If you want to see what it looks like, take a trip to Calcutta's Indian Museum; displayed alongside bundles of true Indian Hemp *(Cannabis sativa)* is an aging sheaf of the golden fibres – awaiting the interest of some passing entrepreneur. ■

Tim Low is a Brisbane-based environmental consultant and the author of four books on wild foods and medicines. He loves old museums.

P R O F I L E

Ken and Yasuko Myer quietly gave an example to private sponsors of science, one which now urgently needs to be emulated by the next generation.

PATRONS OF SCIENCE

BY ROBYN WILLIAMS

WHEN KEN MYER WAS appointed Chairman of the ABC in 1983 he swiftly made arrangements to see us in the Science Unit. Visits from the high and mighty usually resembled schoolkids' memories of royal visits in the 1950s—you spent ages sprucing up, waiting, then the notable zipped past before you'd even time to raise your little flag.

Not with Ken Myer. He arrived unheralded, tall and aquiline, accompanied only by the tiny Yasuko, his wife. Eagle and sparrow. And he stayed. For hours. Did we know about the latest broadcasting technology? Would we like it? Did we have any contacts with NHK (the Japanese State system)? Would we like him to organise some (Yasuko's father ran it!)? What about genetic engineering, was it well understood by the public?

Ken would lean back in his chair in enthusiasm, waving arms, nearly toppling over, but not quite, and Yasuko would gently push him back to the vertical, preserving both her husband's stability and our carpet. The flow was uninterrupted. The advice was impeccable. It was tremendous fun.

This was no dilettante. Ken Myer's grounding in science and technology, although always that of an amateur (in the best senses of the word), began early in his distinguished career. In 1992 at the age of 71, just before being killed with Yasuko in a light aircraft crash in Alaska, he was appointed a Fellow of the Australian Academy of Sciences. It was one of many honours that recognised how someone from the ranks of business, indeed from the retail trade, might make a vital contribution to the scientific life of the nation.

His involvement spanned information technology, physiology, botany, molecular biology, satellites, and science policy areas such as the Cooperative Research Centres. He was President of the Howard Florey Institute of Experimental Physiology and Medicine, to which he brought support from worldwide sources and stratospheric levels of influence. He was an active lobbyist, critic and counsel, insisting research results were taken through to useful applications. Yasuko shared Ken's fascination with the exciting developments in molecular biology. Together they were instrumental in the development of the CSIRO's Plant Industry Fellowship Scheme, which helps to foster closer collaboration with industry.

There are plenty of rich people in Australia, many of whom give quite generously to research. The special point about the Myers was that they were thoroughly *involved*. But they managed a light touch at the same time. I'll always remember one particular occasion at the Australian Museum. I was leading the Minister for the Arts, Peter Collins, on a tour of a new wing when the official party came across the Myers, who stepped aside. As we passed, Ken winked and popped a piece of paper in my pocket. It turned out to be a cheque for $50,000 for the Museum's electron microscope facility! (Unknown to me, he later, year after year, came back to see the instrumentation he'd helped to support, keen to see the best work being done with good equipment.)

Most remarkable for someone who could seem impatient with those unable to appreciate bright ideas, he was able to take criticism. He would often phone me on Monday morning if a Science Show had given him pause, especially after someone like David Suzuki had attacked his beloved Japanese way of doing things. "Interesting program" he'd say. "Don't go along with that fellow on some points but good to hear the issue being raised energetically!"

I wonder what the senior executives of the ABC would have thought if they'd known the *Chairman* made a habit of calling the broadcasters every week! I spared them the knowledge.

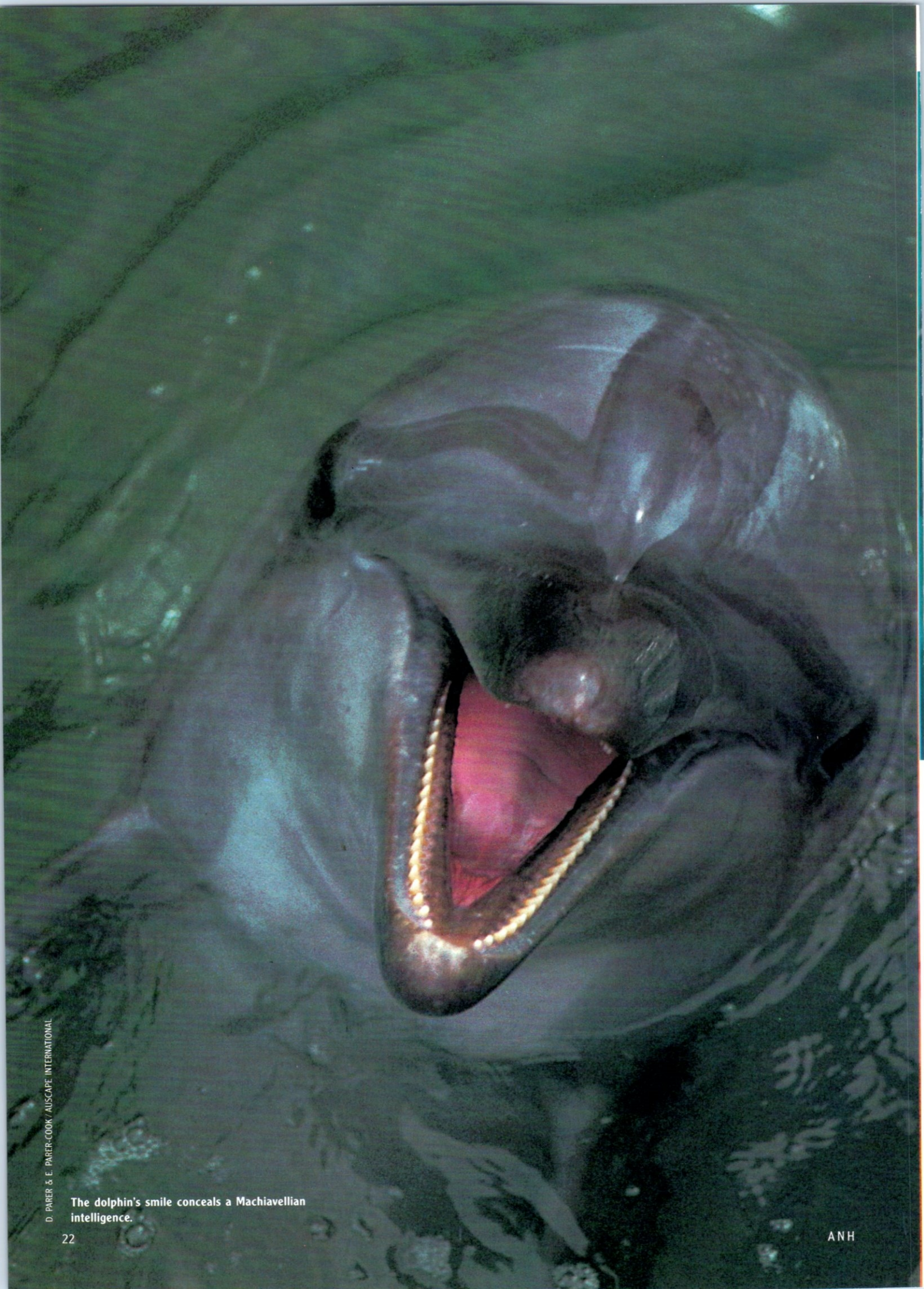
Ken left the ABC, after three years, fed up with the Board's wrangles, which were common in the first years of the new Corporation. But whatever his intolerance of bureaucracies, Ken Myer knew his priorities. At the very start he promised the ABC broadcasters a radio HQ to match any in the world, brimming with the best technology. He made it happen.

He also, rather more quietly, gave an example to private sponsors of science, one which now urgently needs to be emulated by the next generation of Ken Myers. This is support and leadership based on enthusiasm and understanding. Ken had one of the best educations available, at Geelong Grammar and at Princeton. But his scientific background was self-taught. This is open to *any* intelligent Australian, any person in business. Ken's patronage was of the most elegant, appropriate and stimulating kind. It can change a nation. We shall miss him and Yasuko for this, but also for their charm, excitement and friendship. ■

Ken and Yasuko Myer.

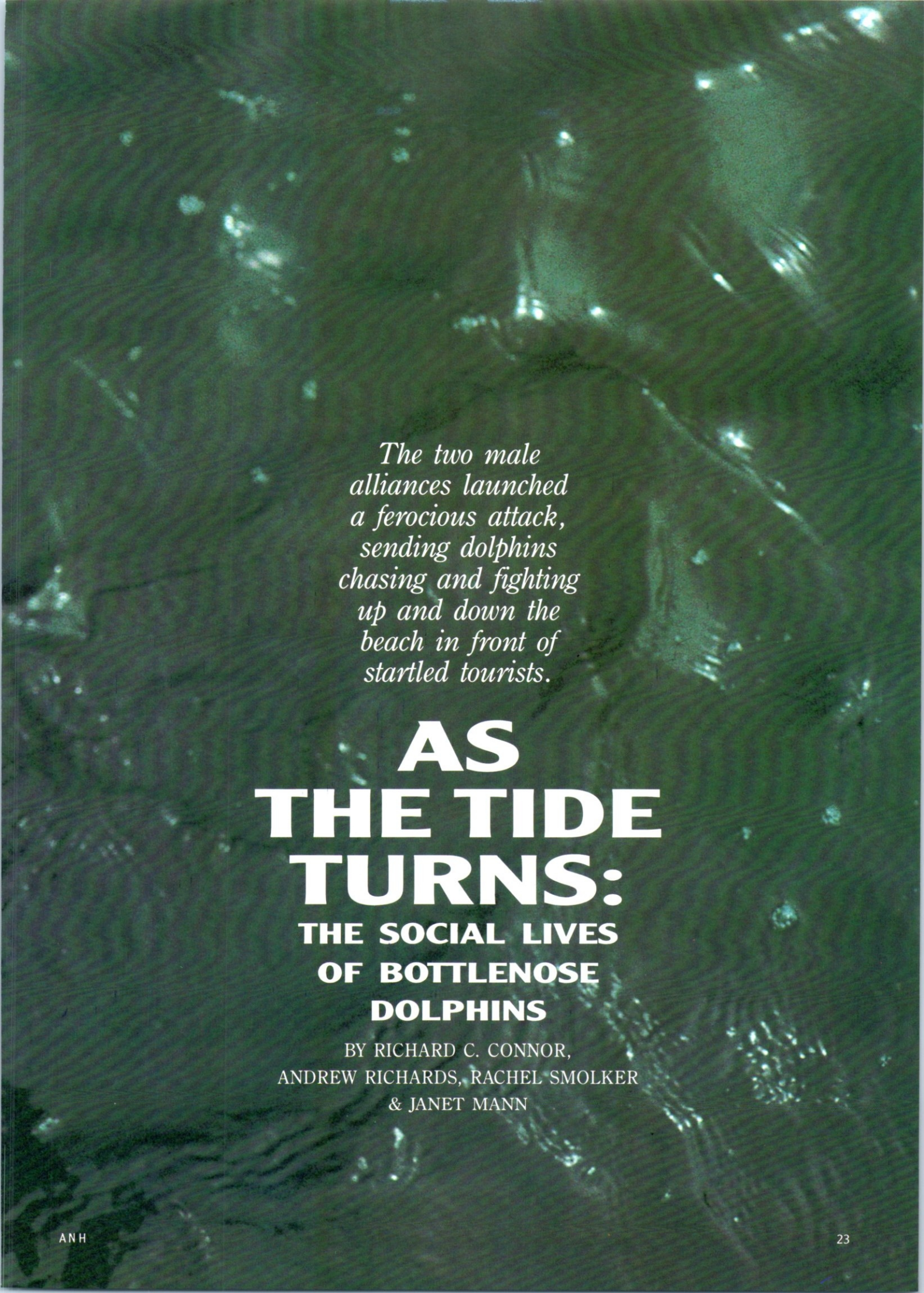
GARRY BROWN / CSIRO PLANT INDUSTRY

As Presenter of Radio National's Science Show, Robyn Williams has the opportunity to interview many interesting people in science.



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

The dolphin's smile conceals a Machiavellian intelligence.



The two male alliances launched a ferocious attack, sending dolphins chasing and fighting up and down the beach in front of startled tourists.

AS THE TIDE TURNS:

THE SOCIAL LIVES OF BOTTLENOSE DOLPHINS

BY RICHARD C. CONNOR, ANDREW RICHARDS, RACHEL SMOLKER & JANET MANN

WHEN THE NOTORIOUS WEST coast winds disappear, the magic begins at Shark Bay. The water turns to glass, the horizon vanishes, and an incredible abundance of marine life comes crisply into view. Dawn on 19 August 1987 revealed such a glassy calm day, a top day to boat around watching some of the 350 bottlenose dolphins (*Tursiops* sp.) we have identified in the bay. But in Shark Bay, one need not go offshore to be with dolphins. We were camped at Monkey Mia, the famous beach where wild dolphins visit every day to interact with people.

Early that morning, the three Monkey Mia males, Snubby, Sickle and Bibi, charged into the shallows with unusual exuberance, wheeling around and slapping the water while emitting a cacophony of whistles and clicks. We knew it was them because of their distinctive patterns of nicks and scars on their dorsal fins. They were excited because the grand old lady of Monkey Mia, Holey Fin, was in oestrus. A 'pop-pop-pop' sound from the males told us that they were herding Holey Fin, a behaviour in which alliances of males attempt to monopolise mating opportunities by forcing oestrus females to swim with them. Later that morning a rival male alliance—made up of Trips, Bite and Cetus—made a rare appearance at Monkey Mia, swimming side by side and surfacing together with military precision. We waited expectantly for a fight between the male groups. But after 20 minutes nothing happened; the rival males had simply looked and left.

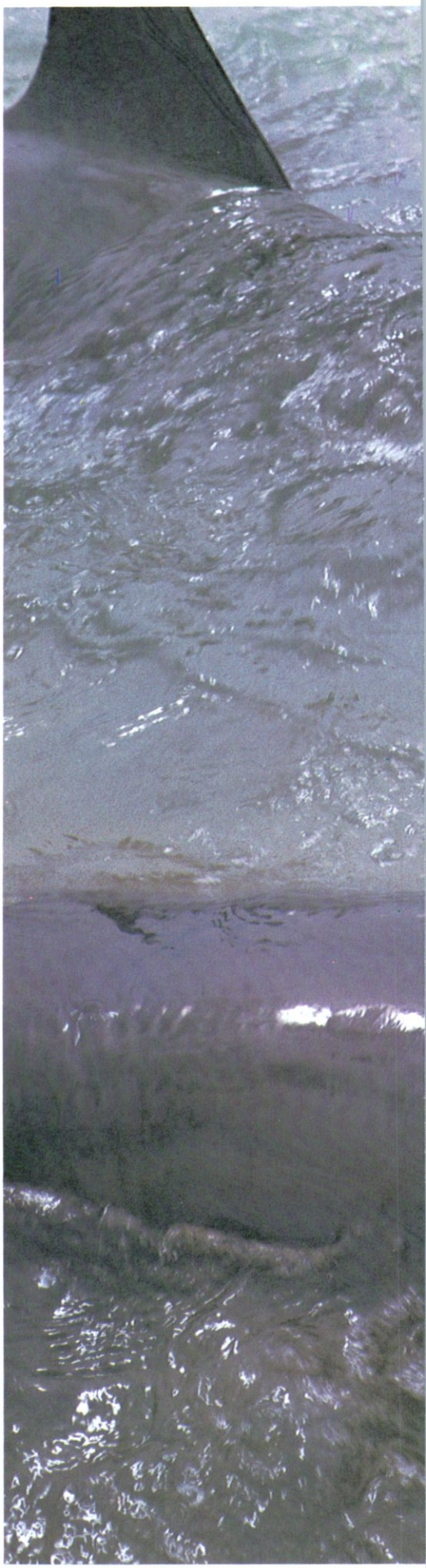
What was up? We jumped in our boat and followed, with film rolling, after the rival males. About a kilometre offshore, they joined up with Real Notch and Hi, another alliance of males that were established enemies of the Monkey Mia males. This union was surprising, for only the day before Real Notch and Hi had been travelling with a different alliance that had chased Trips, Bite and Cetus away from a female. Relationships among alliances of male dolphins clearly had an element of opportunism. With differences of the previous day apparently patched up, the two alliances swam back to Monkey Mia and launched a ferocious attack, sending dolphins chasing and fighting up and down the beach in front of startled tourists. In less than a minute the attacking alliances emerged from the chaos—with Holey Fin—performing excited and elaborate synchronous leaps and underwater turns around her. Snubby, Sickle and Bibi were positively frantic. They made repeated rushes towards the 'thieves', only to go fleeing in the opposite direction if the others as much as turned around to face them. Outnumbered five to three, the Monkey Mia males were excited, but not stupid.

The attacking alliances emerged from the chaos, performing excited and elaborate synchronous leaps and underwater turns around the captured female.

Our excitement may have equalled that

RICHARD CONNOR

A synchronous display: two males perform 'belly-slaps' on either side of a herded female, while swimming in opposite directions.



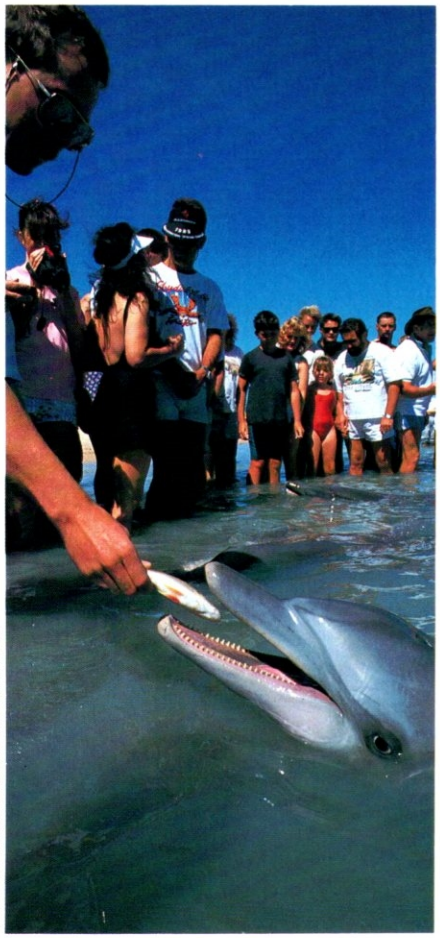
Dolphins at Monkey Mia.

S.C. GASCOYNE / PHOTO INDEX

The free lunch by the beach and the herded female produced a conflict of priorities for the guarding male, often with amusing results.

of the dolphins. The implication of what we had just witnessed was not lost on us. In many birds and mammals individuals form alliances against others that are not members of their group; male Lions defend a pride of females from other males; the females of one troop of Rhesus Monkeys spar with females from another troop; birds chase intruders out of their territory. In many primates, individuals form coalitions against members of their own group; for example, two male baboons may form a coalition to chase a rival male from an oestrus female. However, apart from dolphins, we know of no other species except our own that forms two or more levels of male alliances within their social group. Such 'alliances of alliances' are very important in human politics as we know all too well: family against family, village against village, nation against nation.

And what do the female dolphins think of all this attention from males? Not much, judging from their dramatic attempts to escape from the alliances. At Monkey Mia, it didn't take herded females long to learn that the best time to try to get away was when the males' attentions were diverted by tourists offering fish. The manner in which males pursued fleeing females gave us insight into how males benefit by herding females cooperatively. Rather than chasing directly behind the bolting female, the males often angled off to either side, effectively cutting off her escape routes. While waiting for the rangers to bring the fish buckets down to the beach, one of the males often played the major role in guarding the herded female. The free lunch by the beach and the herded female swimming a few metres offshore produced a conflict of priorities for the guarding male, often with amusing results. Parked halfway between the fish and the female, the guarding male would whirl around back and forth, seemingly in a dither of indecision over which to approach.



DAVID DARE PARKER / AUSCAPE INTERNATIONAL

Tourists flock to Monkey Mia in Western Australia to meet and feed wild dolphins.

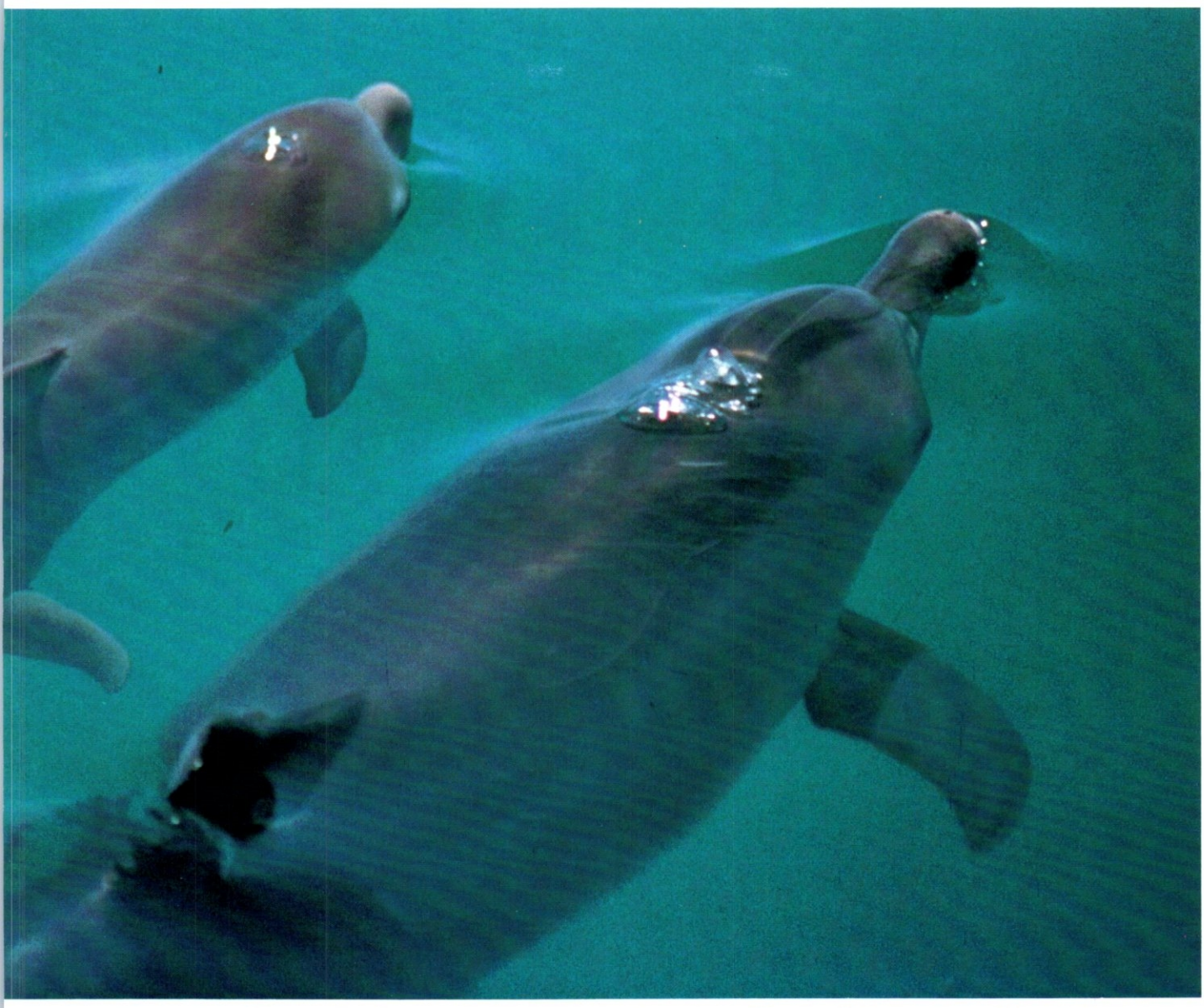
Herding, by its aggressive nature, reflects conflict between the interests of males and females. But just what is the nature of the conflict? Males of many species attempt to monopolise females when they are in oestrus to increase the chance of fathering the females' offspring. This may be done by defending a territory containing females, following females and chasing rival males away or, as in the case with the Shark Bay dolphins, by making females stay with them (that is, herding). However, what is good for the gander may not be good for the goose. Females may prefer to mate with a different male than the ones seeking her attention, or, as we suspect, she may want to mate with several males.

Mating with several males or 'promiscuity' is common in many species of birds and mammals, but the benefits females accrue from this mating tactic are unclear. The evidence for promiscuity in female dolphins comes not only from our behavioural observations but also from what we know of male anatomy. Male bottlenose dolphins have very large testes. In other mammals large testes are associated with females mating with many males. The reasoning goes like this: if males are unable to monopolise females physically, they may still compete with other males by making more sperm—and larger testes can produce more sperm. A male that inseminates the female with more sperm will have a better chance of having one of his spermatozoa fertilise the female's egg. The large size of dolphin testes suggests that females mate with many males. Indeed, we have observed females being herded by as many as 13 males during the

season they conceive. Thus herding may be a strategy to monopolise females but it is not an entirely successful one. The reason males have difficulty monopolising females may be attributed to a female counter-strategy.

Most female mammals conceive during a single oestrus cycle. But bottlenose dolphins and some primates appear at first glance to 'waste' cycles because they may cycle and ovulate several times before conceiving. During each of these cycles they are attractive to males. We suspect that such multiple cycling is a female strategy to avoid being monopolised by one or a few males: an alliance may be able to monopolise a female through one cycle, but not through several.

Herding is the only kind of mating relationship between males and females that we have documented in Shark Bay, but that does not mean that herding is the only or even the most important context in which offspring are conceived. From our observers' perspective herding is easy to see and record, but we must be alert for other behaviours that might be more subtle, but just as important. A different mating relationship might be based on



RICHARD CONNOR

Mother and baby exhale as they break the surface. The 'rings' on the baby were caused by the way the baby was curled up in the mother's uterus. They may last a few months.

mutually friendly behaviour and, indeed, we do see that a few males maintain friendly relationships with particular females. A pair of old males, Slash and Crinkles, seemed hopelessly enamoured of Holey Fin; they followed her around and stroked her even when she was very pregnant. One goal of our long-term research is to document the full range of relationships between males and females, and how these relationships affect opportunities for reproduction.

DURING MOST OF THEIR LIVES, WHEN females are pregnant or nursing, they are not concerned about being chased around by obnoxious males. Their primary concern must be protecting themselves and their offspring from the ever present sharks, and getting enough to eat to sustain a growing foetus or infant. This is not an easy task; more than one infant has disappeared after becoming emaciated or being attacked by sharks. Infants don't make the task of protecting them any easier by wandering off to surprisingly large distances from their foraging mothers. Interestingly, individual infants differ in their tendencies to wander away from their mother. We are currently trying to understand what wandering infants might gain by taking the risks of going 'swim-about'.

We have always been struck by the wide range of female 'sociability' compared to males. Males are rather predictably found with their alliance partners. In contrast, some females are relatively solitary, some have relatively stable relationships with a few other females, and some are all over the place with everybody—the 'social butterflies' of Shark Bay. We suspect that there may be a general relationship between female differences in sociability and their feeding habits. In primates, social bonds between female kin are often thought to be based on collective defence of food or prime feeding areas. If this is true of dolphins, then solitary females may be unable to compete with more sociable females for prime feeding areas and they may simply be making the best of a bad job. Documentation of such female–female alliances has proven elusive. Part of the problem is that female–female aggression may occur less frequently and be more subtle than the highly visible antics of males.

RICHARD CONNOR

Sometimes it is hard to tell exactly what is going on in dolphin social groups.

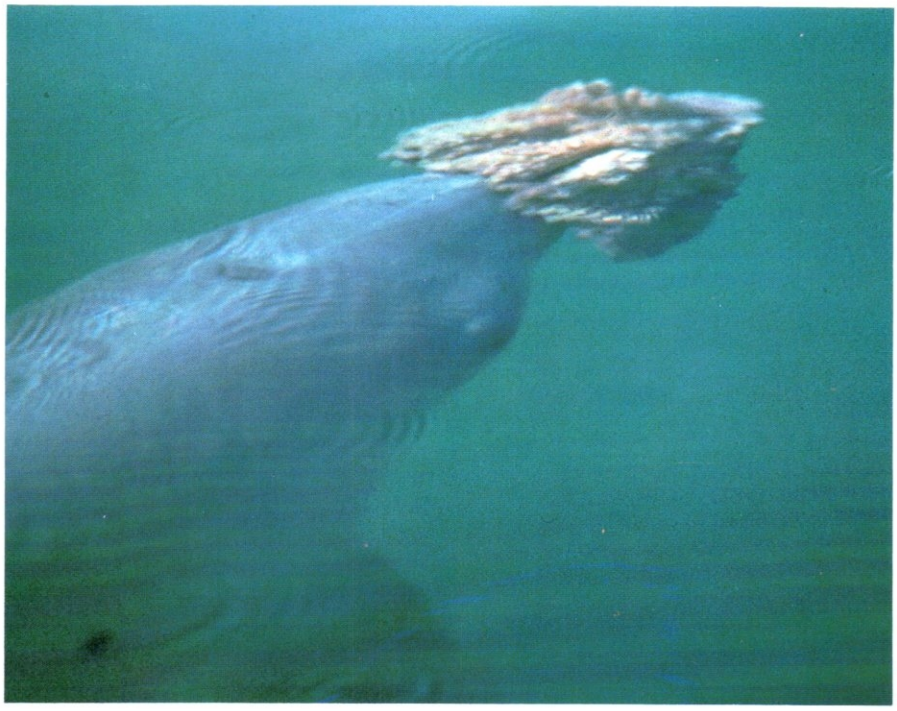
Among the least social of all females are those individuals that carry sponges (filter-feeding invertebrates that grow up from the sea-floor and superficially resemble plants). This extraordinary behaviour was first brought to our attention in 1982 when one of the fisherman who was camped at Monkey Mia told us of a dolphin he saw regularly with a "funny growth on its nose". This funny growth turned out to be a cone-shaped sponge 'worn' like a glove over its beak. And we found not one but several dolphins, all of which turned out to be females, carrying sponges.

Sponge-carrying was mainly restricted to a large channel in our study area. These dolphins seemed to spend most of their day foraging for fish, leaving little time to socialise with others. We suspect that the sponge is used as a tool to protect the dolphin's beak from abrasive rocks and sand or the spines of poisonous fish as it probes the bottom for prey. Occasionally a worn-out sponge is traded in for a new model.

Being sociable animals ourselves, we sympathise with infants of sponge-carriers, who rarely get to play with other infants and spend much of their time alone while their mother forages. At times they forage or play-forage near their mothers, wearing appropriately tiny sponges over their beaks. Most infants, however, are exposed to a rich social life from a very early age. As their mother swims in groups of constantly changing composition, infants are introduced to a large number of individuals in widely varying social contexts. Of course, if several nursing mothers get together, it's playtime. Even older juveniles and adults may join in the romp, which can last for hours.

Play in dolphins includes sexual behaviour. In fact, sex is commonly incorporated into a variety of friendly and aggressive interactions that have nothing directly to do with reproduction. Only humans and the 'Pygmy Chimpanzee' or Bonobo rival dolphins in the frequency and variety of such 'social sexual' behaviour. Sex, mostly in the form of mounting, may be used to express aggression or friendship between two males, two females, or infants and adults. Several males may gang up sexually on one male. A young male may mount its mother or an adult male. We have even

seen a young female, unable to arouse the interest of several young males, make do with a flipper of one of the males. And a trainer at a captive dolphin facility in Hawaii told us she had seen females form a 'stack' of up to four dolphins, each inserting the dorsal fin of the one below into her genital slit! Sex, it would seem, is just another tool dolphins can use to negotiate their intricate and often changing social relationships.



RACHEL SMOLKER

Sponge-carrying dolphins have researchers perplexed.

It has been ten years since we first visited Shark Bay and we have just scratched the surface. But what a surface! It is now clear that we are dealing with a society that may be as or even more complex than that of our chimpanzee cousins. Our findings shed light on what dolphins do with their huge brains, a feature that has long puzzled biologists. In evolutionary terms, big brains have to be doing something important because brains are energetically expensive to maintain. The human brain greedily consumes 20 per cent of the oxygen we breathe. Many researchers now believe that social complexity was the force driving the evolution of large brains, especially in humans. In this view, Kipling's six 'honest serving men of intellect', are not equal partners. Rather, What, When, Where, Why and How are all servants to the most important: Who; who you cooperate with, and who you cooperate against. Our observations in Shark Bay suggest that Who presides over the dolphins' court as well. ■

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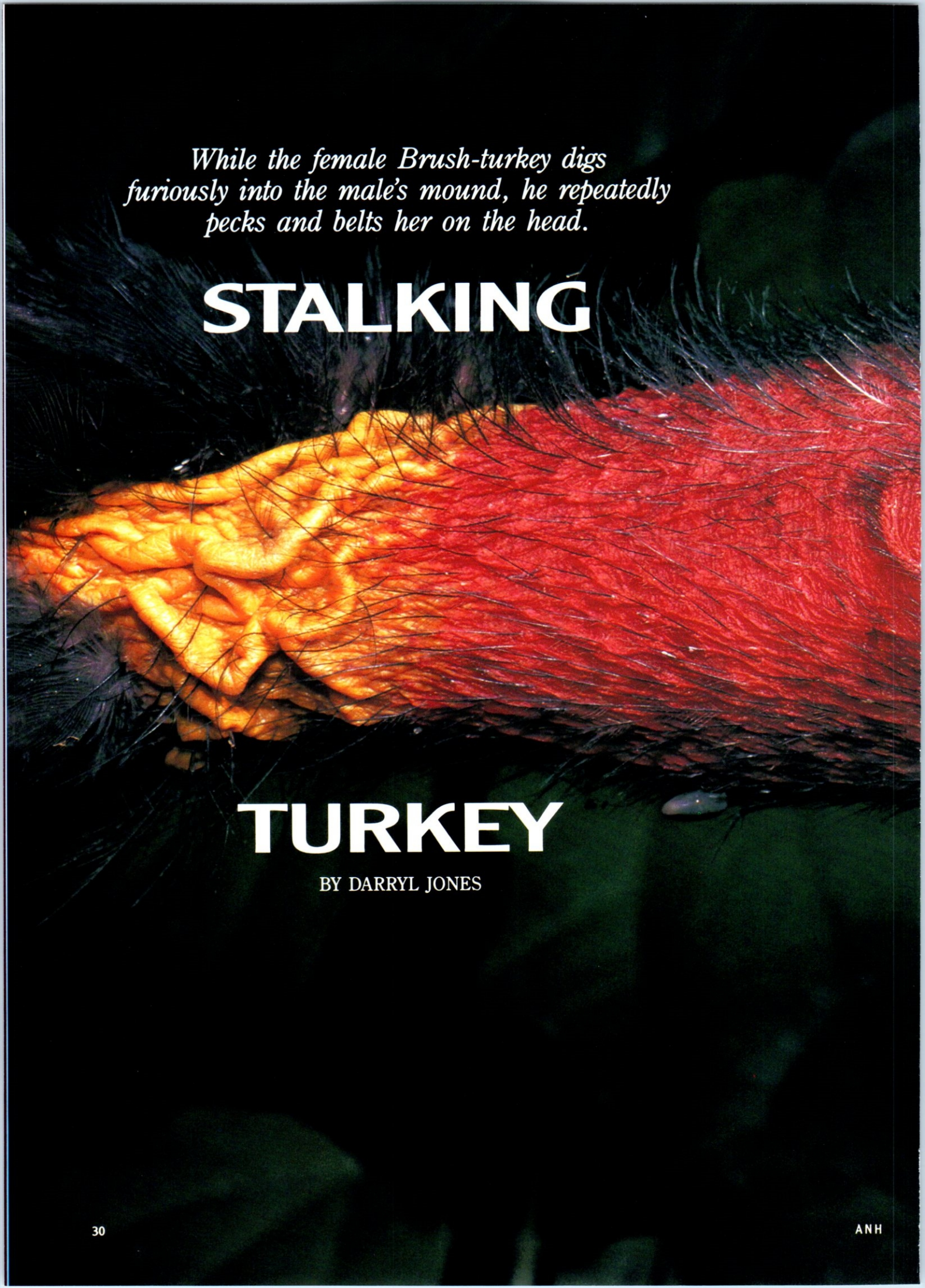
Dr Richard C. Connor is a post-doctoral fellow at Harvard University. His research in Shark Bay focuses on the social relationships of male dolphins. Andrew F. Richards and Rachel A. Smolker are Ph.D. candidates; Andrew works on female social relationships in dolphins, while Rachel's research is on vocalisations. Dr Janet Mann is an Assistant Professor of Psychology at Georgetown University in Washington, DC. Janet studies infant behaviour and development in dolphins.



While the female Brush-turkey digs furiously into the male's mound, he repeatedly pecks and belts her on the head.

STALKING TURKEY

BY DARRYL JONES

Brush-turkeys have bright yellow wattles, which in the male can be extended at will.

FRITHFOTO ANT PHOTO LIBRARY

IT ALL BEGAN WHEN I CAME ACROSS A large incubation mound being worked by a bedraggled male and, with a day to spare, I hid quietly among the undergrowth to observe. The diligence of the male Brush-turkey was impressive. He appeared to eat only rarely, doggedly raking leaf litter into long 'windrows' and then kicking them backwards towards his mound. This continued without a break until the middle of the afternoon when, without any sign obvious to me, a female appeared beside the mound. With a minimum of fuss she walked onto the mound and the two mated—a brief, violent affair that lasted about three seconds. As soon as the female had shaken the male from her back she set about digging a deep hole into the mound. The male remained close, delivering pecks and the occasional wing-blow to the industrious female but making no real attempt to chase her off the mound. Eventually she stopped digging, laid her egg and departed quickly. The entire procedure had taken less than half an hour, and the male was left to fretfully reshape his construction.

Although new to the field of animal behaviour, I was sure I had witnessed something odd. It seemed obvious that the purpose of the male's toil was to provide an incubator for eggs. Even though examples of males undertaking the bulk of parental responsibilities are rare among birds, there are a number of well-studied examples including familiar species such as Emus and cassowaries. In many of these species, males guard or watch their respective mates carefully during the

Brush-turkey mating is a brief, violent affair. Here the male bites the female's neck.

R. BROWN / NPIAW

the often brief period of fertility to ensure no other males get too close. So, even though they may get lumbered with single parenthood as the female moves on, males can usually be sure that the chicks are their own.

But this male Brush-turkey appeared to have no such certainty. Busy with the work required to build his mound, he couldn't have had any idea of where that female had been, or with whom! Why, then, does the male Brush-turkey continue to care for a mound full of eggs that could possibly belong to other males? Here was the perfect excuse for me to escape the city for a forestful of mound-builders.

AUSTRALIAN BRUSH-TURKEYS *(ALECtura lathami)* are megapodes (family Megapodiidae)—large fowl-like birds found on the islands of South-East Asia and the south Pacific, as well as in Australia. By far the most well-known megapode is the Malleefowl *(Leipoa ocellata)*, which became internationally renowned through the exhaustive (and exhausting) studies of Dr Harry Frith. Rather than incubating their eggs using

JAN ALDENHOVEN / AUSCAPE INTERNATIONAL

Male Brush-turkeys construct huge mounds of leaf litter in which the eggs are incubated.

body heat, megapodes use a variety of sources of environmental heat, including sun-warmed beach sands, geothermal areas and the heat produced by the decomposition of organic matter. In Australia, all three megapode species (including the Orange-footed Scrubfowl, *Megapodius reinwardt*, of the tropics) construct huge mounds of leaf litter within which the eggs are placed. Frith demonstrated clearly that the Malleefowl was capable of astonishingly sophisticated incubation behaviour: by manipulating the mound's surface layers, the male Malleefowl is able to control the internal temperature very precisely.

Frith's studies were largely responsible for replacing the prevalent ideas about the apparently primitive, 'reptile-like' behaviour of these birds (which supposedly abandoned their eggs in warm places) with a modern scientific view of the megapodes as having evolved a unique approach to the challenge of incubation. There was, however, a tendency to generalise Frith's findings on Malleefowl to all megapodes. This has led to a simplistic and sometimes misleading picture of the group because we now know Malleefowl to be the most aberrant species of the entire family. Malleefowl, for example, live in the dry inland while almost all other megapodes are found in tropical rainforests. And, of course, the many megapodes that do not build mounds do not need to give extensive attention to their incubation sites.

Despite these major differences between species, studies of megapodes indicated that most species were monogamous, maintaining their mates for life. Many, especially those not tied to maintaining a mound, stay in close permanent pairs and are never seen apart. Similarly, Malleefowl pairs appear to form intimate and life-long pair-bonds, even though the sexes may spend considerable time apart. In all species the large number and size of eggs produced (amounting often to two or three times the female's weight) mean that females must feed continually during the breeding season, which inevitably involves foraging away from the mound. In species where males remain near their mounds, there is obviously some risk that females could mate with other males. This risk appears especially important in species whose males

tend the incubation mounds. Unless he is careful, he could end up looking after another male's young. In evolutionary terms, this would be a dead end; unless he is related to the young, he gains nothing and loses vital opportunities to reproduce. Because male Malleefowl go to such lengths to provide incubation mounds, it was argued that the eggs they were caring for must be their own. In the dry, empty mallee forests the possibility of philandering and cuckoldry among megapodes is hard to imagine...but not so in the steamy jungles of Queensland. It wasn't long before I began to suspect that marital relations among Brush-turkeys may be somewhat different.

For one thing, the density of the birds was remarkably high. In my smallish study site there were between 50 and 80 birds, with an average of about 12 mounds being built each year. This meant that, on a leisurely morning stroll through the forest, any female could visit numerous mounds and meet their owners, who were always nearby. When a female approaches, the resident male begins to strut about with his bright yellow neck wattle fully extended. Once on top of the mound, females solicit mating by fluffing their body feathers, raising their tails and drooping their wings; males react promptly to this obvious signal. Immediately after mating, if she has an egg to lay, she quickly begins to dig a hole into the mound; otherwise (and about half of all females visiting mounds do not lay) she leaves, often after an unfriendly peck from the male.

While the female digs furiously into his mound, the male repeatedly pecks and belts the female on the head. In an apparent attempt at reducing this violence, females will sometimes stop digging and again solicit copulation. Just as often though, males will bully the female out of the hole and force a mating without her consent. Either way, many females receive up to three additional matings while trying to lay. The only time females are free from the harassment of the males is during the actual process of egg laying. As soon as she begins to refill the hole the male resumes his assaults.

Providing a plausible explanation for this peculiar behaviour by male Brush-turkeys has been one of the biggest challenges of my work. Among the nagging features of this bird's nuptial behaviour were the facts that females laid eggs that had already been fertilised some days before and that, despite the male's brutal attempts at securing as many copulations as possible from a female, the actual process of laying the huge egg was likely to displace his sperm. Recent studies of sperm competition in other birds, however, has shed some light on these apparent paradoxes.

The best time for fertilisation to occur is very soon after egg laying when the next ovule is released. Although this indicates that male Brush-turkeys should mate with females as soon as they have finished laying, this was never observed. However, investigations of the oviducts of many birds have revealed the presence of tiny hollow organs in which sperm is stored following copulation. We do not yet know whether these organs exist in Brush-turkeys, but the disruption to laying caused by male copulations could be interpreted as momentarily stalling the passage of the egg so that sperm can move further into the female's reproductive tract. This would ensure that this male's sperm was the most likely to fertilise the next ovum. Any additional copulations would simply improve his chances of success. If this scenario is correct, males should be particularly interested in receiving females with eggs to lay, rather than avoiding them because they may carry another male's offspring.

ALTHOUGH BRUSH-TURKEYS CAN CERTainly be described as promiscuous, females exhibit some choosiness when selecting mates. Sharon Birks (Cornell University, USA) found that females visit and mate with the same male for varying periods during the breeding season. They almost always favour males with recently constructed mounds, moving on to new mounds as they become available. Just how females decide who or where to visit remains a major question for us.

The only time females are free from the harassment of the males is during the actual process of egg laying.

Unlike many animals, female Brush-turkeys seem to have the 'mating game' going almost all their own way (apart from the harassment at the mound). With each male stationed resolutely beside his mound, females are free to wander as they like, assessing all the males in the area, and mating with the male of their choice. Females produce up to 30 eggs each season, which are laid separately at intervals of several days. Because females are inseminated each time they lay, they have the extremely unusual opportunity of being able to choose the father of each of their offspring. In many other bird species, a single copulation often leads to the fertilisation of the entire reproductive effort for the season.

With a breeding season that often lasts for eight months, males hoping to mate with as many females as possible face a daunting challenge. Few are able to keep up the task of constructing, maintaining and defending a mound for such a long period, and so retire after several exhausting months.

Those males that keep their mounds going for the longest time do indeed receive the greatest numbers of eggs and, presumably, the associated copulations. Although Brush-turkey mounds are simpler and considerably easier to maintain than those of the Malleefowl, the job is not for the faint-hearted. Most of the effort goes into the first few weeks of construction when the three to four tonnes of damp soil and leaf litter are raked into a huge pile. During construction, temperatures inside the mound begin to rise and eventually stabilise at around 33°C. Maintaining these temperatures requires the less arduous task of gathering fresh leaf litter and mixing it into the top of the mound. Although this part of a male's life is not so difficult, he must be on the constant lookout for other males.

Throughout the breeding season males compete over the ownership of mounds. Young males, especially, have a hard time of it, with most being displaced by older, more dominant birds as soon as they start their own mound. It may be several years before they are able to successfully defend their own mound from other males. In fact, about half of all mounds construct-

A newly hatched chick emerges from the depths of its mound.

ed are never used by their constructors. Birds that have been chased away from their mounds may give up altogether, or they may try to build another mound further away in the forest.

Some moundless males have also been seen waiting atop another male's mound in his absence. However, none of these interlopers has yet been seen to successfully mate. This interloping tactic is only possible because some males have doubled their chances of attracting laying females by building two mounds. Indeed, in the dense study population, this laborious effort is often more common than keeping a single mound. And it works! Males with two mounds received twice the number of eggs that single-mound males did. And, because each egg can be regarded as evidence of at least one copulation, these males have greatly increased their chances of siring young. By far the best approach of all, though, is that of the usurpers: these males acquire a second mound by expelling another male from his mound, thereby gaining the benefits without the costs!

BY STALKING BRUSH-TURKEYS THROugh Queensland rainforests I have come closer to understanding why males look after other males' eggs. For one thing, mounds are far more than just nests: they are the only way that males are able to gain mating access to a female. Female Brush-turkeys are free to wander where they like, but when they have an egg to lay they must find an incubator. These are provided by any number of obliging males, on the condition that copulation precedes laying. Although the precise mechanisms involved are yet to be confirmed, it seems likely that this leads to fertilisation of the next egg. Even though this may mean that males end up with other males' eggs, this would only be serious if the cost involved in this form of 'cuckoldry' meant some reduction in the time or energy available for improving the male's own reproduction. In Brush-turkeys there is virtually no such cost; the mound has to be maintained at the correct temperature anyway (with or without eggs) because females will simply not return to a substandard incubator.

I had little idea of the complexity of the lives of male and female Brush-turkeys when I started this study. The remarkable attempts by males to gain the most from the visits by females, and the females' apparently sophisticated decisions about where to lay and with whom, are all the more astonishing because all this behaviour is innate. For Brush-turkey chicks, like all megapodes, receive no parental care of any kind from their parents. They are alone from the time they emerge from the mound, the only 'help' being that of the male in keeping the incubator functioning. The lives of these defenceless hatchlings are a mystery. They seem to be entirely solitary for the first days or weeks and, not surprisingly, suffer very heavy mortality. By the time they are a few months old, however, they have banded together into close-knit groups of similarly aged birds. These groupings last until the young males begin to respond to their mound-building instincts, and leave to seek a dark, leafy spot for a mound of their own. ■

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Dr Darryl Jones teaches ecology in the Faculty of Environmental Sciences at Griffith University. He is a co-author of The megapodes, *soon to be published by Oxford University Press. Current studies focus on the behavioural ecology of rainforest birds, and wildlife–human conflicts.*

CYRIL WEBSTER / ANT PHOTO LIBRARY

There is something almost unearthly about the evening exodus from a flying-fox camp.

THE CONTENTIOUS FLYING-FOX

BY CHRIS TIDEMANN

AS THE HEAT OF THE DAY FADES AND the sun slides below the horizon the dinning noise, which has assaulted the ears since the sun came up, is suddenly replaced by complete and utter silence. It is a relief to be able to talk once more, instead of shouting above the chorus of squeals, shrieks, hoots and screams of a myriad of animals. But silence lasts for only a few minutes before a deafening insect orchestra of bush crickets begins shouting in a different key. Like the changing music of a horror movie, it forewarns of a happening. And happen it does, always on cue, as hundreds of thousands of large, winged animals take to the air and fly silently off into the gathering gloom like a spiralling cloud of ghosts.

To those brought up on stories of blood-sucking bats and ghoulish Transylvanian counts, it could indeed be a scene from a horror movie, for there is something almost unearthly about the evening exodus from a flying-fox camp. In flying-fox areas of course, it is an everyday event, but what you see depends entirely on which way you look at it. People either love flying-foxes or hate them. There is little middle ground. From my side of the fence, I hope never to see the day when these magnificent flying mammals no longer stream out like clouds of smoke in search of their evening meal, but there

KATHIE ATKINSON

People either love flying-foxes or hate them—
this Grey-headed Flying-fox was hand-raised.

are many who would like to rid the planet of them, and they too have their reasons.

A commercial fruit grower from near Sydney told me a story that, more than anything else, brought home to me how attitudes to flying-foxes are black and white. He told, with some anguish, of shooting flying-foxes to stop them eating his crops, and then of his daughter finding and hand-rearing the resulting orphans. Flying-foxes undoubtedly cause problems for people, particularly in the fruit industry, but also in a variety of other ways. They can cause electricity blackouts by shorting out power lines, and in some places they are a hazard for low-flying aircraft. They can be a nuisance in rather more personal ways too, by defecating on washing hung out to dry overnight, on the paintwork of cars, or in water supplies. And many people hate the smell of flying-foxes, which is undeniably powerful, particularly if you live downwind from a colony.

On the other side of the fence, flying-foxes are a valued source of human food in many countries and, as we are slowly beginning to understand, they are ecological linch pins. Linch pins keep the wheels on a cart. If they fall out, the wheels fall off and the cart crashes, with dire consequences. Without flying-foxes, so too will many natural ecosystems crash. It may take longer than a cart to crash, but the results will be every bit as certain, and infinitely more far-reaching. Five species of flying-fox have already gone down the one-way track to extinction and another 21 are seriously endangered, all because of too many being eaten by people, or too much forest being cleared.

FLYING-FOXES ARE EATEN BY HUMANS IN most countries of the world where both occur. Flying-foxes contain good red meat that, although strongly flavoured, is palatable enough when cooked up with spices and other condiments. Traditional methods of capturing flying-foxes worked on a sustained yield, year after year, and had little overall effect on populations. But most flying-fox hunters now are equipped with firearms, and huge numbers can be harvested in a short time. Two species of flying-fox once occurred on Guam in the Mariana Islands in the Pacific Ocean. One has not been seen for over 20 years, and is now presumed extinct; the other has been reduced to very low numbers, largely because of overhunting. Once the local supply began to peter out, an import market was set up. In the early 1980s more than 24,000 flying-foxes a year were imported to Guam from other islands as far afield as Papua New Guinea. They sold on the local market for up to $US30 apiece, such was the appetite of the local Chamorro people for this delicacy. By Australian standards, 24,000 is not a huge number, but it far exceeds the total population of many species of flying-fox that are restricted to small islands. The trade in Guam was banned in 1989 by international agreement, but not before a great deal of damage had been done.

Humans are not the only animals that like the flavour of flying-fox. Goannas, pythons and birds of prey eat them in most areas and, in the tropics, crocodiles and large fish, like Barramundi, catch flying-foxes as they swoop down over water to drink. There are stories of crocodiles hitting mangrove trees in camps with their tails and devouring the resulting 'rain' of little bodies. In eastern Australia, foxes commonly frequent camps and snap up any young that may fall to the ground, and on Christmas Island, in the Indian Ocean, feral cats rely on flying-foxes for about a third of their food intake. Brown Tree Snakes, which were accidentally introduced to Guam during World War 2, are now a serious predator of the endangered Mariana Flying-fox. However, apart from a few exceptions, non-human predators have little overall impact on flying-fox populations, simply because there are usually many more prey than predators.

In Australia we are still working out which bits of the ecological cart involve flying-foxes. It is a complex problem and, until quite recently, one not much studied by biologists. We now know that flying-foxes are important long-distance pollinators of many species of eucalypts and seed dispersers of many rainforest trees, but there is much more that

Two-week-old orphaned Grey-headed Flying-fox.

KATHIE ATKINSON

FLYING-FOXES IN AUSTRALIA

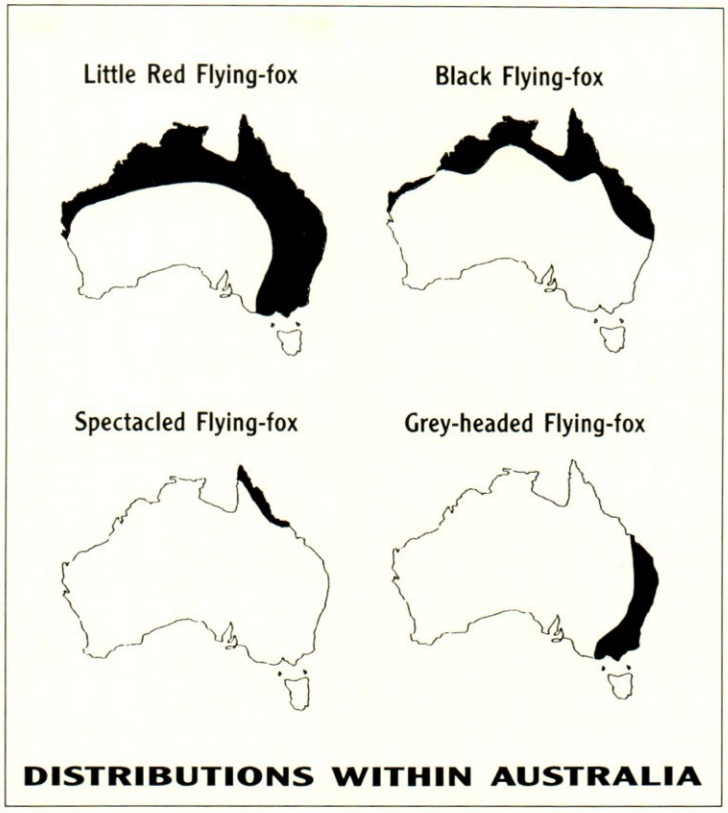
There are about 70 different species of bats in Australia. Of these, only nine feed on flowers and fruit. These are sometimes known as the 'megabats' because of their generally large size, and all belong to the family Pteropodidae. Among the largest megabats with fox-like faces are the flying-foxes *(Pteropus* species).

Black Flying-fox
(Pteropus alecto)
- males up to 1,200 grams; females up to 900 grams
- fur short, jet black but sometimes varies (collar fur or shoulders may be brown)
- if collar present, it rarely fully encircles the neck
- common in mangrove or paperbark swamps where camps often consist of hundreds of thousands of individuals

Grey-headed Flying-fox
(Pteropus poliocephalus)
- males up to 1,000 grams; females up to 850 grams
- long, shaggy fur
- belly fur greyish
- fur extends to ankles
- dark brown with grey head and collar of orange–brown fur fully encircling the neck
- large camps, but feeding groups seldom exceed ten individuals

Spectacled Flying-fox
(Pteropus conspicillatus)
- males up to 850 grams; females up to 750 grams
- black with pale yellow 'spectacles' around its eyes
- pale yellow fur often found on shoulders and back of neck
- camp sizes vary from hundreds to tens of thousands of individuals

Little Red Flying-fox
(Pteropus scapulatus)
- males up to 500 grams; females up to 400 grams
- short, reddish to light brown fur; light brown to yellow mantle across shoulders
- cluster together in camps, unlike other *Pteropus* species that usually hang with spaces between individuals
- wings pale and semi-transparent in flight



DISTRIBUTIONS WITHIN AUSTRALIA

Long-eared Flying-fox*
(Pteropus macrotis)
*This species has only recently been recorded from an island in Torres Strait, but it is included here because it is possible that it could be present on the Australian mainland.
- adult males up to 500 grams; adult females up to 400 grams
- body fur greyish, head russet brown
- obvious 'epaulettes' or whorls of thicker, lighter-coloured fur on shoulders
- ears very long and placed well back on head, bottom edge of ear in line with mouth

Discoveries or sightings of banded flying-foxes should be reported to The Flying-Fox Project, Forestry Department, ANU, GPO Box 4, Canberra, ACT 2601; phone (06) 249 2375 or (008) 804 325; fax (06) 249 0746. Advice on plant species suitable for replanting as flying-fox food trees can be obtained from this address and Greening Australia's offices can offer advice about procedures and information on financial assistance for revegetating. All species listed will eat domestic fruit but the principal food plants are blossoms of hardwoods, particularly eucalypts. Information is also being collected on all other aspects of flying-fox biology, which may enable us to manage these animals better, such as the location of camp sites and the times of year and species using them, details of crop damage, and the success or otherwise of particular control measures.

Spectacled Flying-fox.

G.B. BAKER / ANT PHOTO LIBRARY

Many solutions to the problem had been tried, including explosives, poisoning of fruit, flamethrowers and poisonous gases.

remains to be discovered.

Francis Ratcliffe pioneered flying-fox research in Australia in 1929–1930 at the request of fruit growers who, even then, sought methods of eradicating flying-foxes or reducing their numbers. Many solutions to the problem had been tried, including explosives, poisoning of fruit, flamethrowers, poisonous gases and even a bounty system where threepence was paid for a pair of feet. Ratcliffe concluded at the end of his study that flying-foxes were not a very serious problem for fruit growers and that, in any case, their numbers were so high as to be almost impossible, and certainly uneconomic, to reduce significantly.

From the commercial fruit grower's point of view now, flying-foxes are far from a trivial problem. Flying-foxes cost fruit growers in Queensland an estimated loss of about $20 million from XY to 1987, and significant losses are experienced in other States because they eat most of the fruits that humans find palatable: apples, bananas, custard apples, durians, figs, guavas, jackfruit, lychees, mangoes, nectarines, peaches, rambutans to name a few. In some situations it is possible to completely enclose fruit crops with netting and so keep flying-foxes out, but the cost is somewhere between $12,000 and $25,000 per hectare, depending on the terrain, the height of the crop and the quality of the

Flying-foxes, like this Grey-headed Flying-fox, are important long-distance pollinators of many species of eucalypts.

FOXY FOOD

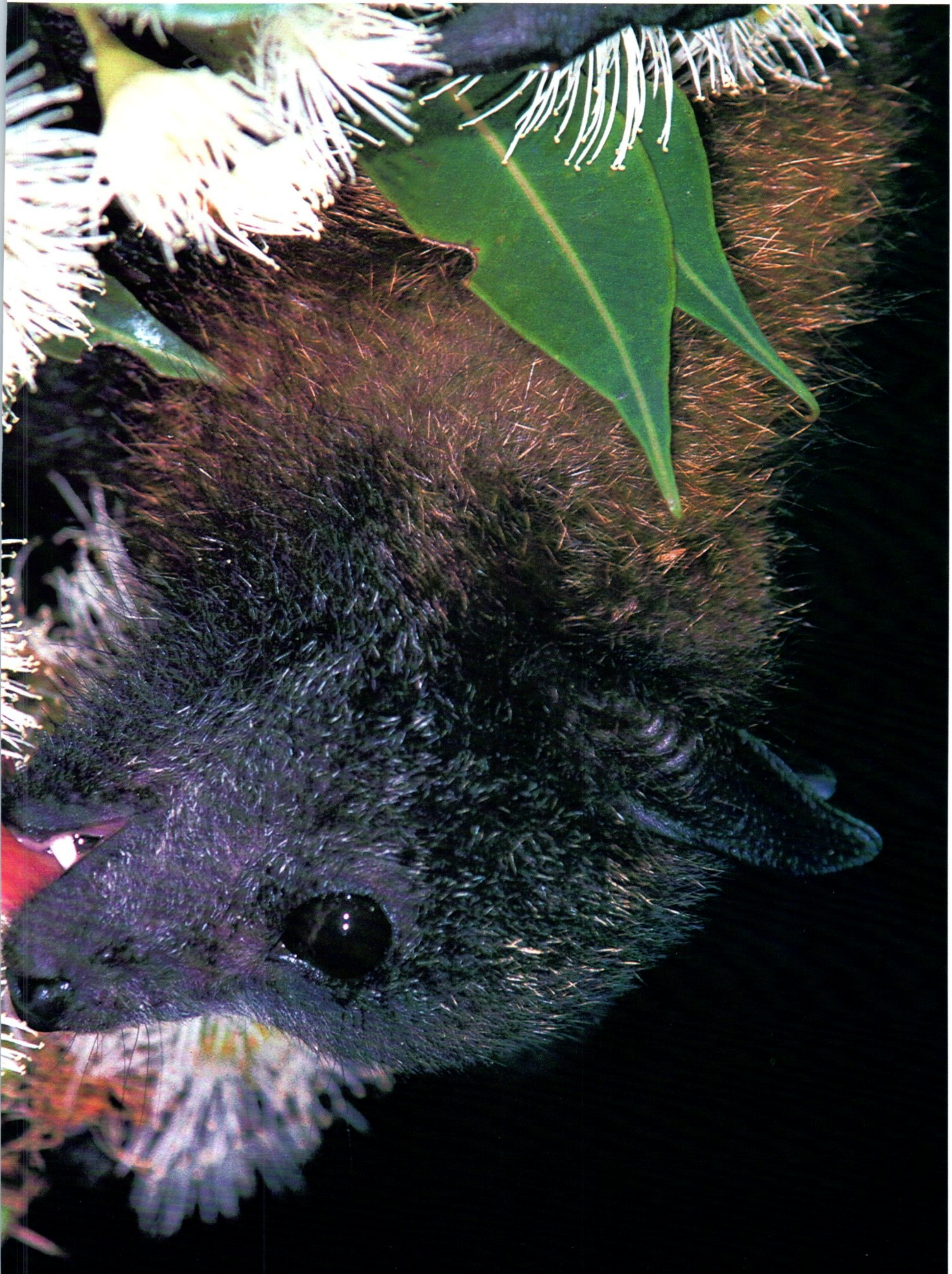
Flying-fox flesh was used in traditional Chinese medicine as a general tonic, and its dung was used to treat, among other things, snake bite, malaria, abdominal pain after childbirth, diabetes, poor circulation, fractures, fever, jaundice due to alcoholism, bleeding moles and, according to old Chinese medical literature, "for anaemia with good appetite but unable to speak and the hair stands out like wire".

Today flying-fox is a valuable source of protein for indigenous people around the world and in some places, such as Vanuatu, can be found on restaurant menus. The flavour is pungent and gamy, but cooked with the right blend of herbs and spices, can become an acquired taste. Readers should be aware that the use of flying-foxes for food is prohibited in some States of Australia and that excessive harvesting has contributed to the decline of more than a few species in other parts of the world. If harvesting could be carried out in a sustainable and humane manner, there seems no reason why flying-fox could not join 'bush meat', like kangaroo, crocodile, Barramundi and crayfish on Australian restaurant menus.

FRITHFOTO / ANT PHOTO LIBRARY

Samoan Islanders roasting a Royal Flying-fox *(Pteropus tonganus)* for their evening meal. Hunting pressure has contributed to the demise of many flying-fox species.

ANH



KEN GRIFFITHS

TIM AICKIN / HORIZON

Tree branches often strain under the weight of too many flying-foxes.

materials used. Apart from the cost of netting and maintaining it against environmental wear, some crops—notably bananas, which are grown on steep slopes—are not such an easy matter to protect and there is a need to develop other environmentally friendly methods of deterring flying-foxes from eating them.

The conflict arises because many commercial fruits, particularly the tropical ones, have been developed from wild species that were originally pollinated by flying-foxes or had their seeds dispersed by them. Although genetic engineering has given us almost magical possibilities of manipulating the characteristics of plants and animals, we can't produce new genetic stock from nothing. When plant breeders need to combat a new problem, such as fungus attack or frost susceptibility, they must invariably go back to wild stock to get new genetic material. And, the wild progenitors of most of the delicious tropical fruits that we eat depend, holus-bolus, on flying-foxes for continued survival, as do many important timber species, plus thousands of other plants that have no commercial use at present.

Australia in 1993 is a very different place from when Ratcliffe carried out his study, both for fruit growers and flying-foxes. Vast areas of natural forest, which once provided food for flying-foxes as well as places for them to camp, have disappeared over the last 60 years. In NewSouth Wales alone about 50 per cent of the original 62 million hectares of wooded land have been cleared or extensively modified to grow food for the 17 million people that now live in Australia. In northern New South Wales most flying-fox camps are confined to tiny remnants of semi-natural vegetation, many only a few hectares. Flying-foxes confined to such small patches can cause extensive damage to the vegetation. Leaves are stripped from trees and the sheer weight of animals may cause quite large branches to break. In drought years, or when eucalypt flowering is poor, large mobs of flying-foxes, particularly Little Reds, may gather in camps on the east coast of Australia, forced in from drier areas further inland. Under these conditions they can wreak havoc on local fruit crops, and they almost certainly cause food shortages and crowding for the more normal residents of these camps, the Grey-headed and Black Flying-foxes. Replanting of unproductive areas of land with native shrubs and trees would provide food and shelter for flying-foxes, as well as many other species of animals, and would also lessen the impact of wildlife on crops. None of the flying-foxes in Australia is thought to be endangered, although we have seen a dramatic decline in the numbers of several species in the last 50 years. We still don't really know what the safe limits are, for there is much basic biological information about these animals that we don't have.

HANS & JUDY BESTE / AUSCAPE INTERNATIONAL

A Black Flying-fox feasting on bananas: flying-foxes can be costly for fruit growers because they eat the fruits we enjoy when their usual food supply is depleted.

KLAUS UHLENHUT / ANT PHOTO LIBRARY

Little Red Flying-foxes may be forced to venture to the east coast in large mobs during poor eucalypt flowering seasons or droughts.

The evening exodus from a flying-fox camp is an eerie sight. Like a spiralling cloud, large swarms take off to feed around sunset.

THE FLYING-FOX PROJECT HAS BEEN SET up to answer some fundamental questions about flying-foxes, which will be important for their management not just in Australia, but also in the many other places where they occur. What are their migration patterns? Are the vast numbers that we see spread evenly across the country, or is it just a few large groups moving about? How much forest do these animals need for food? What environmental conditions are likely to precipitate heavy crop damage? What are the birth and survival rates of young and how many can we afford to cull or harvest?

Paradoxically, given the size of flying-fox populations, one of our major problems in answering these questions has been catching the animals alive in large enough numbers to carry out routine ecological studies. After much experimentation we now use a trap that I developed specifically for the project. It is an imposing structure: 15 metres high by 16 metres wide with a frame of aluminium yacht masts and steel cables supporting 120 vertical plastic-covered stainless steel strings. In essence it is just like a very large harp, except that the strings are all of the same length. The trap is collapsible and portable, so that it can be moved from camp to camp on a car roof rack. With an experienced crew it takes about two hours to set it up and about half that time to dismantle it. In many camps its height gets the trap up into the canopy where flying-foxes roost and very large numbers (200 or more) can be caught at the one time. But one of the best things about the harp-trap is that very few animals are injured and minimal stress is involved.

Once the animals are caught, their reproductive status and age can be assessed and they are also individually marked so they can be recognised if caught again. This is done with a numbered metal band on the thumb and a brightly coloured plastic collar around the neck. When they have been measured and marked, the animals are released. We have marked and released about 3,500 flying-foxes so far, of which 50 have been recovered. Each reported recovery represents a great deal of useful information about what the animal has done since it was first marked and, if enough can be recovered, a picture can be built up of what the populations are doing. Virtually all of the recoveries so far have come from people finding dead bodies and reporting their discoveries to the Australian Bird and Bat Banding Scheme, which monitors records of all banded animals in the Australian region. The reason we put plastic collars on the marked bats is to make them more noticeable, and stamped on each collar is a toll-free phone number, (008) 804 325, to encourage people to report their findings.

In addition to measuring animals, we record what they have been eating by microscopically examining their faeces, and, with radar imaging, the areas over which colonies forage. Supplementary information on migration is coming from genetic studies. Ecological studies, like The Flying-Fox Project, need to run for several years to cover fluctuating environmental conditions, like drought and flood years, and it has not been an easy matter to attract sufficient funding to run it, particularly during a recession. Virtually all of the considerable labour force needed has come from volunteers donating their time to the project. Their satisfaction comes from knowing that their efforts are helping to generate information that will enable the conservation of a unique resource and so keep the wheels of the ecological cart from falling off. ■

WAYNE LAWLER / AUSCAPE INTERNATIONAL

Suggested Reading

Hill, J.E. & Smith, J.D., 1984. *Bats. A natural history.* Rigby: Adelaide.

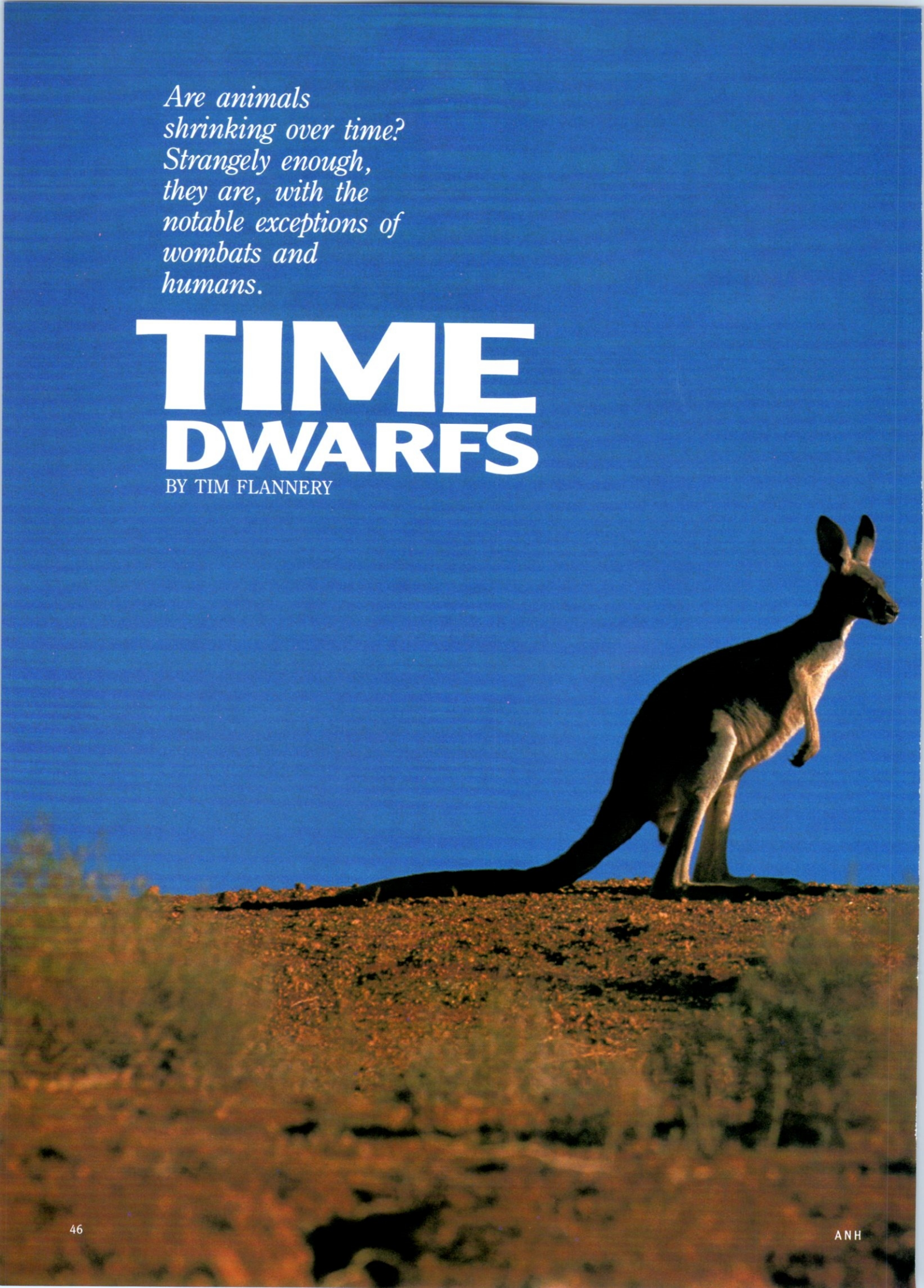
Ratcliffe, F., 1948. *Flying-fox and drifting sand.* Angus & Robertson: Sydney.

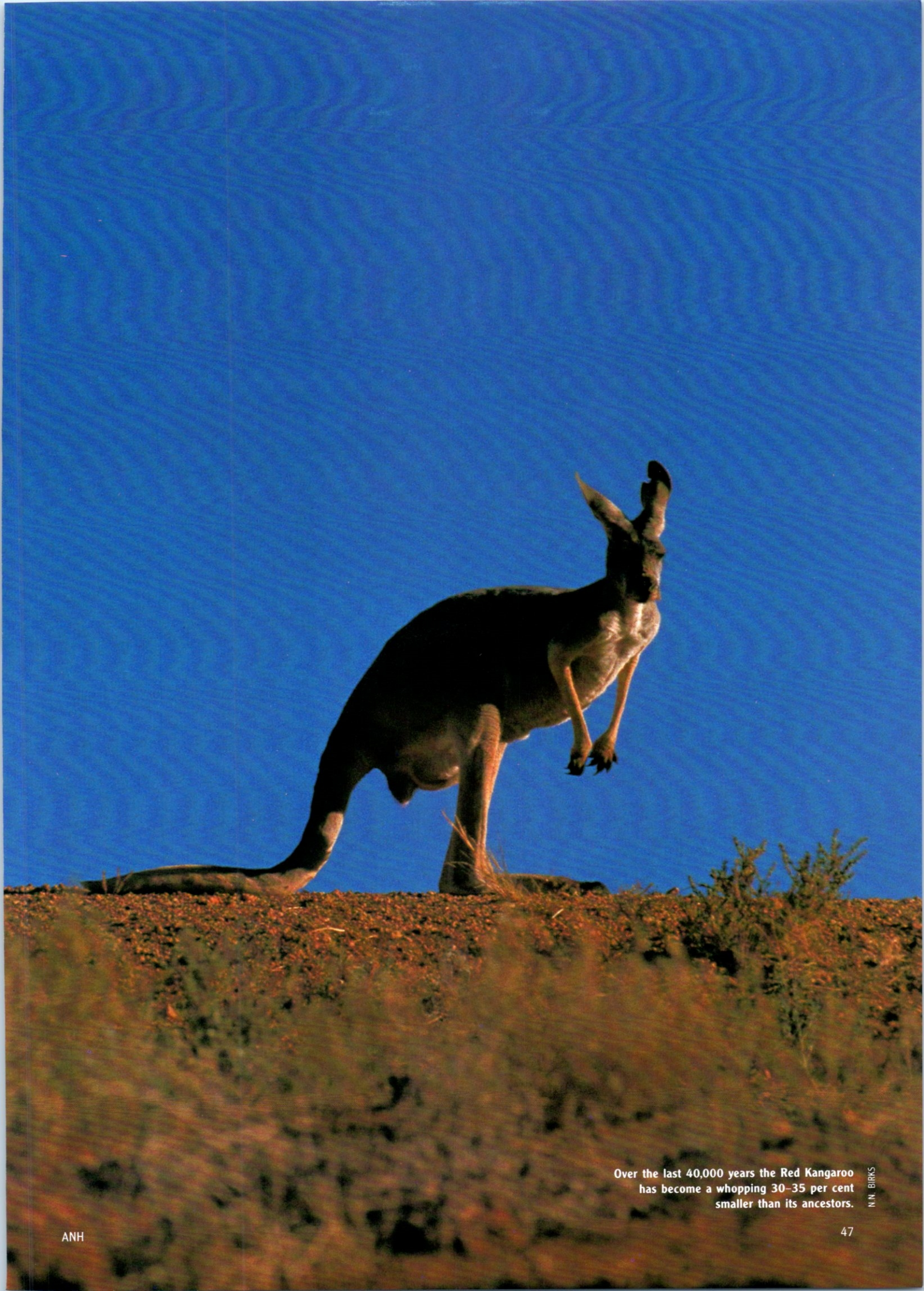
Dr Chris Tidemann is a lecturer in wildlife conservation and management with the Department of Forestry, School of Resource and Environmental Management, Australian National University. He has studied bats for over 20 years, and is a Vice-President of the Australasian Bat Society and Director of The Flying-Fox Project.

Are animals shrinking over time? Strangely enough, they are, with the notable exceptions of wombats and humans.

TIME DWARFS

BY TIM FLANNERY





Over the last 40,000 years the Red Kangaroo has become a whopping 30–35 per cent smaller than its ancestors.

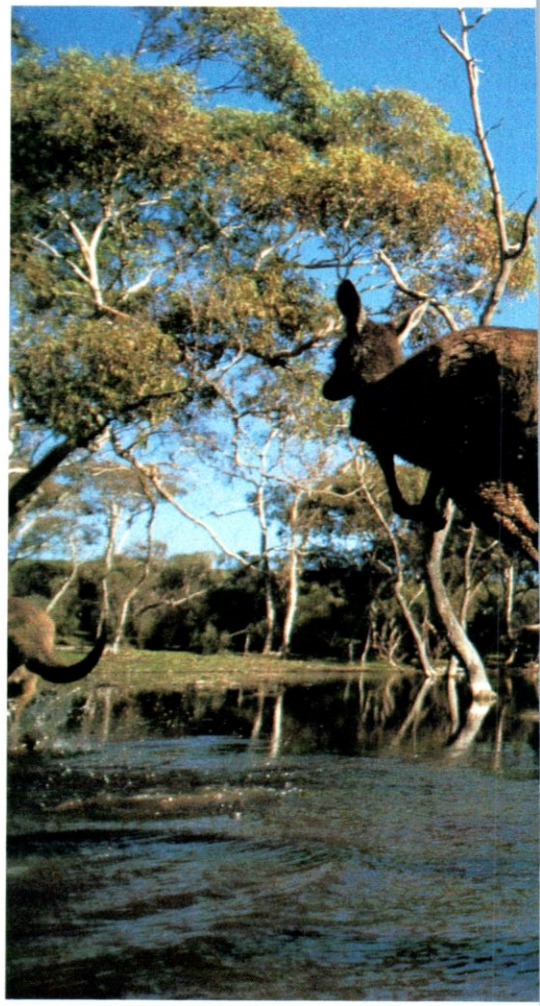
N.N. BIRKS

OLD FISHERMEN ARE FAMOUS FOR their tales of whopper fish, most of which got away. I have always viewed such stories with a large dose of scepticism, but recent research by fisheries experts suggests that the old codgers may not be such terrible liars after all. Scientists have found that in many intensely exploited fisheries the average size of individual fish is decreasing. They think this is because the tiddlers are thrown away or get through the net. This selects for early maturing dwarfs. These individuals breed and spread their 'dwarf' genes, while their larger cousins are caught before reaching sexual maturity. Unfortunately, as the average size of fish decreases, yesteryear's tiddlers become today's whoppers; and so the cycle is perpetuated, the average size of fish decreasing with the years and our octogenarian anglers being viewed with more and more disbelief!

Of course this trend is quite alarming to fisheries biologists, as the productivity of the fisheries, as well as fish ecology, can be severely affected. They may be interested to know that fish are not the only organisms to have shrunk in average body size through time. Many well-known Australian marsupials are 'time dwarfs' too. My own interest in such matters dates back more than a decade, when as an M.Sc. student, I realised that the Eastern Grey Kangaroos (*Macropus giganteus*) that exist today are much smaller than their ancestors of 40,000 years ago. Could it be that intense exploitation by humans has affected the size of kangaroos as well as fish?

THE FACTORS THAT CONSTRAIN THE size of living organisms are many and complex. At the most fundamental level are the structural constraints. The efficiency of the breathing organs of insects, for instance, places an upper size limit on them; the heaviest insect, the South American beetle *Megazoma action*, weighs around 200 grams. Likewise, the physiology of leaf digestion places a lower size limit (around half a kilogram) on leaf-eating mammals such as ringtail possums (*Pseudocheirus* species).

Many other more subtle factors influence size. Where two ecologically similar species coexist, the less dominant species will often be smaller than in areas that it alone inhabits. Latitude can also have an effect, as generally mammals from higher (colder) latitudes are heavier and have shorter appendages (and so lose relatively less body heat) than those from lower latitudes. Thus, the Koalas (*Phascolarctos cinereus*) and Eastern Grey Kangaroos of Queensland tend to be smaller than those of Victoria.

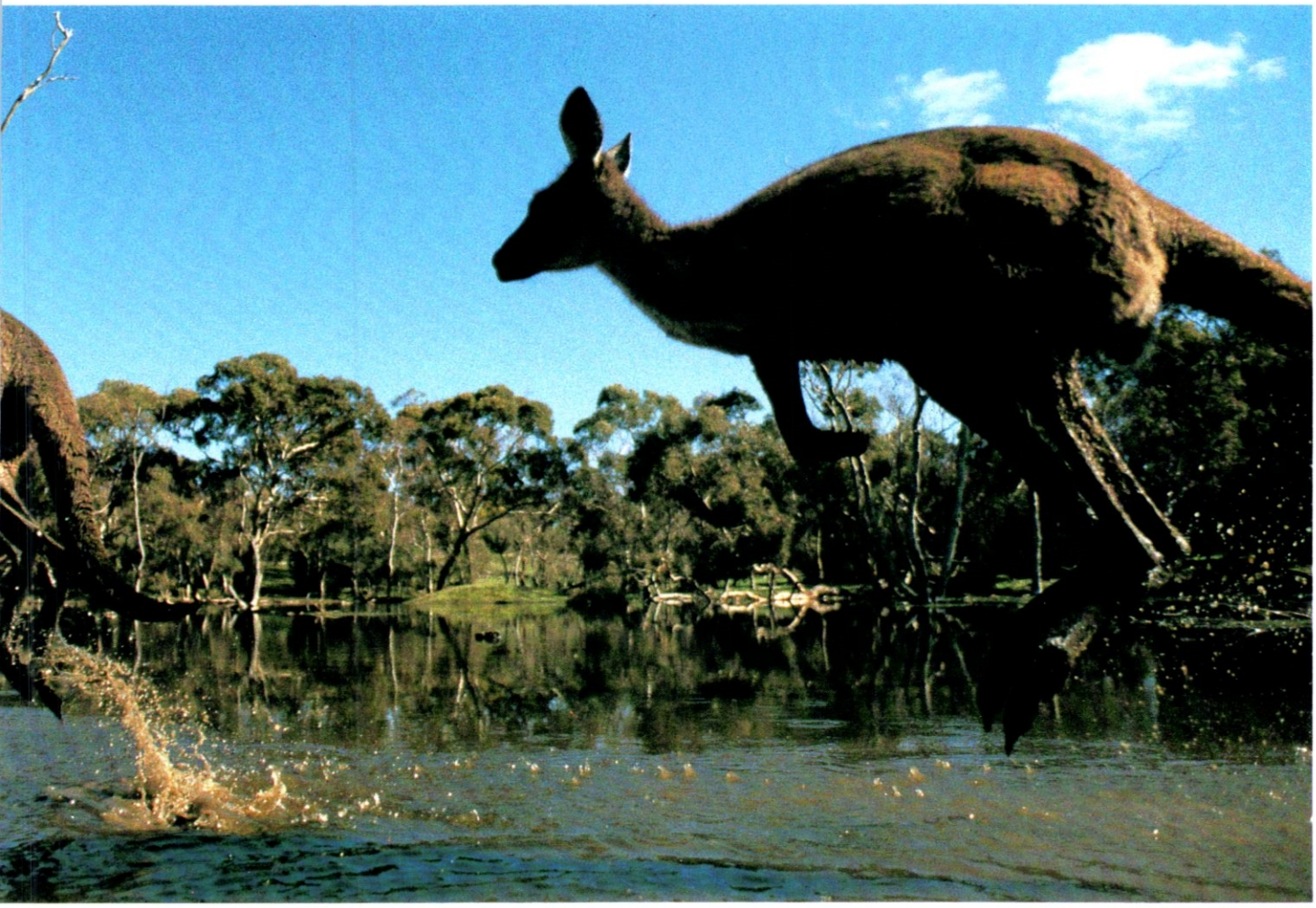


Nutrition is also important in determining body size. It is well established that there was an increase in the stature of Japanese men and women when a more nutritious diet was introduced after World War 2. On the other hand, you need to be a large animal to exist on poor-quality food, and thus low-nutrient food may increase the average size of an evolving lineage of animals. Take, for example, Australia's extinct diprotodons. Over the past 15 million years as Australia dried out and fodder quality became increasingly poor, these animals increased in size. Physiologists argue that herbivorous animals need enormous, complex stomachs to act as fermentation vats if they are to gain sufficient nutritive value from poor-quality food. Thus, as food quality decreases, herbivores of larger size are selected for. Also, larger warm-blooded animals require less energy per kilogram than small ones.

Eastern Grey Kangaroos also increased

The way a body is built constrains its potential size. Leaf-eating mammals, such as this Common Ringtail Possum *(Pseudocheirus peregrinus)*, have a lower limit of about half a kilogram.

KEN GRIFFITHS



N N BIRKS

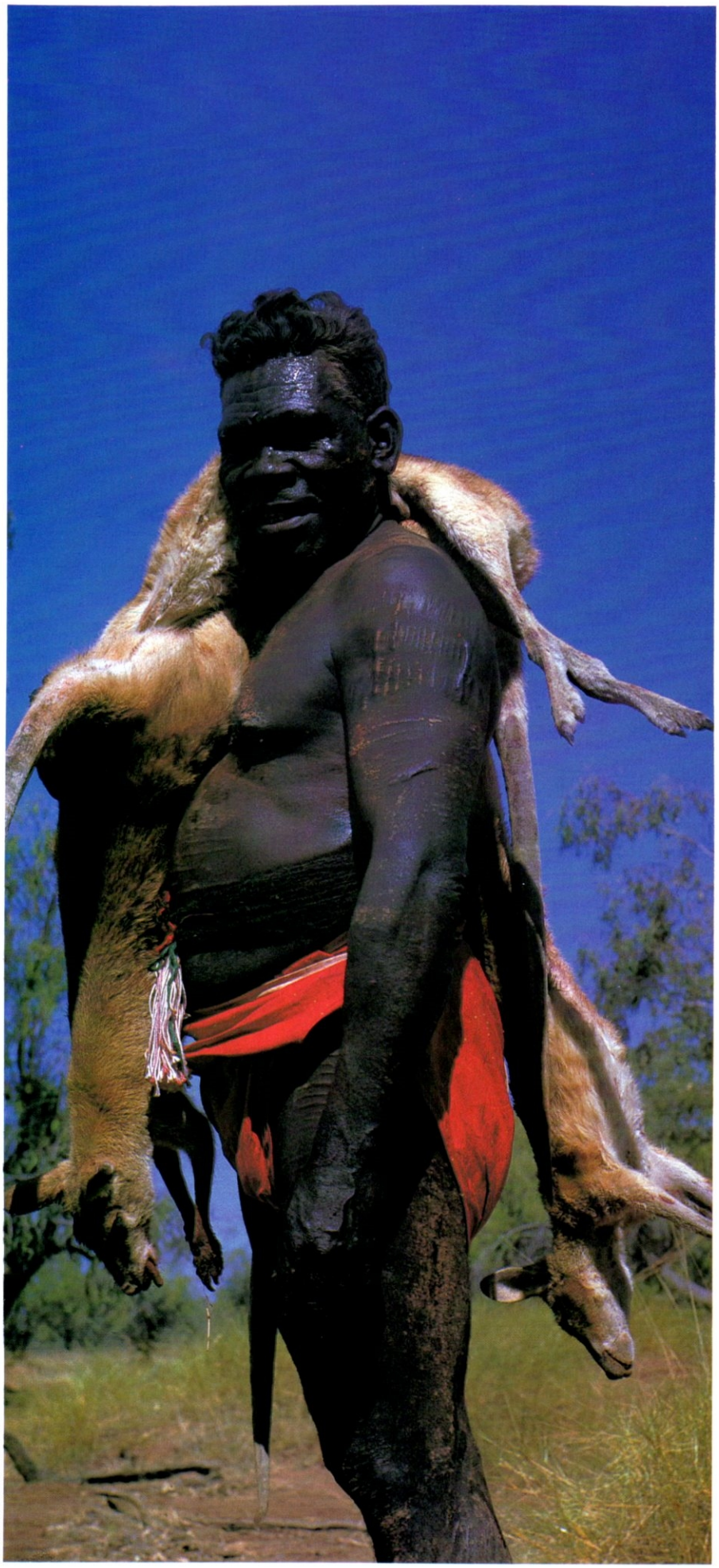
The oldest Western Grey Kangaroo remains are about 13 per cent larger than their descendants.

in size over the two million years that the species has been in existence. But about 20,000–40,000 years ago, after the arrival of humans, they began to decrease in size. At around this time the diprotodons and many other large marsupials became extinct. Fossil deposits covering the past 35,000 years from Devil's Lair, south-western Western Australia, reveal that, although the size decrease may have begun at around the time of the diprotodons' extinction, it did not stop at that time and has continued to the present. There are no remains of diprotodons or other large extinct marsupials in the site, so we can assume that they became extinct, at least locally, before 35,000 years ago. The oldest Western Grey Kangaroo (*Macropus fuliginosus*) remains are between 27,000 and 19,000 years old, and are 13 per cent larger than a modern Victorian sample of Eastern Grey Kangaroos, while those dating from between 19,000 and 12,000 are ten per cent larger, indicating something of the rate of size decrease.

The very largest Eastern Grey Kangaroos existed in Victoria some 25,000–30,000 years ago. Some must have been truly enormous, for their teeth alone are

BRIAN L. DOWNS / LOCHMAN TRANSPARENCIES

Yellow-footed Rock-wallabies have shrunk by around nine to ten per cent.



DOUGLASS BAGLIN / HORIZON

30 per cent larger than living Victorian animals. This suggests they were about twice as heavy, the largest probably weighing nearly 200 kilograms and standing, when stretched, three metres tall. They were almost certainly more stocky than living animals. Indeed, so spectacularly different are the fossil remains of these kangaroos that they have long been considered to represent a different species from the living animals. Only after careful research into changes in kangaroo size through time has the true situation been revealed.

Eastern Grey Kangaroos were not the only species to shrink. The American palaeontologist Larry Marshall and co-author Joe Corruccini have shown that over the past 40,000 years teeth of Red Kangaroos (*Macropus rufus*) have declined 30–35 per cent, Common Wallaroos (*Macropus robustus*) by 26–27 per cent, Agile Wallabies (*Macropus agilis*) by 15–16 per cent, Swamp Wallabies (*Wallabia bicolor*) by 15 per cent, Yellow-footed Rock-wallabies (*Petrogale xanthopus*) by 9–10 per cent, Tasmanian Devils (*Sarcophilus harrisii*) by 16–17 per cent and Spotted-tailed Quolls (*Dasyurus maculatus*) by 5–6 per cent. Furthermore, the Director of the Queensland Museum, Dr Alan Bartholomai, has shown that Koala teeth have shrunk by around ten per cent. Indeed, so comprehensive is the list of time dwarfs among the larger surviving Australian mammals that it is easier to compose a list of species that have not shrunk substantially. As far as I have discovered this list includes only the three living species of wombats, and humans. Another important point to note about the dwarfs is that, by and large, the larger their ancestors, the greater has been their shrinkage in size. Also, the smaller species (five kilograms and less) show no reduction in size, while the larger ones that did not dwarf (including the diprotodons) are now extinct.

Most scientists have argued in the past that this shrinkage in size, which also affected larger mammals on other continents, had something to do with the Ice Age, and a drop in the quality and quantity of fodder. For the Australian species, however, the argument seems unconvincing, for we now know that they continued to decrease in size long after the last ice age passed around 15,000 years ago. It also ignores the fact that there have been 17 ice ages over the past two million years. Why should these species start to dwarf only during the last one? Furthermore, it is hard to imagine a change in the quality of food that would affect kangaroos, Koalas and Tasmanian Devils, but not humans and wombats.

I feel that the overexploitation hypothesis might be better at explaining the marsupial time dwarfs, although several things must first be established. Is there any evidence that these species were

Aboriginal hunter with catch: hunting pressure could have suppressed the larger marsupials.

under intense hunting pressure from Aborigines? Is there any evidence to suggest that Aborigines might select the largest individuals preferentially? Are there any 'independent experiments' such as offshore islands where humans do not exist and animals have increased in size? And finally, does the fact that humans and wombats have not shrunk have any bearing on the question?

ANALYSIS OF PREHISTORIC ABORIGINAL refuse dumps is of little help in determining how heavily various species were hunted. If there are many bones of a given species it could be interpreted as being heavily hunted, but then again this may not have been enough to make the population decline. Alternatively, if few bones are present, it is difficult to determine if the species was naturally rare, hunted into rarity, or just taken infrequently. Perhaps the best information available is that from the early European contact period. If it can be shown that various species increased in numbers after Aborigines ceased to hunt them, then it is likely that hunting was having a considerable impact on the population. The best information available is for the Koala and the larger kangaroos.

In the last issue of ANH (Summer 1992–93) Roger Martin put forward a persuasive case arguing that hunting by Aborigines was a significant factor in keeping the numbers of Koalas and tree-kangaroos low, and in limiting their distributions. It is just such predation pressure that needs to be demonstrated for the time dwarfs hypothesis to have validity.

The situation regarding the larger kangaroos is similar. Early explorers such as Major Thomas Mitchell considered the sighting of a kangaroo as noteworthy in areas where today hundreds can be seen in a morning. John Gould wrote in the 1840s that the Government must act to protect the Red Kangaroo (*Macropus rufus*), for "if this be not done, a few years will see them expunged from the fauna of Australia". Gerard Krefft noted that in 1862 the Red Kangaroo was very poorly known to the general public, even its continued existence being doubted, as one "enlightened critic was pleased to designate this species as ante-diluvian". Clearly, Red Kangaroos were much rarer early last century than they are today. Unfortunately the reasons that the larger kangaroos have increased in numbers is not so clear, and it is possible that the extermination of the Dingo and the provision of water and improved pasture in some areas has had an impact. The importance of the cessation of Aboriginal hunting should not, however, be counted as unimportant.

Ecologist Robert May of Oxford University has identified a phenomenon, now called the 'predator pit', that may help explain how Aboriginal hunting pressure could have suppressed the larger marsupials. The model suggests that once the population of a prey species falls below a

Modern Tasmanian Devils are 16–17 per cent smaller than their ancestors.

FORD KRISTO

certain level, a flexible predator can stop it from recovering. It does this by switching much of its attention to another prey species, thus keeping its own numbers high. The small amount of predation it exerts on the species in the predator pit is still, however, enough to prevent it building up to the point where its numbers can increase rapidly again. The small size of a population caught in a predator pit may also help genetic changes (such as that for early-maturing dwarfs) to spread rapidly. The predator pit may also explain why hunting by Europeans has been unsuccessful in reducing kangaroo numbers: perhaps by the time hunting had begun in earnest, Aboriginal predation had ceased for long enough that kangaroos had climbed out of the pit, their numbers reaching a point where they were not easily suppressed again.

We must now address the question as to whether Aboriginal hunting techniques favoured capture of the largest individuals of a species. Some interesting anecdotal data exist. Krefft, writing of the Red Kangaroo in 1862, notes that "when disturbed, the old males cover the retreat of the fleet females who are off first, so that specimens of the latter sex are rare, the dogs generally stopping the progress of the rear-guard of the red 'old men'". Old male Red Kangaroos are the largest individuals of all. Daisy Bates notes that in Western Australia Aboriginal men would track an individual kangaroo for days, exhausting it enough so that they could kill it. Surely, when expending such enormous amounts of energy, it would be sensible to track the largest individual available. The situation with Koalas is less well known, although it makes intuitive sense that smaller Koalas would be harder to see, and thus less vulnerable to predation, than large ones.

A fortuitous piece of evidence helped seal the case for me. While completing my M.Sc. on kangaroos I was lucky

That wombats have not shrunk over time is puzzling. Pictured is a Common Wombat *(Vombatus ursinus)*.

FORD KRISTO

enough to visit Kangaroo Island, South Australia, and to examine some fossil grey kangaroo bones from there. To my great surprise I found that these samples differed from those from all other regions of Australia in that the modern animals were, on average, larger than the 20,000-year-old fossils! At first I thought this might be due to the fact that they were from an island, and I was aware that individuals of island populations of mammals are often strange in size. For example, in the past the islands of the Mediterranean have been home to sheep-sized elephants, and hare-sized hedgehogs. As it turns out, however, it is a general rule that larger animals shrink on islands, and only species much smaller than grey kangaroos show an increase in size. I was stumped. But then I learned that, until 11,000 years ago, Kangaroo Island had been part of the mainland and, up until 2,500 years ago, Aborigines had inhabited it. Could it be that the eight per cent size increase in the Kangaroo Island Kangaroo (*Macropus fuliginosus fuliginosus*) occurred only after human predation had ceased? Unfortunately, the fossil record of kangaroos on the island is not yet complete enough to test this hypothesis. However, it will be a critical test of the time dwarfs theory when material becomes available.

Finally, can we make sense of shrink-proof wombats and humans themselves? Perhaps the burrowing habits of wombats protected them from overly severe predation. Another alternative is that they *have* shrunk, but that this has been difficult to detect because their ever-growing teeth (from which size estimates are made) are difficult to measure accurately. If this is so, however, the average size difference must be small, as it is not detectable when running one's eye over a sample, as it is for all other species. And what of humans? The literature is replete with accounts of tribal warfare among Aborigines, but this kind of 'predation' pressure is quite different from that which humans exert on some animal species. This is because, all other things being equal, the larger human should prevail over the smaller one in combat. Indeed, this kind of competition between males of a species is one of the factors that selects for large size in the first place.

If we humans did create the time dwarfs, then the issue has great significance for modern wildlife management programs. Large males are currently favoured in the commercial culling programs of the three largest kangaroo species. Is this leading to a further decrease in size? At what point are these various species disadvantaged by further size decrease? Should we be culling the smallest adult males in an attempt to increase average size? Whatever the answers to these questions, fisheries experts and wildlife management authorities would do well to look closely at the fossil record before implementing culling decisions. ■

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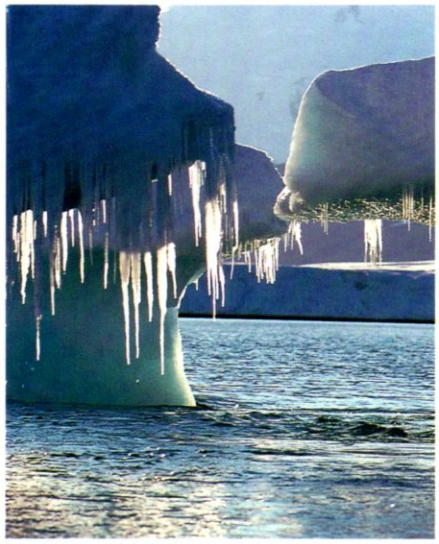
Dr Tim Flannery studies mammals at the Australian Museum. He has long been interested in size changes in kangaroos.



Icicles form when melt water and sea spray refreeze.

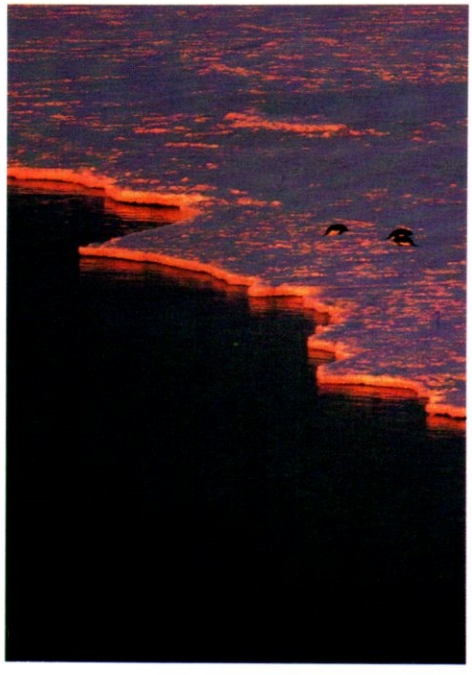
BY JONATHAN CHESTER/EXTREME IMAGES

ANTARCTICA IS, WITHOUT QUESTION, a wilderness photographer's paradise. Herein lies much of its attraction for me. The challenge of conveying images of the many and varied moods, sights and experiences I have encountered keeps me returning time and again.

The Antarctic is the most breathtaking and pristine place in the world. Although it is typically depicted as a white icy void, in summer during the long twilight hours the landscape is often bathed in soft pink, salmon or lilac hues. Antarctica is renowned for its many graphic landforms: glaciers that stretch for hundreds of kilometres, crevasses that could swallow entire buildings, and ice and rock shapes that seem wrought by a master sculptor. Because of the extremely clear air, these features are visible for vast distances and, without vegetation or human presence, there is little sense of scale.

Antarctic coastal scenery and wildlife is especially photogenic. Leviathan icebergs roam the high latitudes and belts of pack ice and coastal rocky outcrops are home to the many penguins and seals.

The indefinable allure of Antarctica itself is the main source of my inspiration. It is a place where every day presents physical and emotional challenges, high adventure and a sense of unparalleled loneliness and beauty.



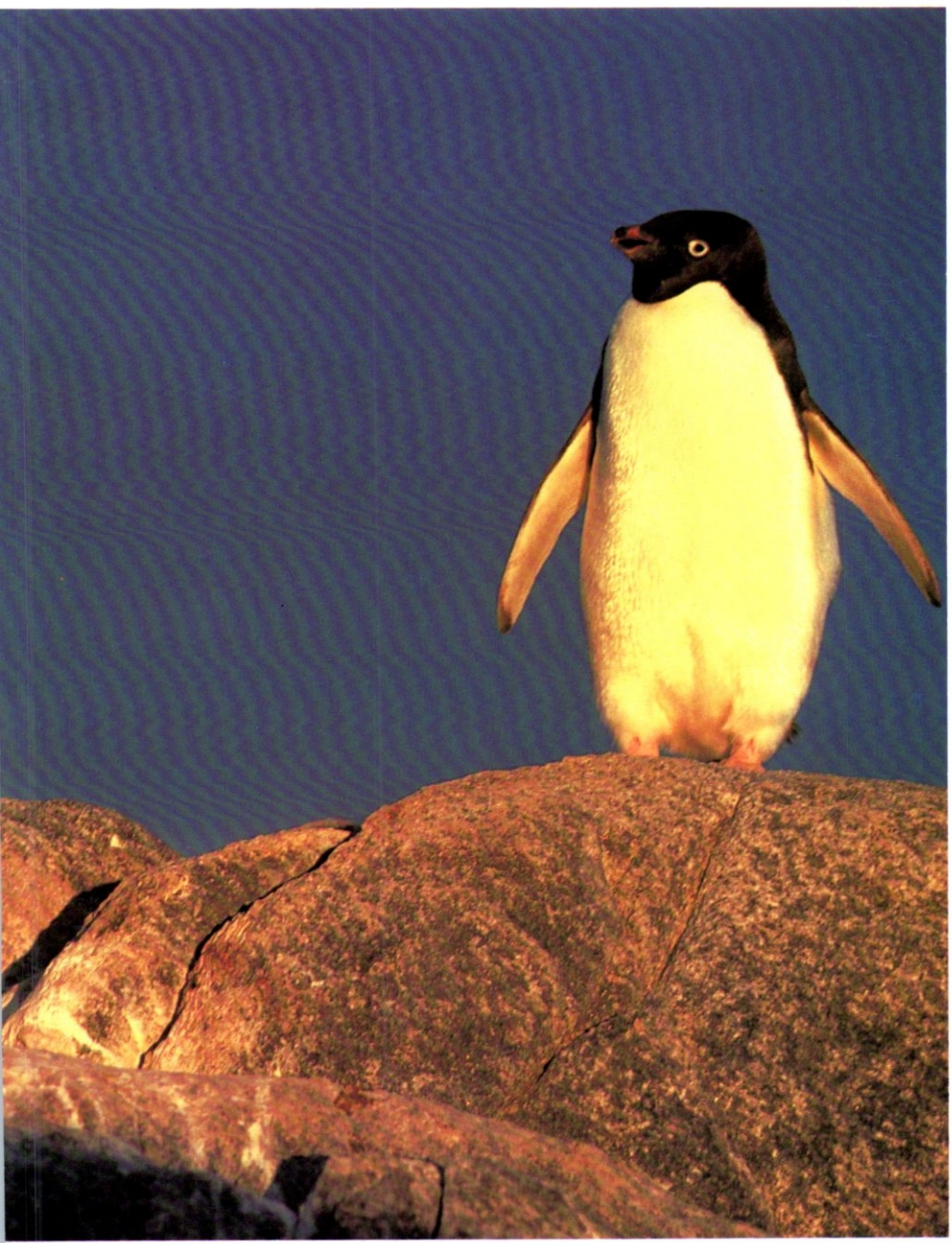
Adelie Penguins sleeping near the edge of the sea ice.

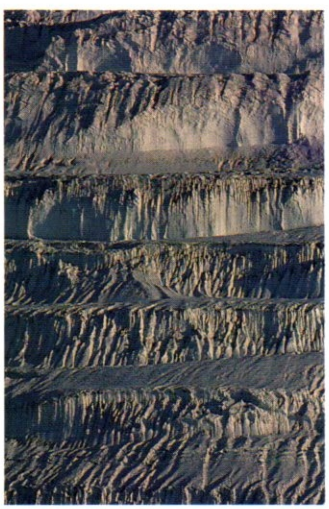
Chaos Glacier near Davis Station pushes ice tongues out into the sea. They will eventually break off and form small icebergs.

FREEZE FRAME: ANTARCTICA

A Weddell Seal emerges through the sea ice. Its sharp teeth are used to open breathing holes.

The imposing Mount Herschal near the shores of Moubray Bay.





The layers in these storm-lit icebergs are formed by annual snowfall being compacted over the centuries.

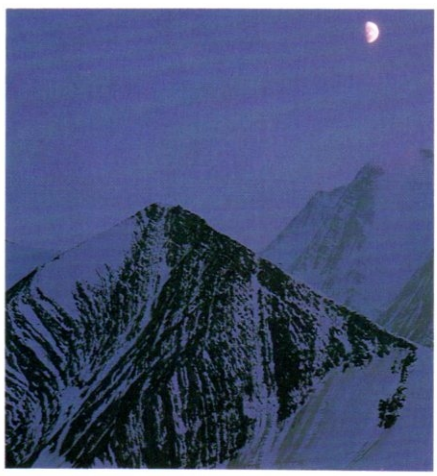
Adelie Penguins come ashore in October to breed.

FREEZE FRAME: ANTARCTICA

During summer the sea ice breaks up into smaller pieces called fast ice.

A massive hanging glacier towers above Cape Hallett.

FREEZE FRAME: ANTARCTICA



Moonrise over Mount Trident, Admiralty Mountains, North Victoria Land.

P H O T O A R T

Adelie Penguins blasted by spindrift march towards the sea.

Marsupials streaked ahead to produce ferocious carnivores while the placentals whimped out.

THE MURGON MONSTER

BY MICHAEL ARCHER

BEING HUMAN, MOST OF us presume that human is the best sort of being one could possibly be. Throughout history, philosophers of the natural world have seen in the maggot, the frog, the lizard and mouse, a progression of increasingly more human-like creatures each hung upon a higher rung of the ladder of Divine Creation. Humanity, beneath which all other life forms dangle in embarrassed imperfection, perches one short rung below humanoid gods who grant to us alone the divine right to flick offensive, lesser creatures off the ladder into the abyss of non-existence. It's good to be the king.

The egotistic view that humans – or more commonly some particular groups of humans – are the pinnacle of purpose in all that matters is little younger than humanity itself. It was our rationale for trashing Tigers, Cave Bears and Toolache Wallabies. In its more secular form, it justified an infinity of racial atrocities that continue to accumulate behind us as a dark shadow we would rather forget. It led 18th-century Europe to declare the newly 'discovered' southland of Australia 'empty', filled by serpents, sands and soul-less savages – thus available as a tip for Europe's misfits.

Within this context of European arrogance were sowed the distorted seeds of a cultural and biological 'cringe' that continues to plague Australia. Failed Englishmen had somewhere to go besides the French Foreign Legion when they wanted to commit social suicide, and biologists had found a menagerie of presumably inferior life forms with which to contrast the superior inhabitants of the Northern Hemisphere.

SUE HAND

Mike Archer's team at the Murgon site.

Conspicuous among the inhabitants of Australia were the marsupials – odd, mostly pouched things that hopped or crawled about at night or stared vacantly from the boughs of an unpleasing vegetation. Certainly there were native placental rodents and placental bats but where were the monkeys, horses, camels or lions? This continent's balance of beasts offended the senses.

It simply wouldn't do to allow that marsupials might be a better solution than placentals to the particularly challenging conditions of Australia. Instead, it was imagined that marsupials were driven to Australia from the Northern Hemisphere with the emergence of the placentals. In fact the fossil record does suggest that, although marsupials were once present on all of the continents of the world, they apparently vanished from the northern continents sometime this side of 17 million years ago, albeit more than 80 million years after the first appearance of placentals. But before the hoardes of placentals could reach this last southern refuge, a miracle of natural intervention must have isolated Australia thus protecting the life forms that would inevitably have screamed 'uncle' if placentals had gotten aboard.

What is not commonly known is that the record of early mammals in South America, 60 million years ago, includes placentals (insectivores and condylarths) as well as marsupials. What subsequently happened in that southland provides little support for placental chauvinism. Marsupials streaked ahead to produce ferocious carnivores such as the giant Sabre-toothed Marsupial Lion and the Grizzly-sized Marsupial Bear. The placentals, on the other hand, whimped out. Although they diversified into a wide variety of distinctive forms including sloths, armadillos and notoungulates, they were all insect-eaters or hay-burners – the fodder upon which the bright-eyed marsupials fed.

But surely *Australian* marsupials have done nothing to further offend the sensibilities of our dented placental chauvinism. Or have they? Until 1991, Australia's fossil record had little to offer in the way of threatening placentals apart from a plethora of bats and rodents. Now, however, we have had a signal discovery from the 55-million-year-old deposit at Murgon in south-eastern Queensland. Although long known to contain the mortal remains of archaic turtles and crocodiles, no mammals of any kind had been found there – until 1986 with the discovery by Henk Godthelp and me of a single marsupial tooth, Australia's oldest by at least 25 million years. Many more shocks followed including the unexpected discovery by Sue Hand that a bat tooth in the Murgon deposit represents the world's oldest – another nail in the coffin of northern egocentricity, the previously oldest known bats having been found in North America and Europe. The North Pole of the Globe was beginning to wobble.

But it was a *totally* unexpected tooth,

found in the lab by Henk on the morning of 24 May 1991, that drove the lance deep into the last vestige of placental chauvinism – a tiny jet-black molar of the most un-marsupial-like form. Although certainty is a very rare thing in science, this tooth appears to have graced the mouth of a primitive placental, one not unlike the condylarths that started and subsequently forfeited the race with marsupials in South America.

Thus marsupials evidently dominated Australia *not* because placentals failed to reach this southland; instead Australia's ancient marsupials tested and gave the flick to these northern pretenders to the throne. Further, it is now clear that less than two million years ago, marsupials (the American Opossum) marched back into North America, trampling underfoot the indignant local placentals. Further still, with assisted passage, Australia's kangaroos have successfully invaded Europe (England and Germany), elbowing aside placental deer to tough out winters and wolves, exceeding in harshness anything tossed at them in Oz – a tit, perhaps, for the rabbit tat? And if we extend our view to plants, the mighty gums and wattles of Oz seem set to become a plague on continents such as Africa and North America.

Somewhere in these muddles of struggles, Australia's biological 'cringe' seems to be losing its point and the view that the beasts of Oz are a menagerie of competitively inferior refugees looks a tad shaky to say the least. Relative superiority of the world's creatures is not something we can usefully rank on the basis of confrontations in the bear pits of biogeographic competition. Perhaps, as a colleague of mine once suggested, the history of life is a bit like a game of roulette but one in which the rules for survival and evolutionary success are constantly changing. Winners and losers are not things you can safely bet on before the game is played out.

For those of us whose job it is to document the events in the world's biotic Olympiad, the greatest joy comes not from seeing our favourites cross the winning line, for the winning line is an ever-receding thing and new participants continually pour in from the sides. For us, the thrill is in comprehending the diversity of the participants that run these races. How dreadfully less interesting would the world be if that first ill-fated Murgon placental that crossed incisors with the first marsupials of Oz had triumphed and the bong of bouncing roos had been silenced before it was ever born. ■

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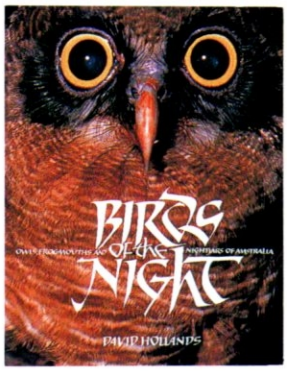
Godthelp, H., Archer, M., Cifelli, R., Hand, S.J. & Gilkeson, C.F., 1992. Earliest known Australian Tertiary mammal fauna. *Nature* 356: 514–516.

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.

REVIEWS

COMPILED BY
JENNIFER SAUNDERS



Birds of the Night

By David Hollands. Reed Books, NSW, 1991, 224pp. $49.95.

Certain groups of birds hold a particularly exhalted position among both ornithologists and people who could not otherwise be called bird-lovers; penguins, pelicans, eagles and owls are prominent among these. In the case of owls, this is due largely to their air of mystery, to which their nocturnal habits and peculiar and characteristic appearance are major contributors.

Sharing with owls the love of the night and distinctive looks, but less familiar to the public, are the nightjars, frogmouths and owlet-nightjars. More often, these nocturnal denizens are known by call rather than sight. If they are hard to see, the task of photographing them presents an even greater challenge. This challenge was taken up by David Hollands who dedicated six years to long hours, extensive distances and often tenuous periods high above the ground.

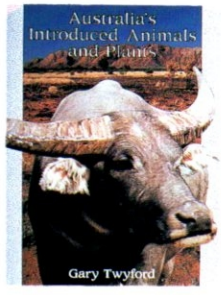
The result is a highly successful attainment of his goal and a striking addition to Australia's bird books. Hollands has followed up his previous book, *Eagles, hawks and falcons of Australia* (1984), with a study of the country's 16 owls, frogmouths and nightjars. The format is the same as his earlier work. As in that volume, the main text is not presented as a scientific treatise; rather it is a narrative of the trials and tribulations, successes and failures, encountered in pursuing this project, intertwined with Hollands' observations on his subjects. Some of the information, particularly that on behaviour, has not appeared previously. Hollands is a gifted writer, and the species accounts are delightful to read. For those readers who want more technical aspects, the last section of the book presents synopses of the 16 species, each covering appearance, voice, food, breeding, habitat and distribution.

The real success of this ambitious endeavour can be judged from Hollands' remarkable collection of photographs of these elusive birds. The compilation comprises shots of birds at rest, in flight, feeding, nesting, with young and even mating. There are many remarkable photographs, but some deserve special mention: a stroboscopic set of images of a Rufous Owl in flight; a series of a young Powerful Owl making its maiden voyage from its nest; and a Lesser Sooty Owl staring at the camera at night, its eyes reflecting blood red in the light.

For some species the pictures are among the best, if not the best, photographic representations ever obtained. The difficulties in obtaining the photographs surely excuse those few that are somewhat less than technically perfect. A greater appreciation of the hardships that had to be overcome becomes obvious in the chapter "Trees, Hides and Cameras". The methods of first finding an owl's nest and then constructing a hide sometimes 30 metres or more above the ground are explained, accompanied by photographs of some rather unenviable feats of tree climbing.

One does not have to be an obsessive owl fancier to enjoy *Birds of the night*. The photographs and writing should appeal to anyone with an interest in nature. It is a worthwhile addition to personal and institutional libraries and to Australian ornithology.

—Walter Boles
Australian Museum



Australia's Introduced Animals and Plants

By Gary Twyford. Reed Books, NSW, 1991, 128pp. $24.95.

This is a book that started with a good idea and good intentions—to provide a summary of introduced animals and plants—but somewhere along the way it went astray.

The book is subdivided into Animals, Birds, Fish, Wild Plants and Introduced Insects. Of the 14 'animals' (which include the Cane Toad), four scientific names are misspelled. Of the 13 'fish' (including the Pacific Oyster!) there are two misspellings, and the 'European Perch' and the 'Redfin' are regarded as different species. The introduced 'insects' include several snails, a virus, slugs, a tapeworm, isopods, a spider and blights; and at least seven misspellings of scientific names and one of common names. The cochineal scale insect is turned into a coreid bug, and the Buffalo Fly into a black fly.

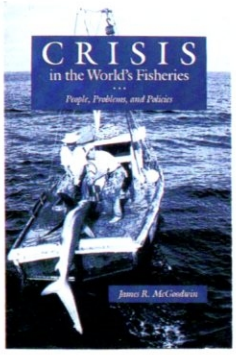
Although the author is an excellent photographer, it appears that sometimes he is unsure about what he is photographing. The Mexican Poppy is called Star Thistle, a picture of a *Dacus* fruit fly is labelled as a Medfly, the Cabbage White Butterfly is called a cabbage moth, and the picture of a native Dayflying Vine Moth caterpillar is presented next to the native adult Vine Hawk Moth (resting on exotic lantana) as if they were kin. The Canadian Pondweed could be a waterlily, but it's hard to tell, and several of the colour plates reappear elsewhere in monochrome.

Mistakes are scattered throughout the text, which consists largely of case histories that often provide no dates of introduction, or wrong ones! Twyford thinks that the Silkworm is widely established—out of doors, not in cardboard boxes—although it is known only as a domestic insect. Brook Trout, we are told, are not related to the trout but are members of the salmon family (so they are, but so are trout). The scientific name of the House Mouse, we learn, means little thief (its real meaning is simply little mouse) and we discover the dog family is the 'order' Canidae. Conservationists will be delighted that the authorities have found good use for the African Boneseed, "now widely planted to stabilise the...dunes of...beaches". And Britons will be shocked to learn that picnicking is almost impossible now in Europe because of wasps.

This is a book that started with a good idea but somewhere along the way it went astray.

There are some good bits but they are overshadowed by the many faults. You would be better off reading Eric Rolls' aging *They all ran wild* (1969). He made only one mistake that I could find, and that was a trivial one.

—Arthur Woods
University of NSW



Crisis in the World's Fisheries: People, Problems and Policies

By James R. McGoodwin. Stanford University Press, USA, 1991, 235pp. $35.00.

The living resources of the sea have traditionally been considered able to provide an endless bounty for the human population. Late last century, Thomas Huxley was even bold enough to state: "all the sea-fisheries are inexhaustible". However dramatic, and at times locally catastrophic, collapses in fisheries over the last two decades have forced a revaluation of limits inherent in the world's fish stocks.

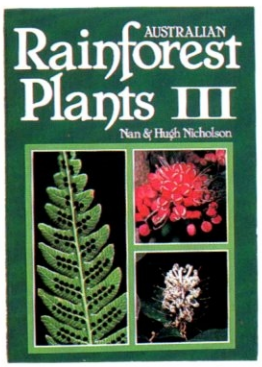
As with other resource-use industries such as agriculture, forestry and mining, the fishing industry has become 'modernised' with huge capital inputs, radical technological developments and an overt affair with distant, as opposed to local, markets. The problem with this, suggests this book, is small-scale fishers (fishing is a male-dominated industry, but McGoodwin acknowledges the important role played by women in the fishing communities by using this non-sexist term) are deprived of their local resource. The over-capitalised industrial fishers are more mobile so are less concerned about local sustainability of both the fish resource and the local community. This has often led to the collapse of the local fishing community and the fish resource.

The solutions proposed are numerous, but the addition of OSY (Optimum Social Yield) to the management paradigms of MSY (Maximum Sustainable Economic Yield) is the main recommendation. This greatly increases the complexity of any future management models, which even in their current form have failed more often than not.

This refreshing review by James McGoodwin (a maritime anthropologist) comes to similar conclusions as many low-growth-economy advocates: the market-driven economy must be radically overhauled to provide the maximum social good without sacrificing the resources available to future generations. "Many fisheries problems are merely a small but interconnected part of more pervasive problems in the world political and economic order."

This book should be read by fishery managers and students, economic rationalists and anyone interested in marine resource conservation. However, the text may be too dry and general to appeal to the author's target audience – the fishers themselves. Figures that related more directly to the text would also have improved this volume. With an increasing human population and a limit to fish resources, it is obvious we need better environmental protection and more effective fisheries management if fish are to continue to provide a significant proportion of protein. Otherwise "there is every likelihood that the world's total catch may soon begin to decline and some stocks will eventually be wiped out permanently". A dire warning for fisheries and all other resource industries.

—Tom Trnski
Australian Museum



Australian Rainforest Plants III

By Nan and Hugh Nicholson. Author, NSW, 1991, 73pp. $12.95.

Since the early 1980s there has been a steady publication of many useful and comprehensive books on Australian rainforests and rainforest plants. *Australian rainforest plants III* is the latest in a series of books by the authors that continue to make valuable contributions to the understanding and awareness of our rainforest flora. It is not, however, a duplication of the material already available but forms a complementary text to the recent publications by Alex Floyd (*Rainforest trees of mainland south-eastern Australia*, Inkata Press, 1989 and *Australian rainforests in New South Wales*, Surrey Beatty and Sons, 1990) and the earlier *Trees and shrubs in rainforests of New South Wales and southern Queensland* by J.B. Williams, G.J. Harden and W.J.F. McDonald (University of New England, 1984).

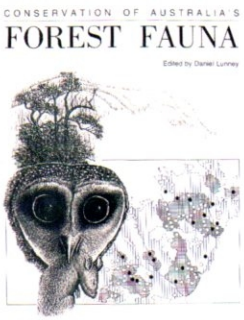
Nan and Hugh Nicholson bring a wealth of field and horticultural experience to their treatment of rainforest plants. This latest book covers 106 species of trees, shrubs, vines, orchids and herbs. Each plant is illustrated by high-quality colour photographs, allowing ready identification of most species, although such groups as the ferns require some caution.

The photographic coverage is definitely the book's most obvious strength, as the authors include many plants with very limited distributions, species that are threatened due to habitat loss, and less conspicuous species of the forest floor. The flowering of many rainforest plants is notoriously difficult to predict and the inclusion here of so many restricted species reflects many hours of patient field work by the authors.

Individual species are accompanied by descriptive texts that outline distribution, habitat, growth, characteristics and notes for cultivation. This volume also includes a very useful treatment and overview of the often synonymous terminology applied to the classification of rainforest communities. (The earlier volumes provided chapters on rainforest regeneration, gardening with rainforest plants, and invasive weeds.) An index to common names is included and, although there is none for scientific names, species are treated alphabetically by scientific name throughout the text. Where there have been recent changes in nomenclature, the synonyms are included.

This book should interest field naturalists, botanists, conservationists and horticulturalists alike. Collectively, the three volumes published to date furnish an illustrated supplement to standard botanical keys and texts published elsewhere. To the ecologist the photographs provide insight into modes of fruit dispersal and pollination in otherwise poorly known species (note, for example, the dark spotted nectar guides on the delicate *Pseuderanthemum variabile* on page 50). It is relatively easy to criticise a book but a somewhat different matter to write one, especially when confronting the complexities of rainforest ecosystems. I could find no real criticisms. The two earlier volumes, no doubt in part due to their very accessible format and photographic emphasis, provided an awareness of rainforests otherwise unavailable to many readers. I suspect *Australian rainforest plants III* will continue to provide that bridge of awareness.

— Geoff Williams
Australian Museum



Conservation of Australia's Forest Fauna

Ed. by Daniel Lunney. Surrey Beatty & Sons, NSW, 1991, 418pp. $65.00.

This volume is a special issue of *Australian Zoologist* and results from the editor of that journal, Dan Lunney, soliciting articles relevant to forest fauna conservation from a range of biologists and land managers around Australia. Together, the 34 chapters represent a significant review

of a diverse range of topics pertaining to conservation, management and research of forest fauna involving all Australian States. It will appeal to the interested public and professionals alike.

The chapters discuss, and in many instances review, such diverse topics as future scenarios for public forests that are not driven by current demands for timber and woodchips, Aboriginal archaeology in forests, the contribution of palaeontology to forest fauna conservation, new approaches to forest faunal conservation from economic theory, and computer modelling for prediction of faunal habitat and population viability. The opening chapter by Dan Lunney provides an overview of the issues covered within the book.

The numerous authors were given strict instructions to avoid jargon and write for a general audience, and they have largely succeeded. Consequently, do not be intimidated by the more than 400 pages of small print, numerous tables, graphs and maps, as they are highly readable and comprehensible.

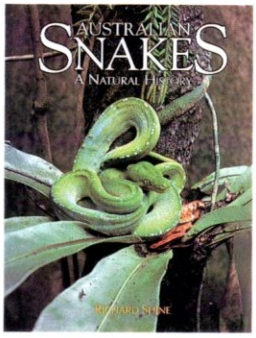
A recurrent theme throughout the book is an urgent need for more research to ensure the continued existence into the next century of the vast array of species and communities of plants and animals that comprise our forests. Unfortunately, detailed knowledge vital for informed management decisions too often does not exist. Did you realise that research on conservation of forest fauna is a comparatively new field and is only about 15 years old? There is little time left to accumulate such information due to the rapid rate at which our forests are being cleared, logged or chipped, and the small remaining areas of substantially unmodified forest. Grim stuff. The financial resources required for such research must be increased by several orders of magnitude to ensure a future for our forest fauna.

There is little time left to accumulate information due to the rapid rate at which our forests are being cleared.

We learn that forest management decisions made last decade, and during the early 1990s, will critically influence the fate of our forest ecosystems over at least the next two centuries due to the fact that natural forest cycles span a minimum of several centuries. The opportunity to conduct faunal research vital for forest management decisions is fast evaporating with each budget slash.

Within this alarming context, *Conservation of Australia's forest fauna* is a valuable review of important issues and a major contribution, at a modest price, to public discussion of the future of our national forest estate.

–J.S.



Australian Snakes: A Natural History

By Richard Shine. Reed Books, NSW, 1991, 223pp. $29.95.

In the reptilian history of Australian herpetology, all but eight of the books produced in the field have been identification guides in one form or another. These have dealt with: the ecology of reptiles in general, the general ecology of desert lizards, the ecological physiology of desert lizards, the general biology and evolution of lizards (two), keeping and husbandry (two), and seasnakes. There is now a ninth book in this group: Rick Shine's *Australian snakes: a natural history.*

Rick Shine is a Reader in Zoology at Sydney University and one of the main lines of research he and his associates have been pursuing for the past 17 years is the ecology of Australia's 175 species of snakes. Their primary focus has been on feeding and reproduction, with forays into growth, thermoregulation and behaviour as the opportunities arose. The work has made technical advances by using transmitters for tracking what is a very secretive group of animals, and it has been trend-setting by being grounded in evolutionary theory. Thanks largely to Shine's work, the ecology of Australian snakes is now probably better known than for any other region in the world, except perhaps for North America. Shine's book represents a very accessible summary of this work to date.

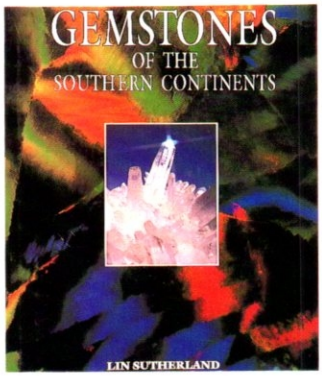
Australian snakes is pitched at a worldwide audience with a general interest in, or fascination with, snakes. It is organised into eight chapters: anatomy, evolution and taxonomy, habitats, behaviour, reproduction (two chapters), food, and snakes and people. There is also a table summarising size, mode of reproduction, number of offspring and type of prey consumed; a short glossary; a bibliography of core books and articles; and an index. The book is extremely readable and includes one of the best set of snake photographs, in terms of quality and information content, ever assembled (over 50 photographers contributed).

This book is outstanding in three areas. First, it is the only comprehensive account to date of the ecology and behaviour of Australian snakes. As such, it will be consulted for years to come by anybody, no matter what their level of knowledge, wanting a basic introduction to Australian snakes. Second, it exposes in a manner that few other books in zoology do, the way an evolutionist thinks about, and carries out, his work. In this regard it should be read by every intending young zoologist (as well as some of their older mentors). Third, the book is both readable and entertaining. The prose flows freely and concisely, and it is spiced with personal experience, wonder and the sense of 'being there' at the critical moment.

Although the book is written primarily for a general audience, the renown of its author and comprehensiveness of its subject matter means that it will be read by those with more than just a passing interest in snakes. This part of the readership will have to put up with some small frustrations. First, only common names are used in the text. This means that someone not familiar with the common name must rely on inference, or in some cases the juxtaposition of common and scientific names used in the figure captions, to be sure of the species being discussed. Second, there are no references in the text. This will be frustrating both to the beginner wanting to follow up a topic in more detail and to the more advanced student or professional wanting to know the source of an as yet apparently unpublished observation. Third, controversy is largely by-passed, either by simply alluding to it or not raising it at all. For general readers this may create a misleading impression about the tidiness of scientific knowledge and, for the young serious student, it fails to flag the areas of real current disagreement. However, these shortcomings are relatively minor and are probably worthwhile sacrifices to gain the overall benefit of accessibility and readability for a general audience.

The author states in his preface that he wanted to produce the kind of book he wanted when he was a teenager. I think he has succeeded admirably; I would certainly have liked to have had such a book when I was a teenager. However, I think the author has done much more than this. He has accomplished one of the most difficult of writing tasks, especially in such a rapidly changing subject as science: to produce a book that one will not only read first as a teenager but a book that one will read and reread throughout one's life. For a young person showing tendencies indicating an incipient scientific interest in snakes, two things can be done. If the case is mild, psychological counselling can be sought; but if the case is chronic, this book can be given as a gift.

—Allen E. Greer
Australian Museum



Gemstones of the Southern Continent

By Lin Sutherland. Reed Books, NSW, 1991, 256pp. $49.95.

Gemstones of the southern continent provides a uniquely fresh approach to the world of gemstones. It is divided into five sections of easy-to-read and understandable information, starting from an introductory section titled simply "The World of Gemstones". This section covers a number of general interest topics, including occurrences, folklore, famous gems and their owners, and some interesting and amusing anecdotes on gem finds and thefts.

The next section, "Minerals and Gemstones", describes all the physical properties of the gemstones in interesting and easy-to-understand terms. It then progresses to the enhancement of gemstones by artificial treatment, and the production of synthetic gemstones and the laboratories that exist to assist in their identification.

Complicated geological concepts are simplified so that non-geologists can understand them, yet there is enough detail included for the more advanced reader.

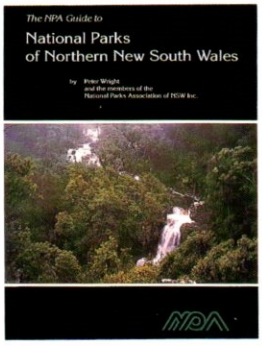
"Geology of Gemstones" takes a topic that is usually hard going to the average gemmologist and simplifies it to the extent that it makes very pleasant and clear reading. It highlights a section of geology that is often neglected by the majority of geologists and mineralogists – the world of precious gemstone deposits.

The following section, titled "The Gems", describes the gemstone species. It starts with a general description of the main features of the gemstone, the geological and geographic distribution, and then details each occurrence. If Australian deposits of importance exist for that species, these are also described in detail. Complicated geological concepts are simplified so that non-geologists can understand them quite easily, yet there is enough detail included so that the more advanced reader does not find it too superficial.

The last section lists some of the major collections of the world, and where they may be found, under the titles "Gem Spotters' Guide to the Northern Hemisphere" and "Gem Spotters' Guide to the Southern Hemisphere"– a surprising and most informative addition to an unusual and well-rounded book on gemstones.

A comprehensive "Glossary of Terms" and many beautiful colour photographs complete the book and make it a very attractive and desirable addition to the serious gemmologist's library.

–Bill', Sechos
Gem Studies Laboratory, Sydney



The National Parks Association Guide to National Parks of Northern NSW

By Peter Wright and the members of the National Parks Association of NSW Inc. National Parks Association of NSW, 1991, 341pp. $40.00.

This reasonably priced NPA guide will enhance anyone's visit to the national parks of northern New South Wales. The guide includes all national parks, State recreational areas (which are now administered by the Department of Conservation and Land Management), and a few of the more interesting nature reserves and historic sites in the northern half of the State, corresponding to the area north of a horizontal line drawn through Sydney.

The use of many people with expert local knowledge to assist in the production of this book is to be commended, and many wonderfully interesting facts are peppered throughout the book. For example, the Border Ranges area has the largest number of bird and non-flying mammal species in Australia, not a similar-sized area of tropical Queensland as I would have expected.

Each national park includes sections on landform, with a summary of the geological history and the resultant landmarks; history, including both Aboriginal use of the area and more recent white occupation, as well as the history (usually battles) for national park designation; climatic and geological influences on vegetation, including specific detail of major vegetation types and where in the respective parks these vegetation types can be found; a similar briefing on wildlife within the park featuring details of more interesting or spectacular species, including the usually neglected invertebrates and fish; details on activities suitable within the park; access points to the park; and finally the facilities available within the park. All these sections are clearly written, informative and usually an interesting read. There is also a useful appendix to the scientific names of the plant species mentioned throughout the guide as well as a reasonable, although not comprehensive, further reading list.

The biggest disappointment is the poor quality of the maps provided and the absence of any overall map showing the location of each park within the State. The maps for each park are difficult to interpret and will frustrate, rather than assist, a navigator. The expense of providing 32 colour plates of a range of scenery, animal and plant close-ups would have been better spent on improved cartography, better reproduction of the maps and perhaps maps in several colours. No-one should consider a walk without a complementary map.

Despite this one criticism, the entire text is a pleasure to read and will inspire many to find out more about our protected natural areas. I look forward to the release of the companion guide to the southern half of the State.

–Tom Trnski
Australian Museum

Just Published

January 1993
Termites of the Top End
By A. Anderson and P. Jacklyn. CSIRO Publications. Vic. $15.00.

February
In the Company of Whales
By Roger Payne. Maxwell Macmillan Publishing, NSW. $42.95.

Leaf Atlas of Australian Tropical Rain Forest Trees
By D.C. Christophel and B.P.M. Hyland. CSIRO Publications, Vic. $80.00.

Fijian Medicinal Plants
By R.C. Cambie and J. Ash. CSIRO Publications, Vic. $80.00.

March
Sharks and Rays of Australia
By P. Last and J. Stevens. CSIRO Publications, Vic. $59.95.

April
Ashton Scholastic Nature Series
Ashton Scholastic, NSW. $4.95 each.

Tours led by Aboriginal guides provide travellers with a unique opportunity to experience their culture and history.

HANDS ON CULTURE

BY CHRIS BURCHETT

DESPITE THEIR PHYSICAL absence, two brothers dominated the rock shelter we were in. Yagdjagbula (pronounced 'yug-jug-bula') and his brother Jabiringi played monumental roles in Creation, as was explained by our host Bill Harney. Bill belongs to the Wardaman people, an Aboriginal language group from the Katherine region in the Northern Territory. I was visiting Bill for a couple of days, tagging along on one of the two-day trips Bill leads through his country.

Over the previous day and a half, our group had been privy to a small slice of the detailed, encyclopaedic body of knowledge that Bill had about his homeland. We had been told of the epic tasks of the Grey Chicken Hawk who, with his cousin the Brown Chicken Hawk, had caused the salt water to retreat from the country, thus enabling all the plants, animals and people to move out across the land. Bill's intimate knowledge of traditional herbs, foods and medicines is combined with an uncanny ability to interpret the faintest animal tracks in the sand.

Other Aborigines are following a similar path to Bill's by guiding tourists through their land and explaining their culture. With increased access to land and therefore greater capacity to control tourism within these lands, they are providing travellers with a unique opportunity to learn through first-hand experience about the culture and history of Aboriginal people.

As these tours must take into account the everyday needs, lifestyles and family obligations of Aboriginal groups, many are part-time operations. Longer tours that incorporate visits to a number of Aboriginal groups are operated by touring companies, with the touring itself in the hands of the Aboriginal guides.

Herman and Mavis Malbunka, an Aranda couple from the Hermannsburg outstation, Ipolera, 180 kilometres west of Alice Springs, adopted the part-time option when they started up a short cultural tour through their country. To avoid clashes with family obligations, their day tours only operate on Mondays, Wednesdays and Fridays. Visitors are split into two groups according to sex and taken on separate walks. This division is necessary to respect the traditional division of information between the sexes: women are not permitted to discuss women's business with men and vice versa. The groups rejoin and the Malbunka's introduce their visitors to the traditional concepts of Aranda land management–including harvesting, animal tracking and the interpretation of seasonal changes in the country–living with, rather than striving against, nature.

The Tiwi people from Melville Island, near Darwin, offer yet another variation in this new style of touring. Located on the north-west tip of Melville Island, the Putjamirra Safari Camp was the concept of the local Tiwi community. They engaged a Darwin-based tour operator to provide air and ground transfers, tented accommodation and meals for a maximum of 20 visitors, while they keep responsibility for the touring.

Visitors spend one or two nights at Putjamirra–but without a structured itinerary. During their stay, activities are determined by a Tiwi interpretation of the tides, wind direction and season. Every morning guides divide the visitors into small groups, offering each the opportunity to participate in activities as varied as fishing, crabbing, collecting bush-honey, tracking animals along the broad beaches, oystering at low tide or searching the nearby mangrove swamps for crabs or shellfish. To reduce the impact of tourists, any food harvested during these foraging trips is strictly controlled and most is returned to the Tiwi community. Just enough is kept to allow the visitors a taste.

Another Tiwi group, on adjacent Bathurst island, offers travellers the opportunity to visit their community at Nguiu where they produce their distinctive crafts. As part of a day trip from

Mavis Malbunka demonstrates the grinding of mulga seeds for flour.

PHOTOS COURTESY NT TOURISM COMMISSION

Bill Harney explains the role of the two lightning brothers in the Creation.

Darwin, Tiwi Tours escorts visitors to the silk-screen workshop, pottery, clothing factory and the area where the famous Pukamani (burial poles) are carved.

On the subject of Aboriginal arts and crafts, there are many opportunities to see, compare and purchase as you travel throughout the Northern Territory. Traditional bark paintings, beautifully woven grass mats, baskets, bags and wooden carvings are features of Top End societies, while the carved wooden animals, and the watercolour, 'dot' or western desert-styled paintings of the central regions are a delight.

If you have time on your hands, you can also undergo a form of cultural immersion at the eight-day 'bush university' run by the Pitjantjatjara community at Angatja, south of Uluru. A maximum of 20 visitors learn to collect and prepare bush foods, listen to stories from the Tjukurpa (the Creation), participate and learn songs and dances of the Creation, and visit sites of religious and cultural importance. The journey includes some spectacular landscapes and, with the pace of the tour reflecting the pace of the country, there is ample time for learning about tracking, for testing yourself against the environment and generally learning about the Pitjantjatjara approach to life.

This is no whistle-stop experience: your hosts expect serious commitment to learning. By limiting departures of this tour to ten per year, the community at Angatja is able to maintain cultural and social responsibilities to the country while ensuring time spent with visitors is of high quality.

Many of these kinds of tours are designed and run at times that maximise visitor comfort and avoid breaching the hosts' social or ceremonial obligations. While Bill Harney runs his tours throughout the year, the onset of the 'wet' season (between December and April) requires that the itinerary change slightly to avoid flooded creeks. Similarly, the Putjamirra Safari camp closes down operation from November to April to avoid the monsoonal downpours. Visits to the Pitjantjatjara people's community avoid the hottest summer months, where daytime temperatures can exceed 45°C.

Such trips provide a refreshingly new approach to tourism. They allow Aborigines to combine their traditional responsibilities to the land with tourism. In turn, as visitors, we are given a way to understand the Aboriginal way of life. ■

Chris Burchett is the Manager of Aboriginal Tourism with the Northern Territory Tourist Commission. He has been working with Aboriginal communities in the Northern Territory over the past 20 years and has assisted many Aborigines with the development of their own tours.

For further information on the range of touring options, and for details about bookings, the Northern Territory Tourist Commission publishes an annual guide to Aboriginal tours, arts and crafts. It lists Aboriginal retail art centres in the Northern Territory and several annual Aboriginal-run festivals. Write to: Aboriginal Tourism in the Northern Territory, GPO Box 1155, Darwin, NT 0801 for copies of this guide.

THE DIRECTORY

QUESTIONS & ANSWERS

COMPILED BY
JENNIFER SAUNDERS

The water-holding frog *Cyclorana platycephala*.

KATHIE ATKINSON

Survival Tactics

Q. ***Is it true that certain animals can live underground in a kind of suspended animation when water is scarce, only to emerge years later during a wet spell?***

—B. Grook
Newtown, NSW

A. Yes, there are a number of animals that can do this, including certain fish, frogs, crustaceans, worms, insects and tardigrades (minute arthropods). However, not all do it in the same way. Some survive in the adult form by encasing themselves in a mud cell (e.g. the fish *Galaxias cleaveri* and the yabby *Cherax destructor)* or covering themselves in a protective skin that reduces water loss (e.g. the water-holding frogs of the genus *Cyclorana)*. Others survive as eggs or pupae, which is the case in most insects, crustaceans and some African and South American fish (e.g. *Nothobranchius* spp. and *Cynolobeius* spp.). Tardigrades are unusual in being able to survive as either eggs or adults. Many of these 'suspended animation' animals can survive years of drought and I believe the record is a tardigrade species resurrected from a herbarium moss sample 120 years old.

—Martyn Robinson
Australian Museum

Young Reds

Q. ***I have noticed that the young leaves of gum trees are red rather than green. What is the advantage of this for the young leaf?***

—Katie Flanagan
Wyong, NSW

A. Young red leaves occur on a wide range of plants, and scientists are unsure as to just why they are red. Some scientists argue that the red pigment (carotene) allows a wider range of light to be absorbed by the leaf compared with the green pigment, and this wider absorption range and subsequent increased ability to photosynthesis is useful when the plant is in its early stages of growth or recovery. Other scientists express doubt as to whether the red leaves photosynthesise at all, and it is thought simply that the leaves have not yet had a chance to form chloroplasts, which contain chlorophyll and give the leaf a green appearance. Alternatively, it could be possible that the red colour is used by the plant to deter predators—when a young plant is growing vigorously, its leaves are often soft and fleshy and attractive to predators. Red is often used to signal danger, and the plant may be indicating it contains toxins, or has the potential to produce them as a response to grazing, and should therefore not be included on the predator's menu.

—Hendrick Hazenveld
Australian Museum

SUE LINDSAY / AUSTRALIAN MUSEUM

PIC TEASER

Do you recognise this? If you think you know what it is, then send your answer to ANH Pic Teaser. Please don't forget to include your name and address. The first correct entry will win a $20 gift voucher from the Museum catalogue. Summer's Pic Teaser was an underwater close-up of the mantle of a giant clam.

Preserving Australia

Q. ***What areas in Australia are World Heritage listed? What criteria are used to select an area and how is the final decision made?***

—K. Graham
Townsville, Qld

A. There are currently nine Australian properties on the World Heritage List. These are the Great Barrier Reef, Tasmanian Wilderness, the wet tropics of Queensland, Western Australia's Shark Bay (these areas have met all four World Heritage natural criteria; see below), Kakadu National Park (stages 1 & 2), the Willandra Lakes region of

western New South Wales, Uluru National Park (these three along with the Tasmanian Wilderness are listed for both natural and cultural criteria), Australian east coast temperate and subtropical rainforest parks and the Lord Howe Island Group. At this point in time, there are also four nominations currently under consideration with the World Heritage Bureau. These nominations are Fraser Island, Kakadu National Park (renominated to include stage 3), the subantarctic Heard Island and McDonald Islands, and Macquarie Island. The latter two nominations have been deferred pending an investigation of the entire subantarctic region, currently underway.

In order to classify for World Heritage Listing, a nominated area must meet one or more of what are termed specific criteria. These criteria are quite detailed and there are four for natural heritage and six for cultural. As well as the criteria there are also a number of conditions of integrity that must also be met before an area can be listed. For example, one of the criteria for natural heritage is: the area should contain the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value still survive. The condition of integrity for this criteria is that the area containing threatened species should be of sufficient size and contain necessary requirements for the survival of the species.

The decision as to whether a nominated property is inscribed on the World Heritage List is made by the World Heritage Committee. Nominations have to be received by UNESCO by 1 October each year for assessment by the World Heritage Bureau and at the end of the following year the Committee makes a decision based on the Bureau's recommendations and evaluations from non-government organisations. Entry onto the list, however, does not guarantee an area's survival and the World Heritage Committee publishes a List of World Heritage areas in danger.

—J.S.

MARIE LOCHMAN / LOCHMAN TRANSPARENCIES

World Heritage site: the Olgas, viewed from Katatjuta lookout, in Uluru National Park.

Answers to Quiz in Quips, Quotes & Curios (page 11)

1. Bali Cattle
2. Easter Island
3. Seventeen
4. International Union for Conservation of Nature
5. Robyn Williams
6. Jonathon Poritt
7. African Elephant
8. Coconut Crab
9. Glass of terrestrial origin formed from the high-speed impact of meteorites
10. Its abnormally long toes and claws enable it to walk on lily leaves, making it look like it is 'walking on water'.

We must not be lulled into a false sense of security by the apparent commonness of tortoises at present.

HOW SECURE ARE 'COMMON' TORTOISES?

BY MICHAEL B. THOMPSON

MOST PEOPLE IN south-eastern Australia are familiar with the Common Long-necked Tortoise *(Chelodina longicollis)*, and those living near permanent water will also know the Common Short-necked Tortoise *(Emydura macquarii)*. On a summer afternoon stroll along the banks of a Murray River wetland, such as the popular tourist location of Lake Bonney in South Australia, one can often count upwards of 100 tortoises. This gives a reassuring feeling that these important wetland animals are abundant and secure.

Both Long-necked and Short-necked Tortoises nest along the Murray in November and December. At this time of year one frequently finds the remains of tortoise nests that have been destroyed by a predator. Indeed, in the 1979–80 nesting season, I calculated the predation rate on nests to be over 96 per cent. At first glance this may sound a lot but tortoises are long-lived. We don't know how long, but they may even live for a century or more. And, even though they do not reach sexual maturity for about ten years, they reproduce yearly after that. Hence they may produce a clutch every year for 90 years. Short-necked Tortoises produce on average about 18 eggs per year and Long-necks about ten. So, unless there is a massive mortality somewhere along the line, we would literally be swamped with tortoises.

The great longevity of tortoises may be masking a tragedy.

JOHN CANN

Common Short-necked Tortoise.

Recent surveys of adult tortoises in the Lower Murray show an aged adult population with very little juvenile recruitment. This is normal in natural populations of freshwater turtles in North America. However, a comparison of the size-structure of Short-necked Tortoises in the Murray with an as yet undescribed species of *Emydura* in the Copper Creek shows a startling difference. About a third to half of the Cooper population is made up of juveniles and subadults. Also, the population density is many times higher than that of their Murray River relatives. Why the difference?

A breakdown of the type of nest predator on the Murray shows that, of the 96 per cent mortality, 93 per cent consists of predation by the introduced Fox *(Vulpes vulpes)*. The other predators are Water-rats *(Hydromys chrysogaster)*, goannas (*Varanus* spp.) and Australian Ravens *(Corvus coronoides)*. These same predators occur in the Cooper Basin, but foxes are rare, kept in check by competition or predation by Dingoes. Prior to European settlement, Dingoes occurred along the Murray, so the Cooper Creek provides the best comparison we have for tortoises on the Murray. We must rely on comparisons such as this because there are no early quantitative data on tortoise populations anywhere in Australia, and nowhere in southern Australia do tortoises occur in isolation from Foxes.

In North America, where there is a large endemic mammalian fauna of nest robbers and where the turtles usually produce more than one clutch per year, high rates of predation on eggs are normal. However, once an egg hatches, that individual has a high probability of reaching sexual maturity and breeding. We have no equivalent data on survivorship of hatchlings in Australia but the Murray–Cooper differences and a lack of a large mammalian fauna of nest robbers in Australia suggest that the situation here may be different from that in North America. It suggests that Australian tortoises may have evolved under a regime of higher hatching success than turtles on other continents, and that post-hatching mortality should be higher. Possible predators on hatchlings include fish, birds and other reptiles. We have no evidence to indicate that any of these potential predators is rarer now than prior to the introduction of Foxes and, therefore, the rate of predation on baby tortoises may not have changed. What has changed is the rate of predation on nests by the introduction of Foxes.

So where does this leave our apparent high populations of adult tortoises in the Murray today? Unfortunately, we do not know whether the population is as high now as it was prior to the introduction of Foxes. But we do have a population composed almost entirely of adults and, therefore, possibly a declining population. What would happen to the Murray ecosystem if tortoises disappeared? We do not know exactly but, based on their predatory lifestyle and sheer numbers, the results are likely to be far-reaching.

Unfortunately we cannot age adult tortoises. But it may be possible that some of the present population of tortoises predates the introduction of Foxes (in the 1880s). Foxes became rare in Australia for several years in the 1950s and this may have allowed an influx of young tortoises into the population. We really do not know. What we do know is that we must not be lulled into a false sense of security by the apparent commonness of tortoises at present. Their great longevity may be masking a tragedy. We must monitor this situation very closely and, if the picture I paint here is accurate, take actions to prevent the possibility of a major ecological shift in Australia's largest river system and elsewhere. ■

Suggested Reading

Thompson, M.B., 1983. Populations of the Murray River tortoise, *Emydura* (Chelodina): the effect of egg predation by the Red Fox, *Vulpes vulpes*. *Aust. Wildl. Res.* 10: 363–371.

Dr Michael Thompson is a lecturer in animal biology at the University of Sydney. His interests include nesting biology and egg physiology in reptiles.

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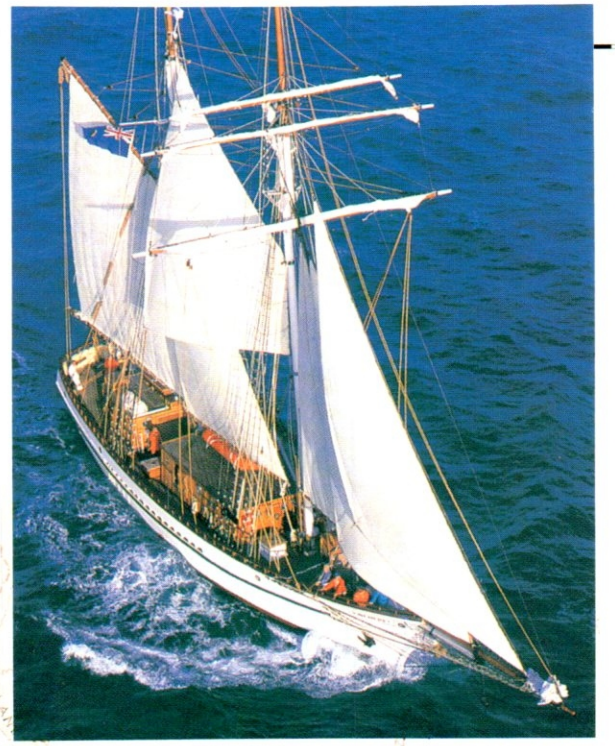

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