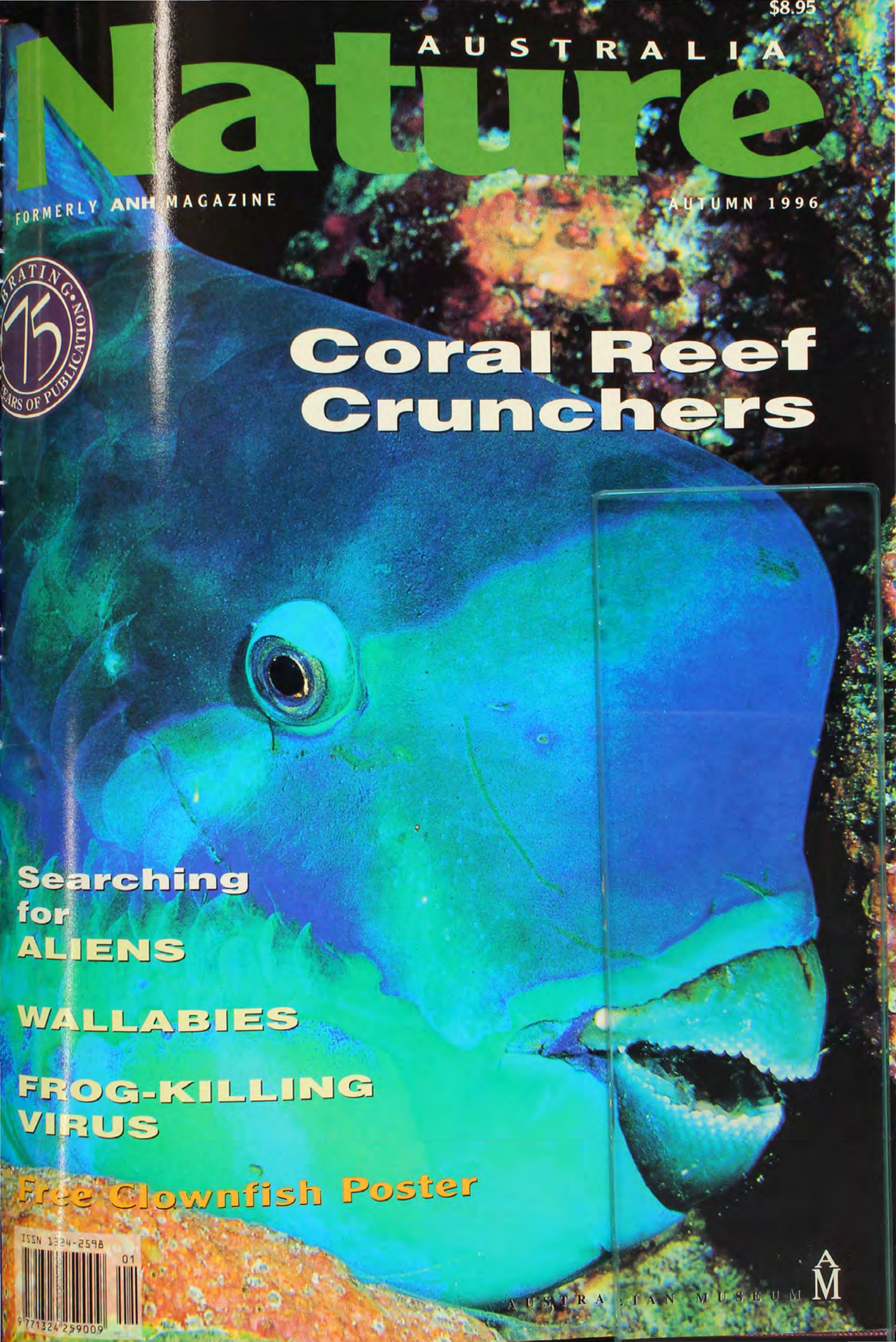
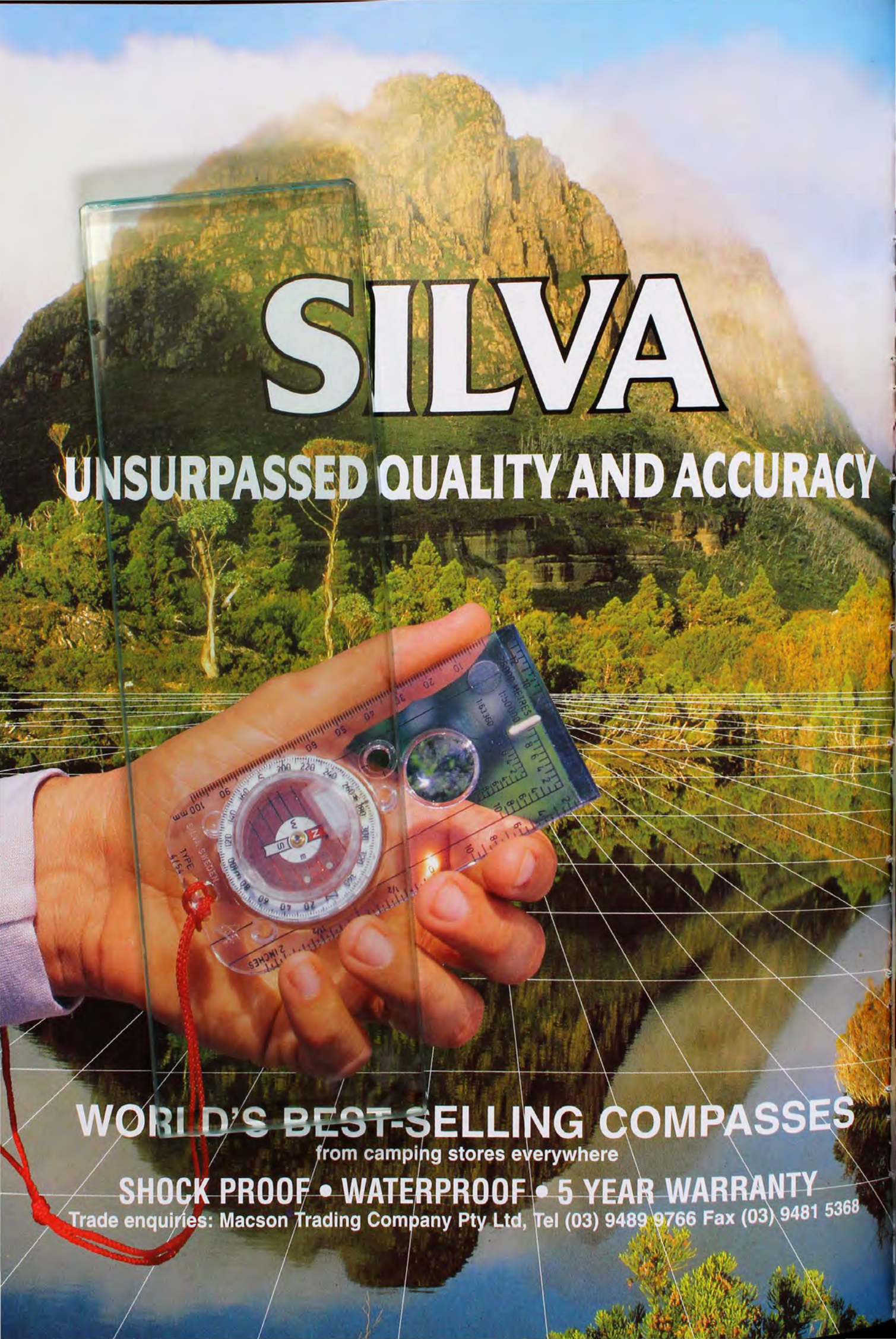

$8.95
AUSTRALIA
Nature
FORMERLY ANH MAGAZINE
AUTUMN 1996
75 YEARS OF PUBLICATION
Coral Reef Crunchers
Searching for ALIENS
WALLABIES
FROG-KILLING VIRUS
Free Clownfish Poster
ISSN 1324-2598
01
9 771324 259009
AUSTRALIAN MUSEUM
AM


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

Up Front

With this issue we discovered just how difficult it can be to find underwater photos that are technically good, graphically interesting and accurate representations of the animals. It all began last June when our Photo Researcher, Kate Lowe, and I were invited to be on the judging panel for the 1995 Australasian Underwater Photographer of the Year Competition. We knew we had a parrotfish article coming up and so we were keen to see what was available. We needed several good images for the article and we hoped that we might also come across that elusive cover shot.

COLLARD/THE BLUE WATER CO.

Bumphead Parrotfish.

Sitting in a pitch-black room judging images as they are constantly flashed up on a screen is not as easy as you may think, but it was fun, and it did give us a good idea of what was, or in this case wasn't, available when it came to parrotfish. However, after talking to a number of the photographers, we did learn one valuable piece of information—parrotfish have attitude and as a result are extremely difficult to photograph! Things were not looking good and it required quite a wide and concentrated search to come up with a possible selection to illustrate the article. Polaroids were made and sent to our author, Dr David Bellwood, for checking. But no good, came the reply. Apparently, parrotfish are often photographed dead or asleep because of their difficult nature. So, as time ran out, the hunt for photos—this time of live and awake parrotfish—continued. Phone calls were made and faxes sent far and wide until finally we had the selection you see today. A selection that is representative enough to please our expert author, yet colourful and interesting enough to please us. This, along with a spectacular photoart and poster that celebrate the finalists from another well-respected underwater photographic competition, Seven Seas, gives this issue a decidedly marine feel.

DENSEY CLYNE

The stick-insect *Didymuria violescens*.

Keep on reading and you will also enter the bizarre world of stick-insects, become part of Project Phoenix and explore the stars for extraterrestrial intelligence, debate the validity of the anti-cat campaign with Tim Low, and meet crocodiles you thought only existed in your worst nightmares. And to top it all off we take a look at what might be causing the sudden extinction of a wide variety of frog species in supposedly pristine mountainous areas of Queensland.

If you are interested in frogs, and in Sydney between March and August of this year, then I recommend that you visit "Frogs", the frog exhibition at the Australian Museum. Covering many aspects of frog biology, biodiversity and ecology, it is a valuable, timely and entertaining exhibition.

—Jennifer Saunders

Nature AUSTRALIA

AUTUMN 1996 VOLUME 25 NUMBER 4

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

EDITOR
Jennifer Saunders, B.Sc.

SCIENTIFIC EDITOR
Georgina Hickey, B.Sc.

PHOTO RESEARCHER
Kate Lowe

DESIGN AND PRODUCTION
Watch This! Design

PRINTING
Excel Printing Company

MARKETING AND SALES
Phone: (02) 320 6331

ADVERTISING
Sari Järvenpää
Phone: (02) 320 6179

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

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

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

Published 1996
ISSN–1324–2598

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

Front Cover

A large Steephead Parrotfish (*Chlorurus microrhinos*) showing the characteristic hump on the head. The highly modified jaws crack rather than scrape the algal-covered coralline rock on which they feed. Photo by Kevin Deacon.

CONTENTS

Articles

WALLABIES ON THE ROCKS?
With hind feet like off-road tyres, rock-wallabies are perfectly adapted to the treacherous terrain of their rocky habitat. But, despite their unique specialisations, rock-wallabies are still finding survival an uphill battle.

BY ANDY SHARP
24

CORAL REEF CRUNCHERS
They sleep in a mucous sac, have very particular toilet requirements, can change colour and sex, and are crucial to the survival of the Great Barrier Reef.

BY DAVID BELLWOOD
48

WHEN AN INSECT IS MORE LIKE A PLANT
Not only do stick-insects look like plants, but some behave like them as well. Lesley Hughes looks at how both stick-insects and plants can exploit the burial services of ants.

BY LESLEY HUGHES
30

IS ANYBODY OUT THERE?
Do you believe in the existence of little green men? Project Phoenix has the Parkes radio telescope trained on the southern skies in an attempt to answer once and for all whether we are all alone.

GEOFF McNAMARA
40

WHY ARE QUEENSLAND'S FROGS CROAKING?
They live in seemingly undisturbed pristine habitats far from the ravages of humanity. So why are they dying? Could an exotic virus be on the loose?

BY WILLIAM F. LAURANCE
56

Regular Features

THE BACKYARD NATURALIST

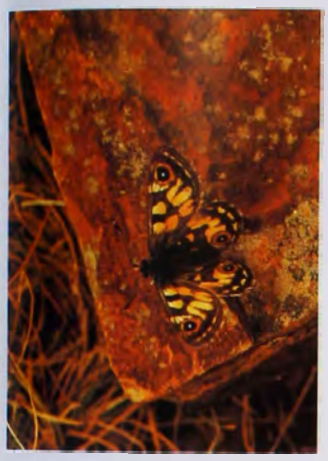
SPARROWS: THE LAST STRAW

The 1863 mail order to England from the Acclimatization Society of Victoria requested 80 Hedge Sparrows be sent over for release in Australia. Unfortunately, somebody in the dispatch section got their hedges and houses mixed up!

BY STEVE VAN DYCK

18

RARE & ENDANGERED



PTUNARRA BROWN BUTTERFLY

This is a story about farmers, conservationists, the timber industry and a little orange and brown butterfly. Does cooperation lead to a happy ending?

BY MARK NEYLAND

20

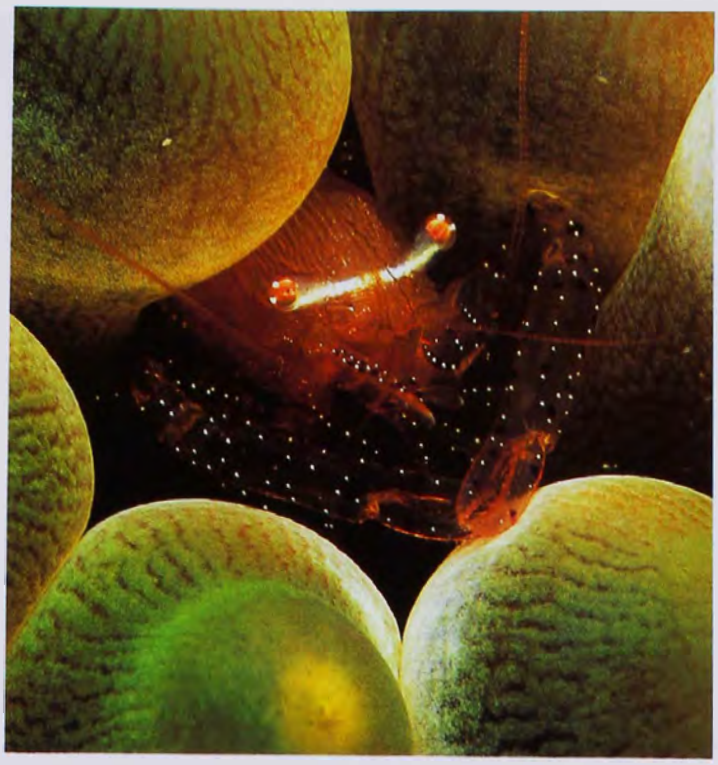
WILD FOODS

THE CASSOWARY'S LAST MEAL

Plants bearing large succulent fruits in southern Queensland may well be a sign that cassowaries once lived there.

BY TIM LOW

22



PHOTOART

SEVEN SEAS

A selection of spectacular images from a competition of underwater photography known as Seven Seas.

64

VIEWS FROM THE FOURTH DIMENSION

CROCODILE DINNERS AND DINERS

Mike Archer gives an account of the diverse lifestyles of our ancient crocodiles and how mammals like us may have always featured heavily on the menu.

BY MICHAEL ARCHER

70

THE LAST WORD

CATS: SCOUNDRELS OR SCAPEGOATS?

Has our obsession with the anti-cat campaign blinded us to the real reasons why many of our wildlife species are now threatened or extinct?

BY TIM LOW

80

REVIEWS

Caring for Possums; The Rise of Fishes; It's a Frog's Life; Spotlight on Spiders; A Field Manual for the Amateur Geologist; Plants of the Perth Coast and Islands.

72

Columns

LETTERS

A Prickly Mistake; Singing Willies; The Devil's Drink; K–T Anomalies.

4

NATURE STRIPS

Hippo Leech; When a Little is Enough; Frills with Chills?; Vibrating Ants; Two Dinosaur Heads Are Better than One; Ford Pill from the Forest; A Relationship Made in Heaven; Poison Prey Makes Poison Frogs; Crazy Cats?; Square Eyes and Hairy Legs; Lions Spot the Difference; Burying Badger Mythology; Quick Quiz; Cinderellas of the Bird World.

6

SOCIETY PAGE

Interested in nature but not sure what to do or where to go? Nature Australia's *Society Page is a great place to start.*

74

THE GUIDE

Nature Australia's *market place.*

76

Q & A

Avian Pox; Pic Teaser; Toxic Toadfish for Dinner; Plants versus *Pests.*

78

LETTERS

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

A Prickly Mistake

May I draw your attention to the supposed photo of the Norfolk Island Hibiscus on page 58 of the Winter 1995 issue. It is not *Lagunaria patersonia* but the endangered (in the wild) Philip Island Hibiscus (*Hibiscus insularis*) and itself the object of a good deal of research sponsored by WWF. The Norfolk Island Hibiscus (once called Cow Itch Tree) has indeed a bad name for the discomfort its seed pods can cause, although it has never bothered me. The specimens of Philip Island Hibiscus we've grown in our garden produced very few seeds, so I'm not in a position to describe problems from them; but it would be a shame if this charming and rather unappreciated species got a bad reputation from your photo. The Norfolk Island Hibiscus is quite a large tree with pale pink camellia-like flowers in late spring/early summer whereas the Philip Island Hibiscus flowers in mid winter.

—Rosemary Opala
Victoria Point, Qld

Singing Willies

Why do Willie Wagtails sing at night? On asking fellow naturalists and biologists this simple question, I have received penetrating answers like "They're practising", or "They like it", "Why not?", "Because they're noisy little buggers", or "I wish they wouldn't". Two recent studies, one on Willie Wagtail (*Rhipidura leucophrys*) breeding biology and another on the dawn chorus in eucalypt forests, suggest that, early in the breeding season and until young are in the nest, the birds' nocturnal calling is most intense just before sunrise. But these studies were not designed to address all the questions we may ask. I suggest the following observations and questions make the matter worthy of study.

Over the years in early to mid summer, which certainly seems to be when the birds call mostly at night, I have noticed intervals of approximately ten seconds between each burst of the 'sweet pretty little creature' call. This can go on for periods of several minutes. The pattern has been the same in Adelaide, Atherton, Brisbane and Longreach. Why such regularity? (Why not?, we may also ask.) Do one or both members of a pair call? Do they call from the same roost each night? Why would a bird repeatedly advertise its presence at one or more spots for much of the night, especially if nocturnal predators are around? Might the calling advise other Willie Wagtails where an important, focal part of the singing bird's territory is located? Is the singing involved in mate location and pair bonding? Why not do all this in the daytime? Does the singing just before sunrise, when other species are also calling in the dawn chorus, have the same function as that earlier in the night when no other species are calling?

Willie Wagtails belong to the genus *Rhipidura*. This includes several species that are migratory at night, presumably calling as they travel. (Here I note that the migratory Fan-tailed Cuckoo, *Cacomantis flabelliformis*, is another good example of a diurnal bird that sings at night and about which we might ask similar questions.) Could Willie Wagtails have inherited from their ancestors a tendency to call at night and, while not now migratory, have evolved an alternative use for nocturnal calling? Perhaps relevant here is that a light source may be a stimulus for the birds to call. After talking to other people and considering my own limited observations, it seems that the birds do start calling around the time the moon appears and that a bright light left on outside all night might also be a stimulus.

So, why do Willie Wagtails sing at night? They are certainly not the only diurnal birds to do this but I suggest that this question is a fine example of how little we know about one of our most common birds.

—Leo Joseph
Montevideo, Uruguay

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

The real Norfolk Island Hibiscus.

The Devil's Drink

Your Autumn 1995 issue carried a report by Rachel Sullivan on the Thorny Devil, in which two independent researchers are cited as having reported that the capillary forces in the Thorny Devil's skin are enough to absorb water from a damp substrate.

My first encounter with a Thorny Devil was in 1950 on a visit to the Alice Springs district. The Aboriginal people of the area brought me a Thorny Devil and, when I asked questions about it, I was told they "drank by absorbing water through their skin". A dish was produced and a small amount of free water placed in it onto which the Thorny Devil was placed. Sure enough, within a short time tiny beads of mois-

REG MORRISON/AUSCAPE INTERNATIONAL

One of the ways in which Thorny Devils drink is by absorbing water through their skin.

ture appeared on the Devil's skin.

It would seem from conversations and observations made on numerous visits to the inland that this is the creature's primary way of gaining moisture, and the channelling of water from rain to its mouth is very much a secondary consideration—especially considering the fact that there may be very long intervals between showers.

It is also interesting to note the increase in numbers of Thorny Devils throughout the camping areas at Ayers Rock, and I wonder whether the invasion of people to an area that was once relatively unpeopled has benefited this endearing little lizard (which would be an interesting reversal of human intrusion on wildlife).

—Jean Whitla
Wodonga, Vic.

K–T Anomalies

Thankyou for the article "The Cosmic Shooting Gallery" by Geoff McNamara, which appeared in your Autumn 1995 issue. As a geologist who has, in the past, drilled for oil on presumed early Cretaceous impact structures in the Eromanga Basin of south-western Queensland, I am well aware that impacts of extraterrestrial objects on the Earth are a relatively common-place occurrence, geologically speaking. Your excellent article illustrates the frequency and inevitability of such strikes.

However, I wish to draw your attention to a statement made in the article concerning the supposed Yucatan Crater and its relationships to the terminal Cretaceous–Tertiary (K–T) event. Other authors have previously pointed out that the iridium anomaly at the K–T boundary is not one isolated horizon, but actually three. Iridium was apparently present in the open ocean during the latest Maastrichtian to earliest Danian (that is, over the K–T boundary) but concentrated only during periods of sea-level rise (transgression) when there was little input of land-derived sediment into the oceans. Thus, while iridium may have been introduced into the oceans via an impact of an extraterrestrial object, it was probably present before the supposed terminal Cretaceous event at the Braggs K–T boundary locality in Alabama (incidentally not very far, geographically speaking, from the supposed Yucatan impact). Concentration of iridium in sediments over the K–T boundary is not, therefore, the result of a sudden introduction of the elements to the Earth by an asteroid/comet at the K–T boundary, but at a somewhat earlier time. Similar conclusions can be drawn about the Frasnian/Famennian (Devonian) iridium anomaly, which is also associated with sediment starvation and sea-level change.

In regard to the mass extinction of dinosaurs at the K–T boundary, Clemens (1982) pointed out that "Terminal Cretaceous extinctions within the terrestrial biota appear to have occurred over a geologically short but biologically lengthy period and to be the results of multiple, interrelated changes in physical and biological factors". Research published subsequently, some of it reported in this magazine, suggests that some dinosaurs lived in near-polar climates and would be suited to survive any nuclear winter produced by impact. Some palaeontologists even speculate dinosaur communities survived the K–T event by as much as 500,000 years and were only killed off by climatic changes.

Consequently, I question McNamara's statement that the impact hypothesis "has been widely accepted", especially as the cause of dinosaur extinctions. I do not doubt that impacts have occurred, even near the K–T boundary, but question whether any have been large enough to cause selective extinction of major animal groups. The sequence of events at or near the Permo-Triassic boundary, involving massive impact and/or major volcanic activity, leading to the largest extinction event yet known in the fossil record, may be another story.

—John D. Gorter
Claremont, WA

NATURE AUSTRALIA **welcomes letters for publication and requests that they be limited to 250 words and typed if possible. Please supply a daytime telephone number and type or print your name and address clearly on the letter. The best letter in each issue will receive a $20.00 gift voucher from the Museum Shop Book Catalogue. The winner this issue is John D. Gorter.**

Nature Strips

COMPILED BY GEORGINA HICKEY

Hippo Leech

Any bushwalker will tell you that blood-sucking leeches aren't too fussy about where their next meal comes from. Indeed, until recently no leech was known to be specific to one mammalian host. However, having studied *Placobdelloides jaegerskioeldi*, a little-known leech in the family Glossiphoniidae that is found on Hippopotamuses, biologists Jan Oosthuizen from the University of Pretoria and Ronald Davies from the University of Calgary believe that these leeches have eyes only for Hippos.

A search for potential hosts (including amphibians, turtles, fish and crocodiles) failed to locate leeches and, in the laboratory, the leeches refused to feed on any of the animals presented to them. More importantly, though, they exhibit a number of anatomical, feeding, locomotory and reproductive features that make them superbly adapted to Hippo lifestyle. They occur only where the Hippo's hide is thin enough for the leech's proboscis to penetrate, and where the leech is protected from dislodgment. As it happens, an ideal spot is in the Hippo's rectum.

Hippos live in fast-flowing rivers, and to reach their hosts the leech must swim. Swimming is rare among glossiphoniid leeches, which usually move by inchworm crawling, and only mature 'Hippo Leeches' are able to do both.

Young leeches are carried to the Hippo's rectum by the parent and remain there until they reach sexual maturity. As the adult enters the rectum, its passage is aided by retractable 'teeth' covering its body, helping to provide traction on the smooth rectal wall. Leeches are hermaphrodites (that is, they contain both male and female sex organs), and they use the rectum as a kind of 'meeting place' where they exchange spermatophores with one another. They then exit carefully and remain on the sandy river bed until another Hippo comes along.

—R.S.

When a Little is Enough

Most bird-pollinated flowers attract their benefactors with copious supplies of sweet nectar. But a rare and widely dispersed Puerto Rican orchid (*Comparettia falcata*) does quite the opposite—it only provides the hummingbirds that come to sup at its flowers with four microlitres (four millionths of a litre) of nectar, a third of the average of other food plants and, what's more, the nectar is only half as sweet.

INTERNATIONAL PHOTOGRAPHIC LIBRARY

Hipppos are the only known hosts of a particular species of leech.

James Ackerman and his co-workers at the University of Puerto Rico in San Juan have come up with an explanation for this apparent stinginess. The orchid in question is pollinated by a common hummingbird, the Puerto Rican Emerald (*Chlorostilbon maugaeus*). By providing the bird with only a meagre supply of nectar, the orchid discourages it and other species from establishing territories where there may only be one plant of that species, instead forcing it to forage widely.

Even though the bird may visit other flower species with more nectar, the package of pollen (pollinium) that it picks up from the orchid retains its power of fertilisation for several days. Hopefully during that time the bird will stop at another *Comparettia* flower and pass on the pollinium.

—G.T.

Frills with Chills?

Some time ago people noticed that Frilled Lizards (*Chlamydosaurus kingii*) disappear during the dry season. But no-one knew where they went or why they went there. Keith Christian and Gavin Bedford of the Northern Territory University and Brian Green of CSIRO have found the answer to one of the questions and gone some of the way to answering the other.

Christian and Bedford attached radio-transmitters to Frilled Lizards in savanna woodland near Darwin and followed them to see where they went. They found that the lizards didn't go anywhere new; they just spent most of the dry season perching high up in the canopies of the same gum trees they were on in the wet season.

Although this answer wasn't particularly interesting, the implications were. The lizards were apparently æstivating (like hibernating, only in hot weather rather than cold) but animals usually æstivate underground, away from the heat and surrounded by relatively moist air, and are completely inactive. Such conditions help them to lower their metabolic rates so they use up their energy stores less quickly. Frilled Lizards, in their exposed sites, must therefore be using some other mechanism to survive the dry season.

By measuring the metabolic rates and body temperatures of Frilled Lizards in the wild, Christian and co-workers found that both were considerably lower in the dry season, with metabolic rates being only 28 per cent of wet-season levels. The lizards managed to keep their body temperatures (and thus metabolic rates) down by basking less frequently than they did in the wet. They were observed shifting around the trunk of the tree to keep in the shade. As to why the lizards reduced their activity during the dry season, Christian and Green believe it is in response to the lower levels of insect prey and water that are available to them at this time of year.

—G.T.

T. KEATING/WILDLIGHT

Frilled Lizards are active during the wet season but slow down during the dry.

Vibrating Ants

They're the Agent Orange of the insect world. The defoliating feats of leaf-cutting ants are the stuff of legend, a colony capable of reducing a patch of lush rainforest to a stand of naked stalks. The leaf fragments are carried in jiggling lines to be fed to a huge underground symbiotic fungus.

It's been known for some time that leaf-cutting ants move their gaster (the swollen part of the abdomen) up and down as they are cutting, producing high-frequency vibrations that are conducted through their legs and

AUSTRALIAN PICTURE LIBRARY/MINDEN PICTURES

By vibrating their mandibles, leaf-cutting is made easier for leaf-cutting ants.

mandibles and into the leaf. These vibrations or stridulations attract nest mates to the cutting site. But it seems they have an even more bizarre function.

Jürgen Tautz and his colleagues at the Theodor Boveri Institut in Germany have discovered that the stridulations are synchronised with movements of the ants' powerful mandibles. They found that these complex vibrations make the mandibles act like a special machine called a vibratome, used to cut very thin sections of soft material. The vibrations of a vibratome's cutting knife stiffen the soft material and permit a smoother, easier cut to be made. A similar process occurs when a single-bladed electric knife is used to cut fresh bread.

Indeed, when Tautz and his colleagues performed experiments using isolated mandibles attached to a special vibrator and force meter, they found that the vibrated mandibles cut the leaves much more smoothly and efficiently. The effect was especially evident when tender leaves were cut, which ties in nicely with the observation that 70 per cent of leaf-cutting ants stridulate when cutting tender leaves compared to 40 per cent of ants cutting tough leaves.

—G.T.

Two Dinosaur Heads Are Better than One

Some animals have evolved to look like other animals or even plants, thereby reducing predator pressure. More often, non-vital body parts like wing tips or tails seem to imitate crucial organs such as the eyes or head, in an apparent ruse to confuse would-be attackers. Such biological notions of mimicry have attracted scientific controversy for well over a century. So, when Queensland University palaeontologist Tony Thulborn coupled the concept with dinosaurs, he anticipated scepticism.

Nevertheless, Thulborn believes that mimicry is a plausible explanation for the weird appearance of the tails of some ankylosaurid dinosaurs. These were large armoured reptiles that carried bony clubs at the ends of their 1.5-metre-long tails. It has commonly been thought that the primary function of these prominent outgrowths was as weapons that could be swept sideways to strike at the ankles of predators.

But Thulborn argues that the tail was too short and inflexible to be effective for this purpose. He believes instead that the club could have been a dummy head, intended to draw attackers away from the real location of the brain, eyes and vital arteries of the neck. Coupled with the fact that the head and neck of ankylosaurid dinosaurs were already relatively inconspicuous (compared with most of the other dinosaur groups), it is not hard to imagine how such a diversion would work. Experiments suggest that many predators, particularly birds and mammals, innately

Far North Queensland
A Bird Watching Experience.

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

BIRD SPECIES

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

#Denotes seasonal visitor.

Day 1

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

Day 2

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

Day 3

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

Day 4

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

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

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

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

Holidays with a Difference

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

FROM P&O RESORTS

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

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

The trip to Cape Tribulation features spectacular scenery.

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

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

Please send me your free colour brochure.

Name: _____

Address: _____

_____

_____ P/Code: _____

POS 0950

Send to: GPO Box 5287
Sydney NSW 2001

P&O Resort Holidays

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

SILKY OAKS LODGE

The Daintree's ultimate rainforest resort.

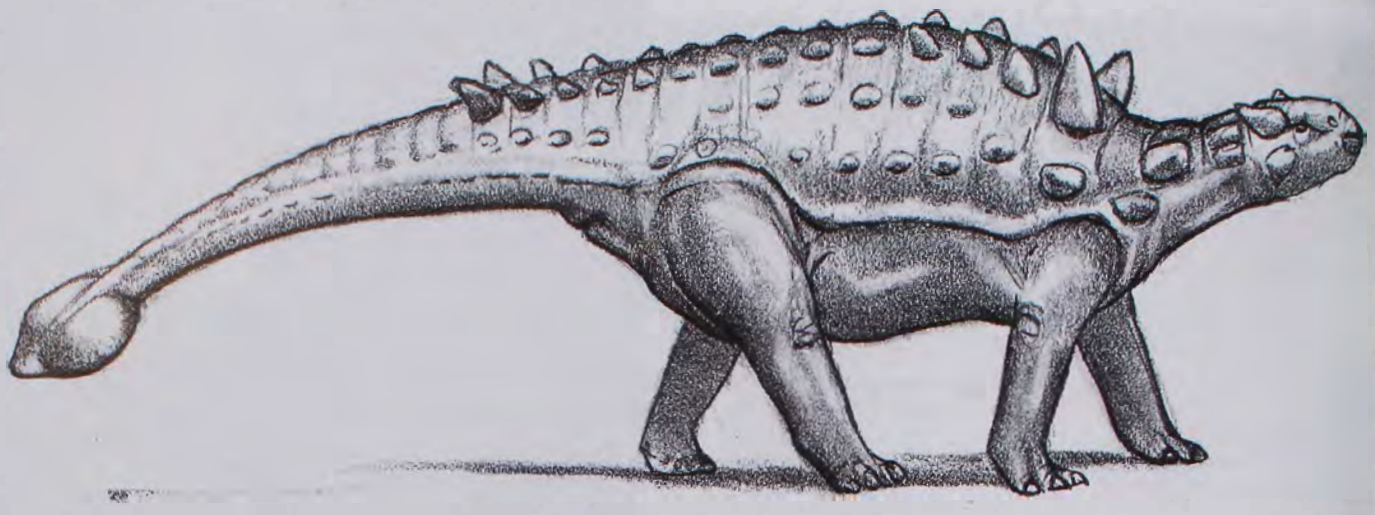


ILLUSTRATION BY PETER SCHOUTEN

Ankylosaurid dinosaurs had a bony club at the end of their tail. This may have acted as a dummy head, luring attackers away from their real head.

target the most obvious constriction of their prey, namely the neck, when they attack.

Even if its primary function was deception, the ankylosaurid tail club may still have had a role as a weapon. By moving the club around to simulate the escape movements characteristic of an animal's head and neck, argues Thulborn, it may have drawn attackers into close range for a more effective strike than if it were merely waved around indiscriminately at the ankles of predators.

Few examples of mimicry have been described in vertebrates and this is thought to be the first time that the concept has been applied to dinosaurs.

—K.McG.

Ford Pill from the Forest

Seeds of a Costa Rican shrub (*Witheringia solanacea*) get a head start in life by being born from fruit that contain laxatives. This is the first time a chemical in fruit has been found that increases the rate at which seeds pass through a predator's gut—a unique situation where a plant exploits consumer physiology, rather than behaviour.

Grey Murray and colleagues from Hope College, Michigan, discovered the laxative effect when they fed artificial fruits to Black-faced Solitaires (*Myadestes melanops*), the plant's main dispersal agent. When combined with the fruit extract, the seeds spent less time in the bird's gut than when fed without it, implying that one or more chemicals in the fruit's juice literally helps the seeds through—like a 'Ford Pill' from the forest. By experimenting with artificial fruits (as opposed to real fruit pulp), the researchers were able to narrow the laxative effect to the juice, ruling out other fruit components, like fibre.

For many plants, dispersal of seeds reduces competition with the parent plant for nutrients and light. This is especially important for *W. solanacea* because it is a 'pioneer' plant that grows in gaps in the forest. However, a laxative fruit seems contrary to the idea of dispersal. If seeds don't spend long in a predator's gut, they won't be carried far from the parent plant. So why the laxative?

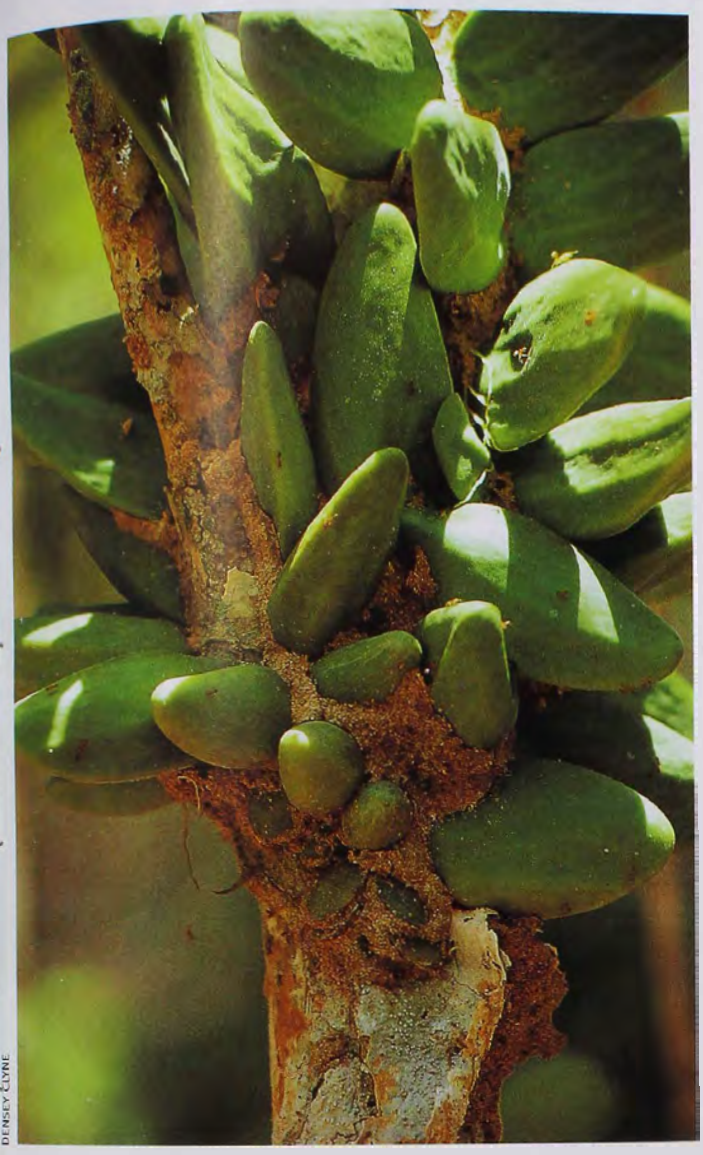
Further experiments by the researchers showed that *W. solanacea* seeds that had been in the gut of a Black-faced Solitaire germinated better, when planted, than uneaten seeds. But as the length of time in the gut increased, the germination rate decreased dramatically. Presumably rapid passing in the gut results in only mild abrasion of the seed coat, which may facilitate water uptake. Too much abrasion, however, may damage seeds.

So, there is some advantage for seeds to be in the bird's gut, but not for too long. Hence the need for a laxative.

—C.B.

THE PHOTO LIBRARY-SYDNEY/JOHN DUNNING

The Black-faced Solitaire is the main dispersal agent of a Costa Rican shrub, whose fruits contain a laxative juice.



DENSEY CLYNE

The epiphytic plant *Dischidia major* has special enlarged leaves that are home to ants.

A Relationship Made in Heaven

Hidden high in the tree-tops of a Malaysian rainforest is a surprising relationship between ants and plants. Kathleen Treseder from the University of Utah and colleagues have examined this relationship and, for the first time, quantified the benefits of an ant–plant mutualism.

The rainforests in Bako National Park, Sarawak, grow on sandstone hills with poor soils. High on the tree trunks, where the sunlight reaches, grow plants called epiphytes. One epiphyte species, *Dischidia major*, has special 'ant leaves' that are home to ants of the genus *Philidris*. The ant leaves are small sacs, each like a one-room flat with a small opening that allows the ants to come and go.

Like all tenants, the ants accumulate a fair bit of rubbish. Dead ants, leftovers from past meals, and waste products build up inside the cavity over time. The epiphyte sends tiny roots into it to absorb nitrogen. The researchers used isotopes to learn that the plant gets a substantial 29 per cent of its nitrogen this way. Other epiphytes must obtain all their nitrogen from rainwater that falls on the plant (rain absorbs nitrogen-containing gases as it falls through the atmosphere).

Likewise, they found that 39 per cent of the plant's carbon is obtained from the carbon dioxide the ants exhale inside the leaf cavities (the rest is obtained from the atmosphere). By absorbing this carbon dioxide, water loss from the leaves via the stomata is also reduced. Water is precious to epiphytes because, living on tree trunks, they can't get water from the soil.

By assisting the epiphytes to capture two limiting resources, carbon and nitrogen, the ants help them gain an edge over other epiphyte species in a difficult environment. And the epiphytes provide shelter for the ants—surely a relationship made in heaven.

—C.B.

Crazy Cats?

Does this sound familiar: your cat rolls on her back in a friendly looking way but when you try to pat her, she goes crazy and tries to bite and scratch you? Some confused cat owners have attributed this behaviour to feline moodiness. However, recent research suggests that

Poison Prey Makes Poison Frogs

Adorned in vibrant colours of red, black, yellow, green, maroon and even blue, the skin of the tiny poison-dart frogs (family Dendrobatidae) produces some of the world's deadliest toxins.

Poison-dart frogs live in leaf litter on the floors of Central and South American rainforests. For centuries, the indigenous people of western Colombia have caught the most toxic species, roasting them and collecting the poison that drips from their skin to lace their blow darts. So potent are the alkaloid secretions exuded by skin glands from these small and vivid amphibians that just one ten-thousandth of a gram is enough to kill an adult human.

When raised in captivity on crickets and fruit flies, however, these frogs were found to lack toxicity, suggesting that the source of their poison may be in their diet. A research team led by John Daly (National Institutes of Health in Maryland, USA) and A. Stanley Rand (Smithsonian Tropical Research Institute in Panama) investigated the theory using *Dendrobates aurates*. Under controlled conditions they raised adults from tadpoles. Some were fed exclusively on fruit flies and others solely on leaf-litter arthropods that were collected from a Panamanian rainforest in which a population of the frogs occurred.

Fruit flies do not contain alkaloids, but leaf-litter arthropods such as beetles, ants and millipedes do. Analysis of the frog skins after seven months revealed that alkaloids were absent in those raised on fruit flies. In the other group, alkaloids were found in large quantities and were of the same types isolated from their forest floor prey items. But the more toxic alkaloids were still missing and the dietary source of such unique alkaloids remains a mystery.

—K.McG.

GEORGE GRALL/NATIONAL AQUARIUM IN BALTIMORE, COURTESY JACK COVER

The poison-dart frog *Dendrobates auratus*.

BRETT GREGORY

Time for a tummy rub, or a sign of submission?

the problem is ours. We humans are miscommunicating with our cats.

A cat lying still on its back, paws raised, abdomen exposed, may be showing submission, not inviting a tummy rub. This discovery was made by Hilary Feldman, an animal behaviourist from the University of California at Berkeley, after observing a group of semi-feral cats near an English farm. Her work helps dispel the idea that cats are solitary animals with no social mechanisms.

Feldman observed that cats in the group usually rolled in front of another cat, rather than on their own. The cats rolled for two main reasons: as a sign of readiness to mate in the case of opposite sex pairs, and as a sign of submission in the case of same sex pairs. The most common situation was younger male cats rolling to older males. Older males didn't attack cats that rolled in front of them but they did attack 'non-rollers'. Feldman concluded that, here, rolling is a submissive behaviour intended to avoid a fight.

Away from human habitation there is seldom enough food to support a group like the one Feldman observed, so cats are often forced to be solitary. This is possibly why we've missed seeing such behaviour in the wild before. But by understanding our cats' social behaviour, we should improve our interspecies communication skills and hopefully get fewer bites and scratches.

—C.B.

Square Eyes and Hairy Legs

To the human eye, the ways in which most bird and mammal species recognise prospective mates are obvious. But in animals with different visual capabilities, small nervous systems and a limited capacity for learning, such as spiders, the cues used to discriminate between similar looking species are more elusive.

George Uetz and colleagues at the University of Cincinnati were interested in exploring the observation that female wolf spiders (in particular *Schizocosa ocreata*) were more likely to mate with males with large tufts of bristles on the forelegs than those with small tufts. As explained at the Animal Behavior Society meeting held in Seattle in July 1994, the researchers tried, with mixed success, to experimentally alter the hairiness of spider legs by shaving, by applying paint or mascara, and by gluing on fuzzy material. They finally turned to video imaging, presenting females with televised pictures of a courting male with the appearance of his legs manipulated. Females were more receptive to images with natural-sized or enhanced tufts than those with bristles removed.

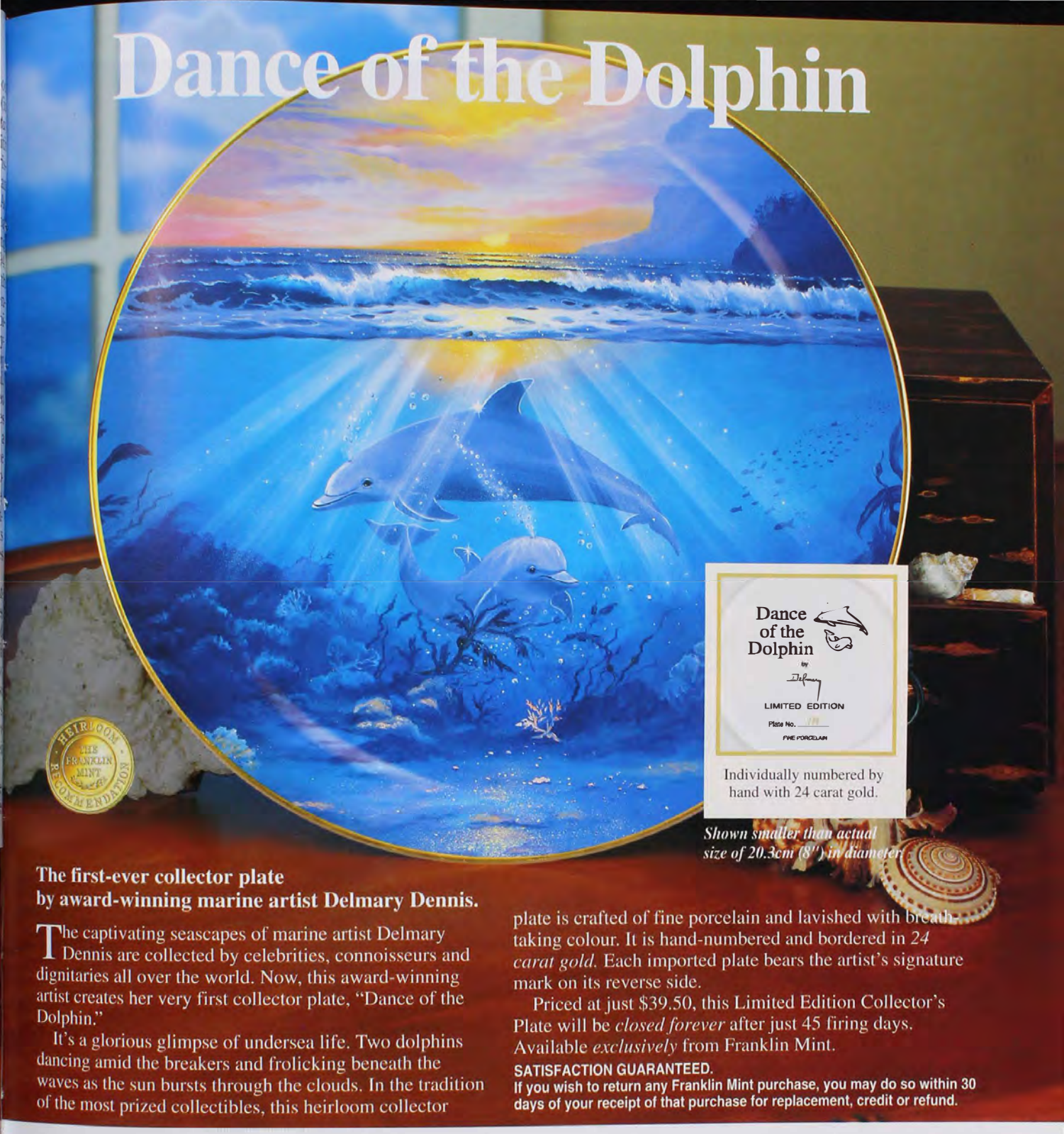
Further studies investigated the reactions of females from a closely related species, *S. rovneri*, in which the males have hairless limbs. These females also responded to hairier legs, even preferring tufted *S. ocreata* males over males of their own species.

Uetz and his colleagues believe that *S. ocreata* males

G. HAROLD

Female wolf spiders seem to have a latent desire for males with hairy legs.

Dance of the Dolphin



Individually numbered by hand with 24 carat gold.

Shown smaller than actual size of 20.3cm (8") in diameter

The first-ever collector plate by award-winning marine artist Delmary Dennis.

The captivating seascapes of marine artist Delmary Dennis are collected by celebrities, connoisseurs and dignitaries all over the world. Now, this award-winning artist creates her very first collector plate, "Dance of the Dolphin."

It's a glorious glimpse of undersea life. Two dolphins dancing amid the breakers and frolicking beneath the waves as the sun bursts through the clouds. In the tradition of the most prized collectibles, this heirloom collector plate is crafted of fine porcelain and lavished with breath-taking colour. It is hand-numbered and bordered in *24 carat gold.* Each imported plate bears the artist's signature mark on its reverse side.

Priced at just $39.50, this Limited Edition Collector's Plate will be *closed forever* after just 45 firing days. Available *exclusively* from Franklin Mint.

SATISFACTION GUARANTEED.
If you wish to return any Franklin Mint purchase, you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

Franklin Mint Pty. Limited, (Incorporated in Victoria), ACN 005 086 591, 3 International Court, Caribbean Gardens. Scoresby. Vic. 3179. Telephone: (03) 9757 5600.

NAT

A Limited Edition Collector Plate. Hand-Numbered and Bordered in 24 Carat Gold.

Please mail by 31st May, 1996.

Post to: Reply Paid 2000,
Franklin Mint,
Private Bag 20, South East Mail Centre. Victoria. 3176.
(No postage stamp required.)

Please enter my order for Dance of the Dolphin by Delmary Dennis. I need send no payment now. I will be billed for $39.50 plus $2.95 postage and handling, when my plate is shipped. *Limit: One plate per collector.*

Signature _____
All orders must be signed and are subject to acceptance

Mr/Mrs/Miss _____
Please print clearly

Address _____

_____ Postcode _____

Telephone _____
Please include STD area code with your number.

00060 34626

EXCLUSIVELY FROM FRANKLIN MINT

REG MORRISON

The pattern of spots above the top row of whiskers can tell you how long a Lion may live.

may have developed tufts because they exploit an inherent sensory bias in females towards evolutionary novelties like male hairiness that may accentuate courtship signals.

The research also highlights the powerful potential for video systems in animal behaviour studies. By allowing selected alterations to an animal's appearance without behavioural modifications, researchers are able to tease apart visual images and determine what cues illicit responses in members of the same and other species.

—K.McG.

Lions Spot the Difference

In many species asymmetrical physical features signify inbreeding or nutritional stress. However recent work on Lions and their whisker spots suggests that this is not always so—in fact, asymmetry can be a sign of longevity in a mate.

Lions (*Panthera leo*) have parallel rows of whiskers (vibrissae) on either side of their muzzle, each whisker originating from a small furless area known as a whisker spot. Above the topmost row are a cluster of additional spots that form a unique pattern. A Lion may be symmetrical or asymmetrical in these spot patterns, either in the number of spots on each side of the muzzle, or in the horizontal location of the rows.

Males with symmetrical patterns tend to live longer than their asymmetric brothers, but for females lopsidedness is an indication of longevity.

Behavioural ecologists Craig Packer and Anne Pusey (University of Minnesota) conducted a long-term study of 920 Lions from the Serengeti Plain and neighbouring Ngorongoro Crater in Tanzania, to determine whether asymmetry was caused by fluctuating food supplies (as in the Serengeti) or by inbreeding (common in Ngorongoro Lions).

The researchers found no evidence to support either theory but, surprisingly, they found a correlation between the horizontal location of spot patterns and the lifespan of their owner. Even more surprising, asymmetry relates differently to each sex: males with symmetrical patterns tend to live longer than their asymmetric brothers, but for females lopsidedness is an indication of longevity.

It seems unlikely that spot asymmetry and lifespan are directly related, and more probable that different spot patterns are a result of an underlying genetic or physiological condition subject to opposing selective forces in each sex. Whatever causes the difference, males and females should show opposite preferences for whisker spots when choosing partners!

—R.S.

Burying Badger Mythology

The romantics among us might like to cling to the old belief that European Badgers (*Meles meles*) commonly bury their dead and that they do so out of some innate sense of decency. But, as is usually the case when animals are ascribed anthropomorphic characteristics, it is likely that the motivation for badger 'funerals' is more primal.

If Badgers did use the chambers of their underground homes (setts) as mortuaries, then the remains of carcasses should turn up as a matter of routine during excavations. However, zoologist Tim Roper, of Sussex University in the UK, reports that recent careful excavations of 12 setts by developers in Britain have revealed no such pattern. Only one Badger skeleton was found in the excavations of 1,153 metres of underground tunnels and that was from an old disused chamber. Reports of Badger remains unearthed during other excavations detailed in the scientific literature are similarly rare.

Despite this, there have been some legitimate accounts of Badgers dragging their dead towards setts and occasionally burying them nearby. But Roper believes the most likely explanation is that the carcasses were being treated as carrion and taken into setts as food.

Although Badgers normally feed on invertebrates, fruits and cereals, they have been observed eating their own dead and are known to consume dead mammals and birds, if they find them. They have been seen dragging large carrion items such as rabbits, pigeons, chickens and even a new-born calf into their setts.

Because confirmed accounts of Badgers burying or eating their own dead are rare, Roper believes it may be uncommon behaviour confined perhaps only to times when food is scarce.

—K.McG.

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

Do European Badgers bury their dead?

FRANCOIS GOHIER/AUSCAPE INTERNATIONAL

Hummingbirds, like *Calypte anna*, may lick ashes from campsites to replace calcium lost through egg production.

QUICK QUIZ

1. What does CSIRO stand for?
2. From where did Dingoes originate?
3. What is the nickname of the largest and most complete specimen of *Tyrannosaurus rex*, discovered in South Dakota in 1990?
4. Which of the following types of electromagnetic radiation have the lowest frequencies: X-rays, radio waves or infrared radiation?
5. What are trogloxenes, troglophiles and troglobites?
6. How many million people live in Australia?
7. What is palaeopathology?
8. Do godwits have fur, fins or feathers?
9. Which is Australia's longest single river?
10. What was the name of the ship that ran aground on Hebe Reef, Bass Strait, in July 1995, and was responsible for one of Tasmania's worst oil spills?

(Answers in Q&A)

Cinderellas of the Bird World

Egg laying is a very stressful time for all female birds, partly because the production of eggs consumes large amounts of nutrients, especially calcium. This is particularly significant to the nectar-feeding hummingbirds, which already lose many essential ions when they excrete the large amounts of water that are a by-product of their mostly liquid diet.

Hummingbirds are known to actively modify their diets to replace missing mineral salts. Some salts are regained through fresh intakes of nectar, and others through the insect portion of their diet. One unidentified individual has even been sighted drinking sea water.

It was not known how the birds replaced the calcium lost during egg production until recently, when a series of fortuitous observations led biologist James des Lauriers and his students from Chaffey College, California, to suggest that the replacement calcium comes from wood ashes, a readily available substance known to be rich in calcium oxide.

Nesting females of four species of hummingbirds were observed on five separate occasions flying purposefully from their nests to nearby dead campfire sites. Once there, the bird remained for several seconds, licking powdery grey ashes before returning directly to the nest. This activity was repeated several times per hour over periods of up to ten days.

Further investigations revealed no evidence that the hummingbirds were using the ashes in nest construction. Des Lauriers suggests that the birds were using a rich and convenient mineral source to replace the calcium lost in egg production, and that the ash heaps were probably located by the hummingbirds' random sampling of their local environment.

—R.S.

Further Reading

Ackerman, J.D., Rodríguez-Robles, J.A. & Meléndez, E.J., 1994. A meager nectar offering by an epiphytic orchid is better than nothing. *Biotropica* 26: 44–49.

Christian, K.A. & Bedford, G.S., 1995. Seasonal changes in thermoregulation by the frillneck lizard, *Chlamydosaurus kingii*, in tropical Australia. *Ecology* 76: 124–132.

Christian, K. & Green, B., 1994. Seasonal energetics and water turnover of the frillneck lizard, *Chlamydosaurus kingii*, in the wet-dry tropics of Australia. *Herpetologica* 50: 274–281.

Daly, J.W., Garraffo, H.M., Spande, T.F., Jaramillo, C. & Rand, A.S., 1994. Dietary source for skin alkaloids of poison frogs (Dendrobatidae)? *J. Chem. Ecol.* 20: 943–955.

des Lauriers, J.R., 1994. Hummingbirds eating ashes. *The Auk* 111: 755–756.

Feldman, H.N., 1994. Domestic cats and passive submission. *Anim. Behav.* 47: 457–459.

Murray, K.G., Russell, S., Picone, C.M., Winnett-Murray, K., Sherwood, W. & Kuhlmann, M.L., 1994. Fruit laxatives and seed passage rates in frugivores: consequences for plant reproductive success. *Ecology* 75: 989–994.

Oosthuizen, J.H. & Davies, R.W., 1994. The biology and adaptations of the hippopotamus leech *Placobdelloides jaegerskioeldi* (Glossiphoniidae) to its host. *Can. J. Zool.* 72: 418–422.

Packer, C. & Pusey, A.E., 1993. Should a lion change its spots? *Nature* 362: 595.

Roper, T.J., 1994. Do badgers, *Meles meles*, bury their dead? *J. Zool. Lond.* 234: 677– 680.

Tautz, J., Roces, F. & Hölldobler, B., 1995. Use of a sound-based vibratome by leaf-cutting ants. *Science* 267: 84–87.

Thulborn, T., 1994. Mimicry in ankylosaurid dinosaurs. *Rec. S. Aust. Mus.* 27: 151–158.

Treseder, K.K., Davidson, D.W. & Ehleringer, J.R., 1995. Absorption of ant-provided carbon dioxide and nitrogen by a tropical epiphyte. *Nature* 375: 137–139.

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

Just eight years after their arrival, their privileged status was revoked in favour of 'pest status'.

HOUSE SPARROWS: THE LAST STRAW

BY STEVE VAN DYCK

WHAT IS IT ABOUT haystacks that we humans find so irresistibly romantic? It must have something to do with a primitive nesting urge that smoulders deep within us and which, every now and then, finds its sudden expression at the sight, touch or smell of a pile of yellow straw. Goodness only knows what wild oats have been sown among the wheat stalks but, if haystacks had tongues, history would have kittens.

House Sparrows (*Passer domesticus*), being sympathetic with nearly everything humans do, also find haystacks magnetic.

I remember about 35 years ago one monster of a stack—as big as a house—while holidaying on a sheep station at Ariah Park, New South Wales. For some reason the whole haystack had been abandoned to the pestilential birds. The old pile of black straw was a sorry sight, compacted and sour, but in it a zillion sparrows had found their bed of roses.

The walls of the haystack were honeycombed with nesting tunnels that the sparrows had excavated by snipping and tugging at the stubble. And with all those little propagators high as kites on summer hormones and hayfever, it goes without saying that, for farming families living within a kilometre of the old stack, each sunrise brought with it a pandemonium of procreative chirping that left the local roosters whistling into the wind.

This was all too tempting for a ten-year-old snooper, so I got a ladder and climbed up to the top of the heap for a bird's eye look. The first discovery I made was that there was far more method in their nesting madness than I'd given the sparrows credit for—it was impossible for even a really scrawny arm to get up into those nests and at the eggs. Every push was agony; the snipped-off stubble dug in like meat skewers and resisted the passage of anything that wasn't small and sparrowy.

The second discovery spelt doom for the ill-fated expedition. By lying down, hanging over the edge of the stack, and thrusting what was left of my arms up into likely holes, something else that lived there decided it was time to leave with the panicking birds.

In a wave like a hot flush, an army of microscopic bird mites (*Ornithonysus bursa*) was on me and coming up my sides, and by the time I was up and flailing they'd finished the trip up my neck, into my hair and everywhere else...enough mites to supply every primary school ceiling in New South Wales.

Now you can have friends and you can have biting mites, but not the two at the same time. So I was ordered into an empty 44-gallon drum, and buckets of some dreadful stuff that smelled like sheep dip were sloshed over me for what must have been hours...or at least until the fear of an imminent mulesing and docking got my feet into gear.

Given Australia's bleak record for ecological forethought, it should come as no shock that House Sparrows were intentionally introduced from England around 1863. It was really a wave of introductions: the first lot of 60 birds died at sea late in 1862, 19 others arrived at Melbourne in January 1863, and plenty of others came ashore in June that year. Some say the birds were sentenced with transportation to the colony to help farmers kill off the caterpillars eating their crops; others say they were imported to soothe the settlers' nostalgia problems (they missed the chirpy calls of the birds that once infested their roofs back home in Britain). Journalist Annie Osborn, however, maintained that the Acclimatization Society of Victoria had originally intended importing unrelated Hedge Sparrows (*Prunella modularis*) whose record was cleaner than the House and the Tree varieties, and that at least one flock of 80 sparrows held over from the June shipment and released by the Acclimatization Society's Secretary, Mr W.G. Sprigg, on 15 September 1863 at Royal Park, Melbourne, were not those on the mail order but instead House Sparrows, "degenerate cousins of the blameless hedge sparrow" (*Almost human, reminiscences from the Melbourne Zoo*, 1920).

Anyway, in spite of all the other people who helped seed the sparrow scourge in Australia, sparrows, from that day, became known locally as 'Spriggies' and Sprigg's tacky act earned him a rebuke that stuck well into the middle of the next century.

The fresh Australian air and balmy days must have done wonders for the House Sparrows' libido because by 1871, just eight years after their much-toasted arrival, their privileged status was revoked in favour of 'pest status', which

HOUSE SPARROW
Passer domesticus

Classification
Family Ploceidae (weavers, waxbills)

Identification
A dirty-looking little brown bird with a cocky disposition; 15 cm long; breeding males with black beak, slate grey cap, large black bib and chestnut back, non-breeding males with horn-coloured beak and very small bib; females plain mouse-brown with faint darker stripe through eye.

Distribution and Habitat
Originally from Eurasia and North Africa. In Australia abundant in eastern States (coastal and arid) around human habitation.

Behaviour
Eats insects, seeds, food scraps, vegetables, fruit; most obvious when a group of males chase a female and display before her with noisy chirping and tail fanning ('sparrow party'). Usually breeds in spring and summer; nests of straw, leaves or paper made under eaves or in any accessible crack in buildings or human-made structures, less often in trees; 3–6 pretty brown-blotched white eggs, female incubates 12–14 days, male assists with rearing. Pair faithful for the duration of breeding season.

Throughout Australia House Sparrows are rarely found away from human habitation.

accurately reflected the sparrows' more demonstrable lust for lust than for life. They had been eating stone fruit, buds, grain, vegetable seedlings, and anything else grown or dropped by humans. They were smart, exploiting new and challenging problems and remembering solutions. But mostly they were breeders doing their best to embarrass the reputation of their furry fecund friends the rabbits, which had fared so splendidly since their own recent intentional introduction.

Into the environmental vacuums created by widespread clearing and habitat degradation the House Sparrows were hungrily sucked. They demonstrated their productivity by averaging up to five clutches of four to six eggs per year per pair. But whereas back in England four of the five or six young raised per year and one of their parents would be dead by the next breeding season, mortality here was initially much lower.

Another benefit the Lucky Country offered was the proximity of unoccupied breeding sites for young first-year birds. Back home in established populations, first-year birds often had to move up to 15 kilometres (some recorded up to 500 kilometres) away to find suitable unclaimed realms. Nowadays House Sparrows fight and bathe in the dust of nearly every town and city on the eastern half of the continent. Western Australia, however, is relentless in its vigil against the spread of the bird, and any House Sparrow cocky enough to fly west of 129° East is smartly dispatched.

House Sparrows and House Mice have more in common than just their Christian names, and there is no doubt that our tomatoes and lettuces, cherries and plums would be better off without sparrows picking at them. Our roofs would be cleaner without their accumulated nesting rubbish and our chooks wouldn't be watching their mash thieved from under their beaks. But House Sparrow resentment is all a bit academic at this stage—the damage they do is not monumental and to most urban dwellers the House Sparrow represents just about the only small bird capable of taking on such bleak surroundings as cold grey railway yards and inner city gutters. Their noisy social cocked-tail parties among swirling lunch wrappers and between train tracks bring a welcome contrast to the anonymity of modern city life.

Most of us cut our teeth on House Sparrows: we robbed our first eggs from their nests, got our first sharp bites from their stout beaks, saw our first examples of how birds 'did it' on the roof, and practised raising our first nestlings from their yellow-gaped youngsters.

But every now and then, when that familiar circular comes home from the headmaster announcing the discovery of crawlies in the heads of the gradeoners, I go a bit weak in the hindquarters. In less than two seconds the smell of Nit-Bar can transport me back 35 years and dump me onto a sheep farm into a drum of cold insecticide, and all to the din of a stack of House Sparrows...a storm of memories I'd sooner not 'wether'. ■

Into the environmental vacuums created by widespread clearing and habitat degradation the House Sparrows were hungrily sucked.

Further Reading

Pizzey, G., 1991. *A garden of birds.* Harper and Collins: New Zealand.

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

The active and ongoing involvement of the timber company has helped to ensure the butterfly's long-term survival in that area.

PTUNARRA BROWN BUTTERFLY

BY MARK NEWLAND

THE PTUNARRA BROWN (*Oreixenica ptunarra*) is a small brown and orange butterfly, with a wingspan of up to 35 millimetres. It inhabits native grasslands dominated by snowgrass (*Poa* spp.), which today occur as discrete islands across the centre of Tasmania. Three regionally distinct subspecies are recognised—one from the eastern highlands, one from the Midlands, and another from the Central Plateau and north-west. Populations from sites at the highest altitudes (Central Plateau and north-west) are smaller and darker than their lower-altitude cousins.

Ptunarra Browns are wimps, even by butterfly standards. They fly for only two weeks a year, in mid to late March, and then only on days when the sun is shining, the temperature is above 18°C, and the wind speed is below 15 knots!

Ptunarra Browns are wimps, even by butterfly standards. They fly for only two weeks a year, in mid to late March, and then only on days when the sun is shining, the temperature is above 18°C, and the wind speed is below 15 knots! The caterpillars hatch in May, remain more or less dormant over the winter, fatten themselves on snowgrass during the spring and summer, and pupate in February for four to five weeks. The male butterflies emerge before the females, which are then mated within minutes of their own emergence. Interestingly (and conveniently for scientists studying them), butterflies living in the highest altitudes emerge before the lower-altitude populations.

The main threat to the butterfly is conversion of its native grassland habitat to 'improved' pasture. This is particularly the case in the Midlands, where over 95 per cent of the native grasslands have been lost. The butterfly is also threatened locally by over-grazing, and in the north-west the available habitat of the butterfly has been greatly reduced by plantation development.

In Tasmania and parts of the mainland, grasslands are maintained by fire or frost. If they are not burnt, or subjected to the occasional intense frost, both of which discourage invading shrubs and trees, then they gradually develop into grassy woodland and, eventually, to forest. In the past, the use of fire by Tasmanian Aborigines maintained some very large areas of grassland, particularly in the north-west and the eastern highlands. In order to maintain these native grasslands today as habitat for the butterfly, an active program of grassland burning has had to be implemented.

In the north-west and on the Central Plateau, the butterfly occurs on land owned and managed by a private timber company. In the north-west, this company is developing large timber plantations. The rich red basalt soils beneath the grasslands and forest of the high-rainfall region are well suited for growing trees. Fortunately the company has sought to conserve the butterfly, and seeks the advice of the Tasmanian Parks and Wildlife Service prior to developing any areas of grassland. Significant areas of grassland have been set aside from the plantation program and the company arranges for regular controlled burns as prescribed in the management plan for the species. While large areas of grassland in the area have been lost to plantations, the active and ongoing involvement of the timber company has helped to ensure the butterfly's long-term survival in that area.

In the Midlands the butterfly is found in grasslands dominated by Silver Tussock (*Poa labillardierei*). Whereas the grasslands of the plains have long since been converted to 'improved' pasture, Silver Tussock persists in the Midlands on the moister south-east-facing slopes. Many of these slopes are too steep or rocky to plough, and the relatively unpalatable and innutritious tussock grass thrives even under quite harsh conditions.

The long-term survival of the Ptunarra Brown is dependent on informed management of the native grasslands that the butterfly inhabits. Grazing by introduced animals is not incompatible with the needs of the butterfly. Whereas overgrazing will eliminate the butterfly, light grazing can actually improve the habitat as it prevents the tussock from becoming rank and overgrown. Ploughing removes the tussock, but many farmers now recognise its importance as reserve feed, and in some cases farmers are working to re-establish tussock grass.

The Ptunarra Brown's story is a successful one in that the species is now known to be more widespread and more abundant than in the past. The recovery team for the species, which was formed in 1994, comprises representatives from the farming community, the timber industry, the University of Tasmania, the Department of Parks, Wildlife and Heritage, and the funding body (Australian Nature Conservation Agency). Its task is to implement actions to conserve and manage habitat for the secure future of the butterfly. This task is mainly one of education. By informing land owners about the butterfly, and by explaining how certain land management practices may actually coincide with its needs, farmers are being encouraged to promote the native grasslands habitat that is essential for the butterfly's survival. ■

Further Reading

Neyland, M.G., 1993. The ecology and conservation management of the ptunarra brown butterfly *Oreixenica ptunarra* (Lepidoptera; Nymphalidae; Satryinae) in Tasmania, Australia. *Pap. Proc. R. Soc. Tas.* 127: 43–48.

Mark Neyland is an ecologist with the Department of Parks, Wildlife and Heritage in Hobart where he has worked on and off over the last 12 years.

JOHN HOMFRAY

I am convinced that, not so long ago, cassowaries strutted about in Tallebudgera Valley, growing plump upon these big fruits.

THE CASSOWARY'S LAST MEAL

BY TIM LOW

IT'S ONLY A SHORT DRIVE FROM THE hedonistic Gold Coast to tranquil Tallebudgera Valley, but it's a big step back in time. A dirt road winds over foothills and along creek flats before bringing you to the door of Lyndria Cook, a doctor whose parents and grandparents farmed the surrounding valley, converting lush rainforest and wet sclerophyll into banana farms and pastures.

Pockets of rainforest still linger in gullies and on slopes, and Lyndria is an expert on the plants they hold. Her valley is a hot spot for rare species, and on a very short walk with her daughter in tow, she was able to show me a swag of trees on the Queensland rare and threatened list: Durobby (*Syzygium moorei*), Red Lilly-pilly (*S. hodgkinsoniae*), Small-leaved Tamarind (*Diploglottis campbellii*), Black Walnut (*Endiandra globosa*) and others.

Some of these trees were carrying fruits, and I was struck by their massive dimensions. Black Walnut fruits are as big as golf balls and Durobbies grow to apple size—6.5 centimetres across. They dwarf most other fruits and berries found in the Australian bush. I wondered what kinds of animals eat them.

Succulent fruits are an adaptation to dispersal by animals. The sweet flesh entices animals to disperse the seeds, either by carrying the fruit to eat elsewhere, or by swallowing it whole and excreting the seeds far away. In Australian forests, birds and flying-foxes are the main dispersal agents.

The Durobby fruit (and its seed) is so big that a flying-fox is the only local animal that could carry it off. But Lyndria says flying-foxes do not visit the trees, nor do Australian Brush-turkeys (*Alectura lathami*) or any other fruit-eating animals. The huge crops of white fruits fall and rot.

The same fate befalls the much smaller fruits of the Small-leaved Tamarind. They are bright red, a colour attractive to birds, but upon ripening they immediately fall to the ground where they lie uneaten. The Red Bopple Nut (*Hicksbeachia pinnatifolia*) is another rare tree in the valley with bright red fruits, of large size, that nothing eats.

I have thought long and hard about these strange fruiting trees and I am convinced that, not so long ago, cassowaries strutted about in Tallebudgera Valley, growing plump upon these big fruits and dispersing the seeds.

PHOTOS: TIM LOW

Fruits of the Small-leaved Tamarind have a delicious, tangy taste, and Tallebudgera pioneers stewed them into jam.

Today, cassowaries (*Casuarius* species) survive only in the rainforests of northern Queensland and New Guinea, more than 1,100 kilometres to the north. But it appears that cassowaries did live in southern Queensland in the recent past—a bone from a dwarf species is thought to have come from late Pleistocene (40,000 to one million-year-old) deposits in the Darling Downs.

The Tallebudgera rainforest is an outlier of the Big Scrub, a huge block of rainforest around Lismore that was cleared by pioneers. This rainforest with its big fruits would have been ideal for cassowaries. Perhaps the big birds were exterminated by Aborigines during a dry climatic phase when the rainforest had contracted, probably within the last few thousand years.

Cassowaries must have roamed beyond the Big Scrub. Fruits apparently adapted for cassowary dispersal are found widely in northern New South Wales and southern Queensland. They include Davidson's Plum (*Davidsonia pruriens*), Rusty Plum (*Amorphospermum whitei*), Brown Pearwood (*A. antilogum*) and Southern Ochrosia (*Ochrosia moorei*).

A horse-dispersed fruit in Central America survived for hundreds of years without a dispersal agent after native American horses became extinct.

The largest number of species seemingly adapted for cassowary dispersal is found in the genus *Endiandra*. Northern New South Wales has 11 *Endiandra* species, with fruits of two types: elliptical fruits 1.3–3 centimetres long (five species), and much bigger, mostly spherical fruits, 5–10 centimetres long (six species). Similar size classes occur among northern Queensland *Endiandra* species, where naturalists Wendy and Bill Cooper have observed a range of birds eating the smaller fruits, but only the Southern Cassowary (*C. casuarius*) eating the bigger fruits. The same dietary preferences would have prevailed in New South Wales.

The giant among the southern *Endiandra* (and among temperate Australian) fruits is *E. floydii* from remnants of the Big Scrub. Its massive purplish-black fruits are 7–10 centimetres long and carry seeds as big as plums, up to 5.5 centimetres long.

Because the cassowary fruits of temperate Australia lost their dispersal agent, we might expect them to be scarce plants with a limited distribution. For most of the species this is indeed the case, although it is difficult to know how much of their rarity is due to recent rainforest clearing.

However, the loss of a dispersal agent does not automatically lead to extinction. Biologist Daniel Janzen deduced that a horse-dispersed fruit in Central America, the Guanacaste (*Enterolobium cyclocarpum*), survived for hundreds of years without a dispersal agent after native American horses became extinct. Its seeds are now dispersed by domestic horses introduced from Europe. There are no plans to reintroduce cassowaries to temperate Australia, so we may need to help the rarer cassowary trees by artificially disseminating their seeds. Considering the amount of damage humans have inflicted upon rainforests in Australia, we owe them that much, at least. ■

Davidson's Plum tree is common in northern Queensland, where the Southern Cassowary eats its big purple fruits, but in northern New South Wales, where cassowaries are extinct, it is very rare.

Further Reading

Cooper, W. & Cooper, W.T., 1994. *Fruits of the rainforest: a guide to fruits in Australian tropical rainforest.* R.D. Press: Sydney.

Floyd, A.G., 1989. *Rainforest trees of mainland southeastern Australia.* Inkata Press: Melbourne.

Tim Low is a nature writer and consultant living in Brisbane.

WALLABIES ON THE ROCKS?

BY ANDY SHARP

The pads of their hind feet are heavily granulated, like off-road tyres, allowing them to move quickly and gracefully across rocky surfaces.

MANY AUSTRALIANS ARE NOW familiar with Banjo the Yellow-footed Rock-wallaby, due to promotional campaigns to raise funds for rock-wallaby research. It is, however, just one of at least 15 species of rock-wallaby. At present, only one species is officially classified as endangered, while another seven are deemed to be vulnerable. However, a recent symposium on rock-wallabies has thrown doubt on the suitability of many of these classifications. The doubt arises from the simple lack of data on the ecology and general population trends of many of the species.

Rock-wallabies (*Petrogale* spp.) occur throughout the Australian mainland and on some offshore islands. As their name suggests, rock-wallabies live in rocky habitats along the edge of escarpments and in isolated boulder outcroppings. The complex terrain of such habitats provides a plethora of caves, crevasses and rock piles in which the wallabies can seek shelter from the extremes of summer temperatures and the attention of predators. These unique animals display a range of specialised adaptations enabling them to move freely through rugged terrain. The pads of their hind feet are heavily granulated, like off-road tyres, allowing them to move quickly and gracefully across rocky surfaces. In addition, their tails are less tapered than that of other macropods and are carried arched over their backs, allowing a greater degree of balance.

Rock-wallabies live in colonies ranging in size from ten to several hundred individuals. They generally display a high degree of fidelity to their colony site, spending the daylight hours along the upper cliff lines of ridges. In the late afternoon they become active and begin foraging on the lower slopes. Some species venture onto the surrounding flats to feed until dawn. Because rock-wallabies must return to their colony sites at dawn, the area over which they can move is limited. For this reason, rock-wallabies eat a broader range of foods than other macropod species. Unlike kangaroos, which can cover greater areas in search of grasses, rock-wallabies tend to feed primarily on herbaceous plants and shrubs. Their broad diet ensures that during periods of drought they can find sufficient food to survive. The high degree of specialisation to a particular habitat type, and the disjunct nature of their populations, means that rock-wallabies are particularly sensitive to changes in their environment.

Prior to their protection under legislation, European hunting practices around the turn of the century resulted in a rapid decline in many rock-wallaby species. In New South Wales, the Brush-tailed Rock-wallaby (*P. penicillata*) was extensively hunted for its pelt. Once abundant throughout its range, hunting pressure led to a decline in many populations and the localised extinction of many others. Similarly, the Yellow-footed Rock-wallaby (*P. xanthopus*) was also extensively hunted for both sport and its ornamental pelt. They were easily shot and hundreds of pelts were collected for the fur trade each year. By the time of their protection in 1912, Yellow-footed

REG MORRISON

The efficiency with which foxes seem to be able to hunt juvenile Yellow-footed Rock-wallabies has put renewed pressure on the survival of the species.

Rock-wallaby numbers were dramatically low and the species was considered rare.

With the introduction of legislative protection, the numbers of many species of rock-wallaby have steadily increased or remained stable. However, rock-wallabies are now facing a new range of threats that may have drastic implications for their survival.

AS WITH MANY SMALL- AND MEDIUM-sized Australian mammals, predation by feral animals is one of the major threats to rock-wallaby numbers. A 16-year study on the Black-flanked or Black-footed Rock-wallaby (*P. lateralis*) and Rothschild's Rock-wallaby (*P. rothschildi*) in Western Australia has revealed that feral foxes can have a significant impact on rock-wallaby populations. Jack Kinnear and associates from the Department of Conservation and

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

Black-footed Rock-wallabies, like this one from the McDonnell Ranges, reach maturity at around two years of age and give birth to only one young at a time.

J. CANCALOSI/AUSCAPE INTERNATIONAL

A young Queensland rock-wallaby, probably the Unadorned Rock-wallaby (*Petrogale inornata*). Further research into the ecology and population dynamics of rock-wallabies is urgently required.

Land Management conducted experiments whereby they actively implemented fox control measures (1080 baiting) on some colonies while leaving others unbaited as controls. The population size of colonies that were baited increased by up to 223 per cent, over four years, while those without control measures continued to decline, the severest being a decline of 85 per cent. The majority of predation was directed towards juvenile wallabies, resulting in a drastic reduction in the level of recruitment into the population and a steady decline in numbers.

Our studies on the Yellow-footed Rock-wallaby in Queensland suggest a similar impact of foxes on population numbers. Relative to Dingoes, the efficiency with which foxes are able to hunt juvenile wallabies may result from an ability to penetrate further into the caves, crevasses and rock piles that they use as refuge sites. An unfortunate side effect of the campaign against wearing furs is that the market for fox pelts has collapsed, with thousands fewer animals being shot annually. This may have caused substantial increases in fox populations and resulted in an increase in predator pressure on native animals.

Another major threat to many rock-wallaby species comes from the ever-increasing level of habitat modification and fragmentation. As could be expected, these processes are particularly critical to wallabies along the populous eastern seaboard and hinterlands. Such is the case with the Proserpine Rock-wallaby (*P. persephone*).

Proserpine Rock-wallabies are found only in a small area of northern Queensland encompassed by the Whitsunday Shire. They live in pockets of semi-deciduous vine thickets and move into the fringes of nearby open woodlands to feed. Already in relatively small numbers, populations are threatened by increased levels of land clearing in the area. However, the impact of development is not confined to the loss of habitat.

Many wallabies are being killed in road accidents, and through predation and harassment by domestic pets. As the level of development continues to spread through the Whitsunday area, the detrimental effects of all these factors will continue to rise.

An unfortunate side effect of the campaign against wearing furs is that the market for fox pelts has collapsed...and resulted in an increase in predator pressure on native animals.

By far the greatest difficulty in managing threats to rock-wallabies lies in our lack of knowledge about the ecology and population dynamics of many species. Of the 15 currently recognised species,

Two adult male Yellow-footed Rock-wallabies.

TOM & PAM GARDENER/NATURE FOCUS

PHILIP QUIRK/WILDLIGHT PHOTO AGENCY

In the late afternoon, Brush-tailed Rock-wallabies leave their rocky habitats and move onto grassy areas where they feed on a wide variety of plants.

only four have been subjected to comprehensive field studies. While the ranges of most species are fairly well documented, our understanding of the condition of these populations is sketchy, being derived from cursory surveys or from anecdotal evidence and gut feelings.

Ironically, the very features that make rock-wallabies so vulnerable to disturbance and predation (their sedentary nature, the relative ease with which many species can be caught and their discrete population units) also make them ideally suited for population studies. Such studies would not only increase the understanding of the ecology of particular species, but could also contribute significantly to the science of population biology as a whole. The only disadvantage is to the researchers themselves, who must tirelessly trudge up and down the rocky escarpments. ■

Further Reading

Kinnear, J.E., Onus, M.L. & Bromilow, R.N., 1988. Fox control and rock wallaby population dynamics. *Aust. Wildl. Res.* 15: 435–450.

Lim, L., Robinson, A.C., Copley, P.B., Gordon, G., Canty, P.D. & Reimer, D., 1987. The conservation and management of the Yellow-footed rock wallaby. *Dept Envt & Plan. (S. Aust.) Spec. Publ.* No. 4.

Ferris, J. (ed.), 1995. Proceedings of the National Rock-wallaby Symposium (1994). *Aust. Mammal.* 18(2).

Andy Sharp is from the Centre for Conservation Biology and Zoology Department at the University of Queensland. He has been studying the population dynamics and space-use patterns of the Yellow-footed Rock-wallaby, in Queensland, since 1991.

ALASKA

America's Great Frontier

American Bald Eagle sculpture shown actual size

The bald eagle is captured in all its wild beauty in a sculptured portrait of astonishing realism.

Dedicated to ensuring the future of all of Alaska's Wildlife. The Alaska Wildlife Conservation Trust proudly presents a world-premiere sculpture in hand-painted porcelain and crystal.

Alaska. Home to the most majestic wildlife on earth. Among these magnificent creatures, the American Bald Eagle. Living embodiment of nature's grandeur. And the inspiration for this original work of art commissioned by the Alaska Wildlife Conservation Trust.

The creation of world-renowned wildlife artist Chris Denbigh this extraordinary sculpture is created in fine Tesori porcelain, a specially prepared sculptor's blend of powdered porcelain and resins. The sculpture comes to life on its own display base, custom designed in fine crystal cut glass, specially contoured to suggest the animal's natural environment. The price for this specially imported sculpture, just $49.50.

SATISFACTION GUARANTEED.
If you wish to return any Franklin Mint purchase, you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

Franklin Mint Pty. Limited, (Incorporated in Victoria), ACN 005 086 591, 3 International Court, Caribbean Gardens. Scoresby. Vic. 3179. Telephone: (03) 9757 5600.

NAT

Please mail by 31st May, 1996.

Post to: Reply Paid 2000,
Franklin Mint,
Private Bag 20, South East Mail Centre. Victoria. 3176.
(No postage stamp required.)

Please enter my order for The American Bald Eagle. I need send no payment now. I will be invoiced for $49.50 plus $1.95 postage and handling when my specially imported sculpture is ready to be sent to me.

Signature _____
All orders must be signed and are subject to acceptance

Mr/Mrs/Miss _____
Please print clearly

Address _____

_____ Postcode _____

Telephone _____
Please include STD area code with your number.

00008 34625

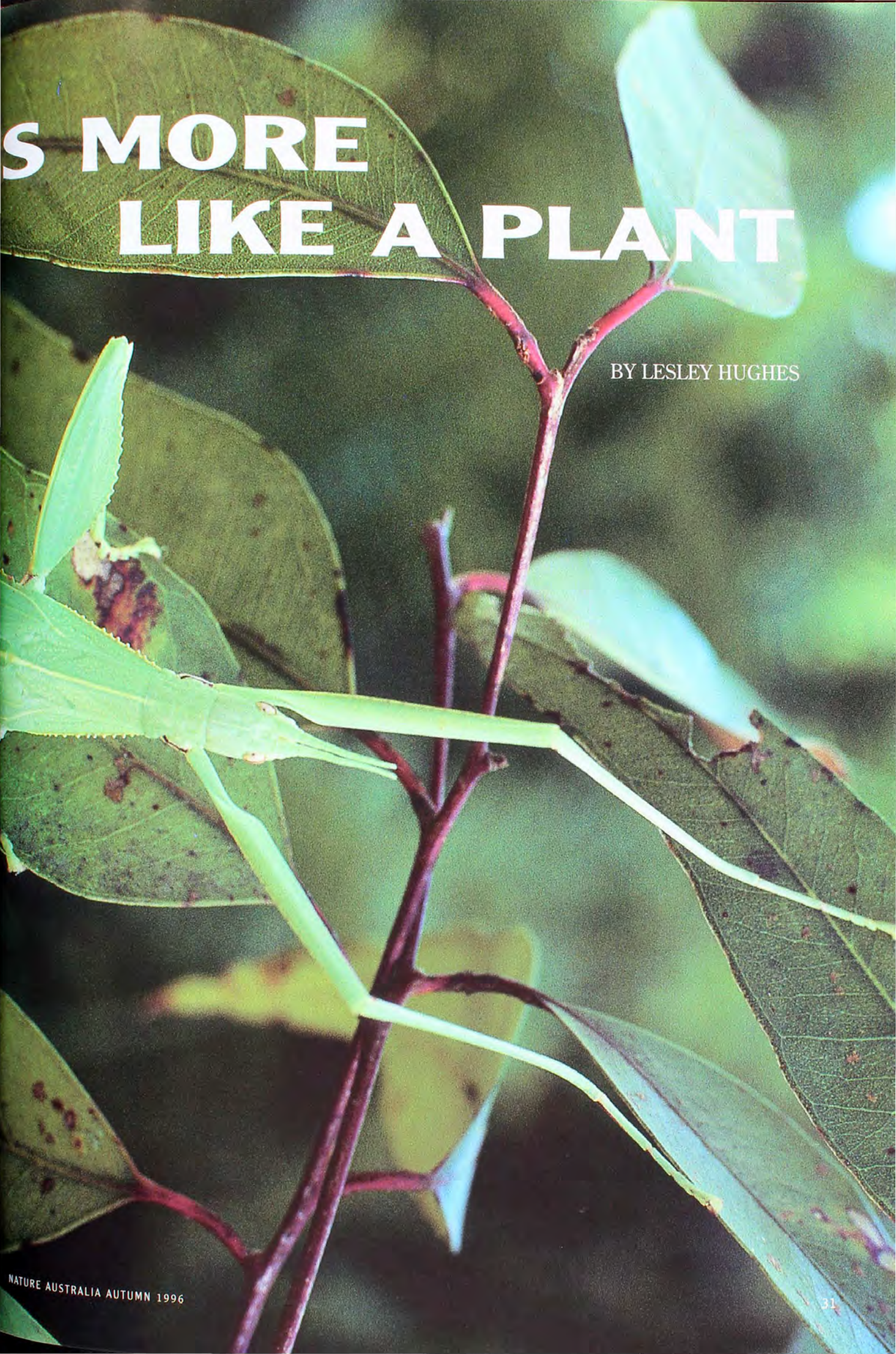
EXCLUSIVELY FROM FRANKLIN MINT

WHEN AN INSEC

Stick-insects have developed remarkable methods of camouflage to avoid their enemies.

S. WILSON

Stick-insects, such as this species of *Tropidoderus*, are truly the masters of camouflage.



S MORE LIKE A PLANT

BY LESLEY HUGHES

UNTIL A FEW YEARS AGO, THE only thing I knew about stick-insects was that many have a remarkable ability to look exactly like the twigs of the plants on which they live. Little did I suspect that not only do they look like plants, but in some respects behave like them as well.

My rather indirect route to studying stick-insects began in 1986 when, as a prospective postgraduate student, I was 'shopping' for a thesis topic with my supervisor-to-be Mark Westoby, at Macquarie University. We discussed several possible projects but the one that most appealed to me was on the ecology of seed dispersal by ants. I learned that many Australian plants, such as acacias, produce seeds that bear a small appendage called an elaiosome (pronounced ell-eye-oh-sohm). This little food body is very rich in fats and is highly attractive to many ant species. When a foraging ant encounters a seed with an elaiosome, it carries the seed back to the colony's nest where the elaiosome is removed and fed to the ant larvae. The seed itself may also be eaten, but is often simply discarded. I found the topic an attractive one for study because, despite the fact that over 1,500 Australian plant species use this method of dispersing their seeds, little was known about the natural history of the interaction. As I was about to leave Mark's office to go and think about the project, he told me as an afterthought that stick-insect eggs look just like seeds with elaiosomes. He said this had been pointed out to him several years earlier by Jackie Fleming, an American student who had visited the lab for a few weeks on an exchange program. Jackie had returned home before being able to follow up her curious observation and no-one had proceeded further with the matter. Her idea lodged itself in the back of my mind but, for the time, was overwhelmed by thoughts of ants and seeds.

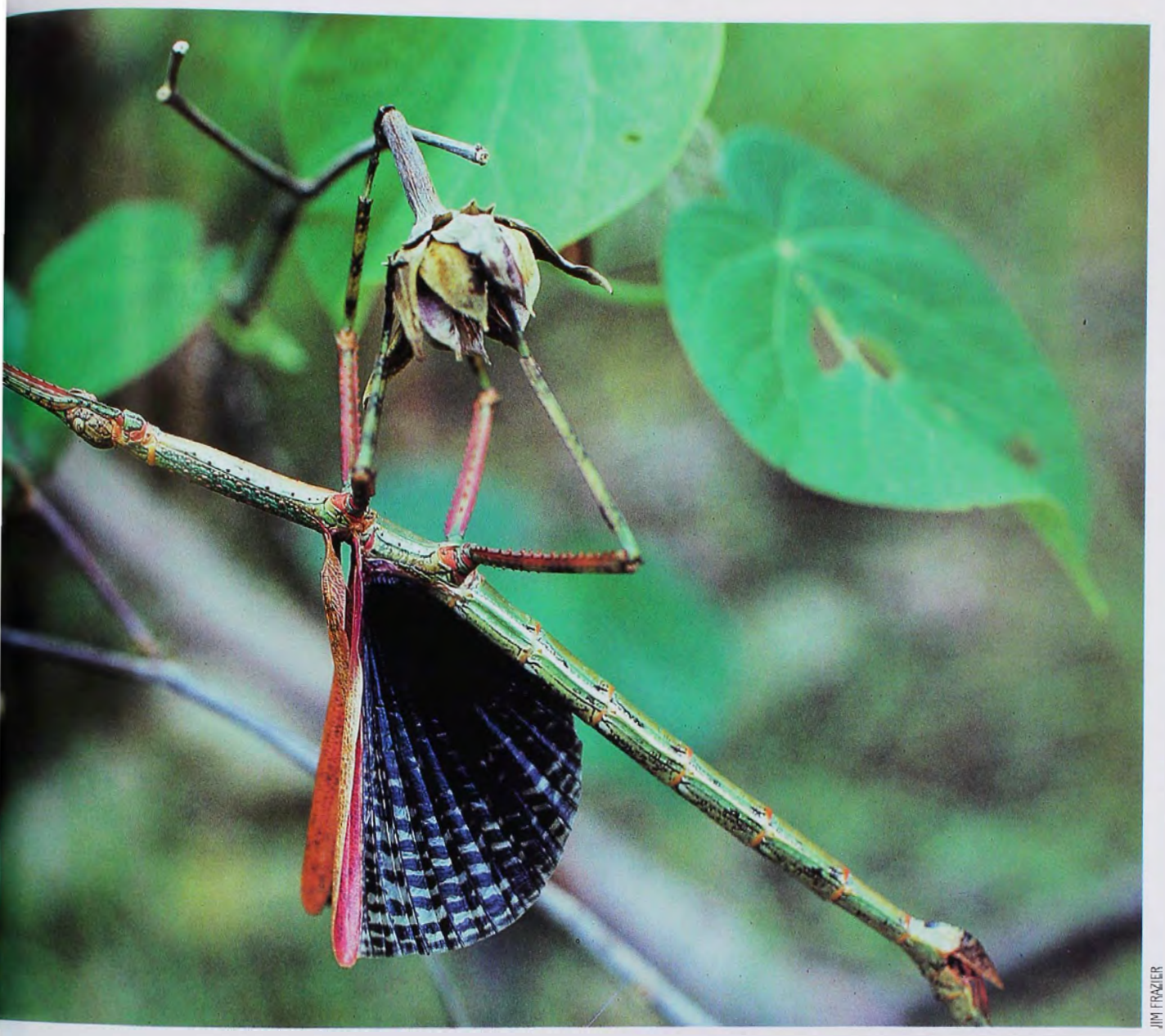
Stick-insects had been introduced to England when their eggs were mistaken for flower seeds.

I went on to do a four-year field study on seed dispersal by ants and didn't think again about stick-insects until some years later. At an Entomological Society Conference in Canberra a fellow student, Louise Rodgerson, who had also started a project on seed dispersal by ants, showed some slides of several different seeds with elaiosomes. During question time a member of the audience, Ken Key from the CSIRO, commented that they looked just like stick-insect eggs. This set me thinking back to the curious resemblance between eggs and seeds.

Some preliminary reading revealed that the general resemblance of stick-insect eggs to seeds had been noticed for some time. In fact several species of stick-insects had been introduced to England when their eggs were mistaken for flower seeds. But what Jackie Fleming and now Ken Key had noticed was, not only were the eggs similar in size, shape, colour and texture to seeds, but in many species the eggs had a small knob-like structure on them that looked remarkably like an elaiosome. I soon discovered that, also like elaiosomes, this structure, called a capitulum, is so fatty that it oozes oil droplets when squeezed with forceps. The capitulum is found on the eggs of stick-insects from several continents, from the tropics to the temperate zone, and from several stick-insect subfamilies. Several different functions for the capitulum had been suggested but there was no evidence for any of them. Was it possible that this small fatty knob might not only look like an elaiosome, but also act like one? I discovered that this question might almost have been posed nearly a century ago. In 1898 D. Sharp first described the

S. WILSON

The egg of *Vetilia enceladus* has a prominent white appendage known as a capitulum. This appendage is attractive to ants, inducing them to carry the egg down into their nest where the capitulum is eaten but the egg may remain until it hatches, some months or even years later.



JIM FRAZIER

Many stick-insects, such as this *Ctenomorphodes* sp., have wings, but most are poor fliers and can only glide short distances. Some individuals may, however, be blown many kilometres in strong winds.

capitulum and observed that it resembled the 'caruncle' on a castor oil plant seed. This caruncle would now be more commonly called an elaiosome. It was not surprising, however, that Sharp didn't wonder about the possible ant connection because it was not until eight years after his observations that elaiosomes and their role in seed dispersal by ants were first described.

MY INITIAL TASK WAS TO GET HOLD OF enough stick-insect eggs to start some experiments. While most people have seen a stick-insect at some time in their lives, they are rather hard to come by when you really need them. I had heard that two entomologists who had worked for the Forestry Commission during the 1960s on stick-insect plagues (see box) were living in Sydney and I decided to contact them in the hope they might have some collecting tips. The first person I phoned was Phil Hadlington. As I launched into my hypothesis about why stick-insect eggs might look like seeds with elaiosomes, Phil suddenly interrupted excitedly and said "I think I know how this story ends!" He then recounted how he had observed ants carrying eggs and had even found hoards of eggs in excavated ant nests. At the time he was not familiar with the resemblance of the eggs to seeds with elaiosomes and had understandably assumed that the ants had collected the eggs to eat them. Phil had many contacts in the Sydney tree-lopping community and put out the word that I needed stick-insects. The insects, mostly of the species *Ctenomorpha chronus*, began rolling in. I set up the insects in a large cage, supplied them with fresh eucalypt cuttings, and was soon able to collect the eggs that dropped to the floor. The second ex-Forestry Commission entomologist I contacted, Keith Campbell, still kept several stick-insects at his home and supplied the eggs of another species, *Podacanthus wilkinsoni*. I then heard about a Blue Mountains resident, Mary Campbell (no relation to Keith), who had appeared in the Unusual Pet segment of a popular television show dis-

M. PROCIV/WETRO-PICS PHOTO LIBRARY

The 'Peppermint Stick-insect' (*Megacrania batesii*).

playing her stick-insects. Mary kindly supplied me with eggs of a third species, *Didymuria violescens*, and even began some experiments with ants in her backyard.

Thus armed with the eggs of three stick-insect species I began my investigations by placing some eggs near the nest entrance of the greenhead ant *Rhytidoponera metallica*, a common and active seed-remover. To my delight the ants took the eggs into the nest straight away. But was it the capitulum that attracted the ants, or would they have taken the eggs anyway? To test this I removed capitula from some of the eggs and put out eggs both with and without capitula. Within a short time the ants had removed most of the intact eggs but had ignored most of the eggs without capitula. It was possible, however, that the presence of the capitulum simply made the eggs easier to pick up, the eggs being rather round and slippery otherwise. To investigate this possibility I replaced capitula on some of the eggs with a small blob of soft silicone sealant that the ants could use as a 'handle' to pick up the eggs. Like the eggs without any appendage, the eggs with the silicone handle were also largely ignored. I repeated the experiment, this time using the seeds of *Dillwynia juniperina*, a common ant-dispersed plant. These seeds were similar in size and weight to the eggs. Some seeds were put out intact, others with the elaiosome removed, and others with the handle of silicone. The results were almost identical to that of the experiment with the eggs; that is, the ants preferentially removed the seeds with elaiosomes, at about the same rate that they had taken the eggs with capitula.

The next step was to investigate what became of eggs taken into an ant nest. Ants are notorious predators and it is usually assumed that anything that goes into an ant nest gets eaten. When I offered some eggs to a lab colony of greenhead ants, the ants treated the eggs just like seeds with elaiosomes, removing the capitula but leaving the eggs themselves intact.

The obvious question now was why should stick-insects produce eggs that were attractive to ants? The answer seems to lie in the particular life cycle of these insects. Young stick-insects, or nymphs, emerge from their eggs in spring. They then head straight for the nearest vertical object (which, if they're lucky, is a tree), climb it and begin to feed. The nymphs grow quickly, moulting several times until they become adults in summer. After mating, the females of many species stay in their feeding trees and simply drop their eggs onto the ground below. Egg-laying continues at a rate of several eggs per day until the female dies a few months later. Now comes the important part: the eggs do not hatch for at least a year, and

S. WILSON

A mating pair of *Extatosoma tiaratum*. As is the case here, the females of many stick-insect species are much larger than the males.

STICK-INSECTS

Classification
Order Phasmatodea. Approx. 2,500 species known.

Identification and Behaviour
Generally large terrestrial insects (some over 30 cm) resembling sticks or leaves in shape and colour. May spend many hours completely motionless. When startled, some drop to ground and lie in cataleptic state for hours. A few species regurgitate food or spray an irritating chemical when handled.

Distribution
Found throughout the world in both tropical and temperate regions.

Diet
The foliage of a wide variety of plants.

Reproduction
One to several eggs laid per day over warmer months until female dies. Eggs take 1, 2, or 3 years to hatch. Nymphs emerge from eggs in spring.

Status and Plagues
Most species quite rare but some, most notably *Didymuria violescens* and *Podacanthus wilkinsoni*, occasionally occur in plague proportions causing extensive damage to eucalypt forests. In the 1960s, a series of devastating outbreaks occurred in mountainous regions of Vic., NSW and ACT. Since then plagues (although less serious) occur about every 2 years, generally corresponding to time period of egg development. During high-density phase, the normally green or brown insects may become brightly patterned in black and yellow (kentromorphism). Whether this serves to warn predators of distastefulness, or to keep the individuals in a group, is unknown.

sometimes for two or even three years. During this time eggs lying on the ground surface are vulnerable to a variety of hazards such as being eaten by mice, or being burnt in bushfires (similar problems are of course, also faced by seeds in the same situation). A further, and probably the most serious danger for the eggs, comes from several species of minute parasitic wasps. The female wasps are wingless and walk through the leaf litter searching for eggs. When they find one, they make a small hole in the eggshell, consume some of the yolk, and then insert their own egg. The developing wasp larva kills the young stick-insect and hatches out of the egg in its place. It seemed logical that, by removing the eggs from the ground surface and burying them in nests, ants might protect them from this hazard.

In the autumn of 1991 the opportunity arose to test this idea. An outbreak of the stick-insect *Didymuria violescens* had occurred during the previous summer in Namadgi National Park in the ACT. The plague had been so intense that one of the rangers described the sound of falling frass (insect faeces) and eggs to be like rain. With the help of my husband John, I collected leaf litter from the ground surface, and soil from various depths. I then sifted out the eggs, counted, and dissected them. I found that over 80 per cent of the eggs in the surface leaf litter were parasitised with fat, squirming wasp larvae. While some of the buried eggs were also parasitised, nearly half contained healthy stick-insect embryos. Burial by ants certainly seemed to be a way of reducing an egg's chance of being attacked.

There remained a couple of vexing questions. First, many ant species are fierce predators of other insects and it is hard to imagine that a newly hatched stick-insect nymph would survive in an ant nest for very long. At this point some of the observations I had made during my study of seed dispersal by ants came

The voracious *Didymuria violescens* is one of the species of stick-insects that can cause devastation to eucalypt forests in mountainous areas of south-eastern Australia.

DENSEY CLYNE

in handy. I had discovered that the colonies of many ant species do not stay put for very long but constantly re-excavate and relocate their nests. Some species move nests several times per year, so I reasoned that an egg taken into a nest was unlikely to still be in an active part of the nest one or two years later when it hatched. Another intriguing, although one-off observation suggests that, even if a nymph did hatch out in an active nest, it may not be in danger. Some workers in South Africa who, coincidentally, were studying the relationship between stick-insects and ants at the same time (in fact they beat us into press by a few months) noted that a nymph that had hatched in a lab colony of ants was apparently ignored.

There was, however, a second and perhaps greater problem that the young stick-insects might face. Newly hatched nymphs are rather delicate-looking creatures, seemingly rather ill-suited for digging their way up through the soil. To

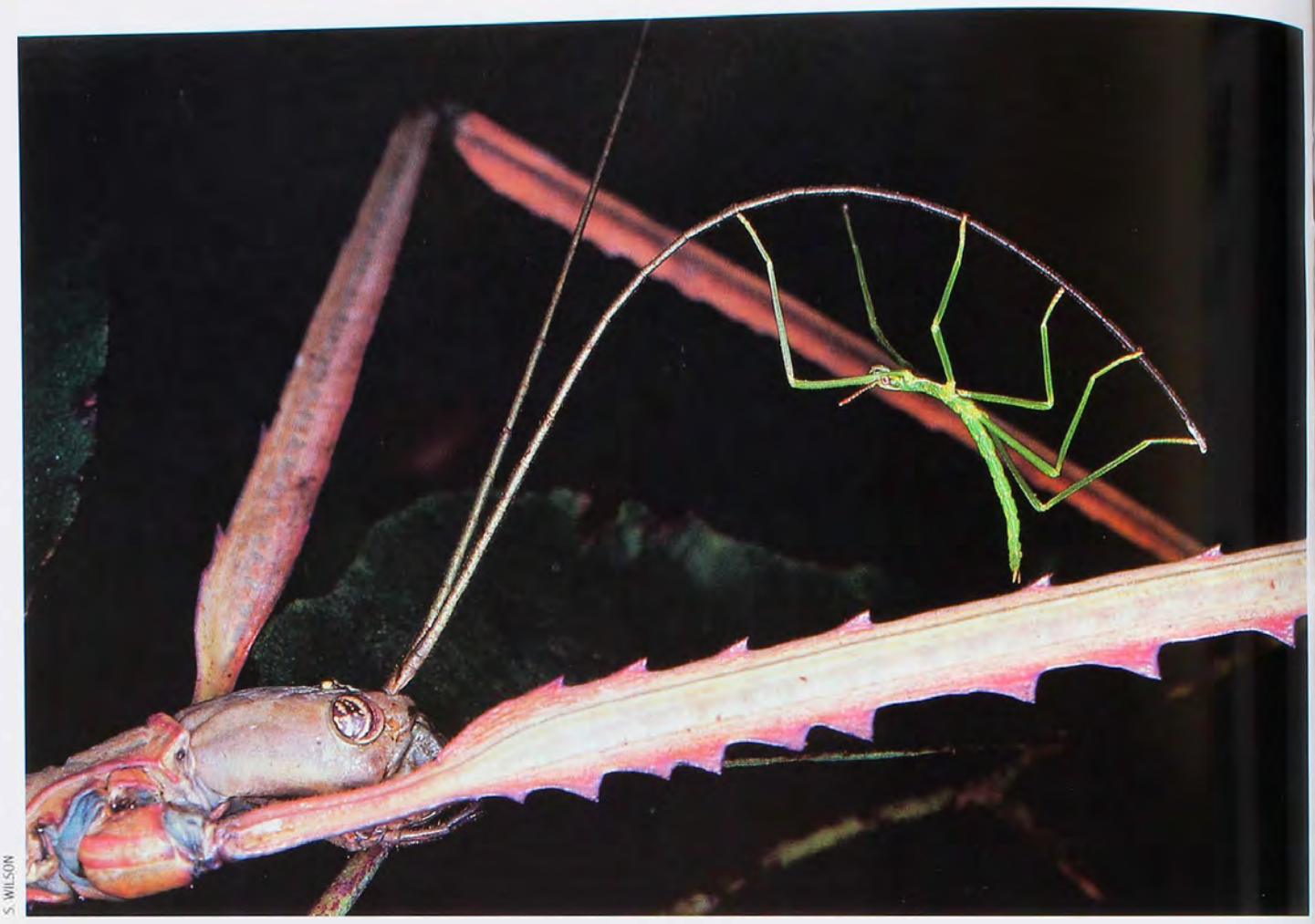
REG MORRISON

An *Extatosoma tiaratum* nymph escapes from its egg.

test whether they could, in fact, extricate themselves, I buried eggs at different depths in pots of soil and waited for them to hatch. Rather to my surprise I found that nymphs from eggs buried under six centimetres of soil were able to emerge just as successfully as those from eggs placed on the surface. One intrepid specimen even managed to emerge from a depth of 12 centimetres. I knew from the results of the soil sampling at Namadgi, and from the many hours I had spent excavating ant nests, that most seeds discarded in nests end up in the top six centimetres of soil and it seemed reasonable that eggs would be buried at similar depths. So, being buried did not seem to be an insuperable problem.

There was a final piece of evidence that stick-insect eggs are specifically adapted to attract ants. While many stick-insect species either drop or flick their eggs onto the ground surface below, there are some species that have more deliberate egg-laying methods. Some produce sticky eggs that they wedge in bark crevices or under leaves, while others descend to the ground and bury their eggs in a shallow groove in the soil. If the function of the capitulum is to attract ants, then it should be absent from the eggs of species that either hide or bury their eggs. I gathered as much information as I could find from the literature and from museum specimens on the presence of the capitulum and the particular egg-laying behaviour of different species. My survey of 34 stick-insect genera revealed that, of the stick-insect species that drop their eggs on the ground, approximately half produced eggs with capitula. But more importantly, capitula are not found on the eggs of any of the species whose eggs are buried or stuck to vegetation, and thus

An outbreak of stick-insects had occurred during the previous summer in Namadgi National Park in the ACT. The plague had been so intense that one of the rangers described the sound of falling faeces and eggs to be like rain.



S. WILSON

An *Acrophylla titan* nymph on the antenna of an adult.

less accessible to ants.

The stick-insect egg puzzle, almost solved nearly a century ago but for the timing of different observations, is an example of a phenomenon called evolutionary convergence. This describes the situation where unrelated organisms evolve a similar adaptation to cope with the same set of circumstances. Seeds of plants such as acacias generally germinate only after fires but need to be buried slightly to avoid being burnt. Stick-insect eggs, like these seeds, are also protected from the hazards of fires (and parasitic wasps) by being buried in soil. Both have come up with the solution of employing ants, those tireless picker-uppers of small round objects, as burial agents.

Stick-insects have developed remarkable methods of camouflage to avoid their enemies. It seems appropriate that these insects, the ultimate plant look-alikes as adults, should have eggs that resemble seeds so closely. The convergence of their eggs with elaiosome-bearing seeds means that these insects are even more like plants than anyone could have imagined. ■

Further Reading

Bedford, G.O., 1978. Biology and ecology of the Phasmatodea. *Ann. Rev. Entomol.* 23: 125–149.

Compton, S.G. & Ware, A.B., 1991. Ants disperse the elaiosome-bearing eggs of an African stick-insect. *Psyche* 98: 207–213.

Hughes, L. & Westoby, M., 1992. Capitula on stick-insect eggs and elaiosomes on seeds: convergent adaptations for burial by ants. *Func. Ecol.* 6: 642–648.

Key, K.H.L., 1991. Phasmatodea. Pp. 394–404 in *The insects of Australia*, ed. by Entomology Division, CSIRO. Melbourne University Press: Carlton.

Lesley Hughes is now at the Department of Organismic and Evolutionary Biology at Harvard University where she is studying the possible influence of future climate change on the interactions between plants and insects.

M. PROCIV

Stick-insects employ a variety of defence mechanisms. Some, like this formidable *Extatosoma tiaratum*, adopt a threatening posture, while others squirt noxious substances or simply fall to the ground and feign death.

WARNING!

THESE MEDICINES HAVE A DEADLY SIDE-EFFECT.

If the killing of tigers for medical remedies continues at its present rate, within 5 years there will be no tigers left alive in the wild.

If that shocks you, so will this. Products like those on this page, which purport to contain parts of tigers, have been purchased in Australia by WWF investigators.

Incredibly, none of the store owners selling these substances are likely to be prosecuted. Because although it's illegal to import products made from tigers, it's virtually impossible to bring a case against those selling them due to inadequate laws controlling domestic sale.

It's a legal loophole which is fuelling the demand for tiger products in Australia and helping to ensure the tiger's extinction.

WWF will soon be lobbying government to change the law and this horrible hypocrisy. We need your support to do this.

Write to WWF at GPO Box 528, Sydney, 2001 and we'll send you information on how you can help us stop the illegal trade in tigers and other endangered species.

Before it really is too late.

WWF

YES, I'LL JOIN WWF IN FIGHTING ILLEGAL TIGER TRADE.

☐ I will support WWF. I enclose $35 by cheque / money order / credit card.
☐ Please accept my donation of $_____ ($100, $75, $50 – other)
Or charge my ☐ Amex ☐ Visa ☐ Mastercard ☐ Bankcard

Card number _____

Signature _____ Expiry Date ___/___/___

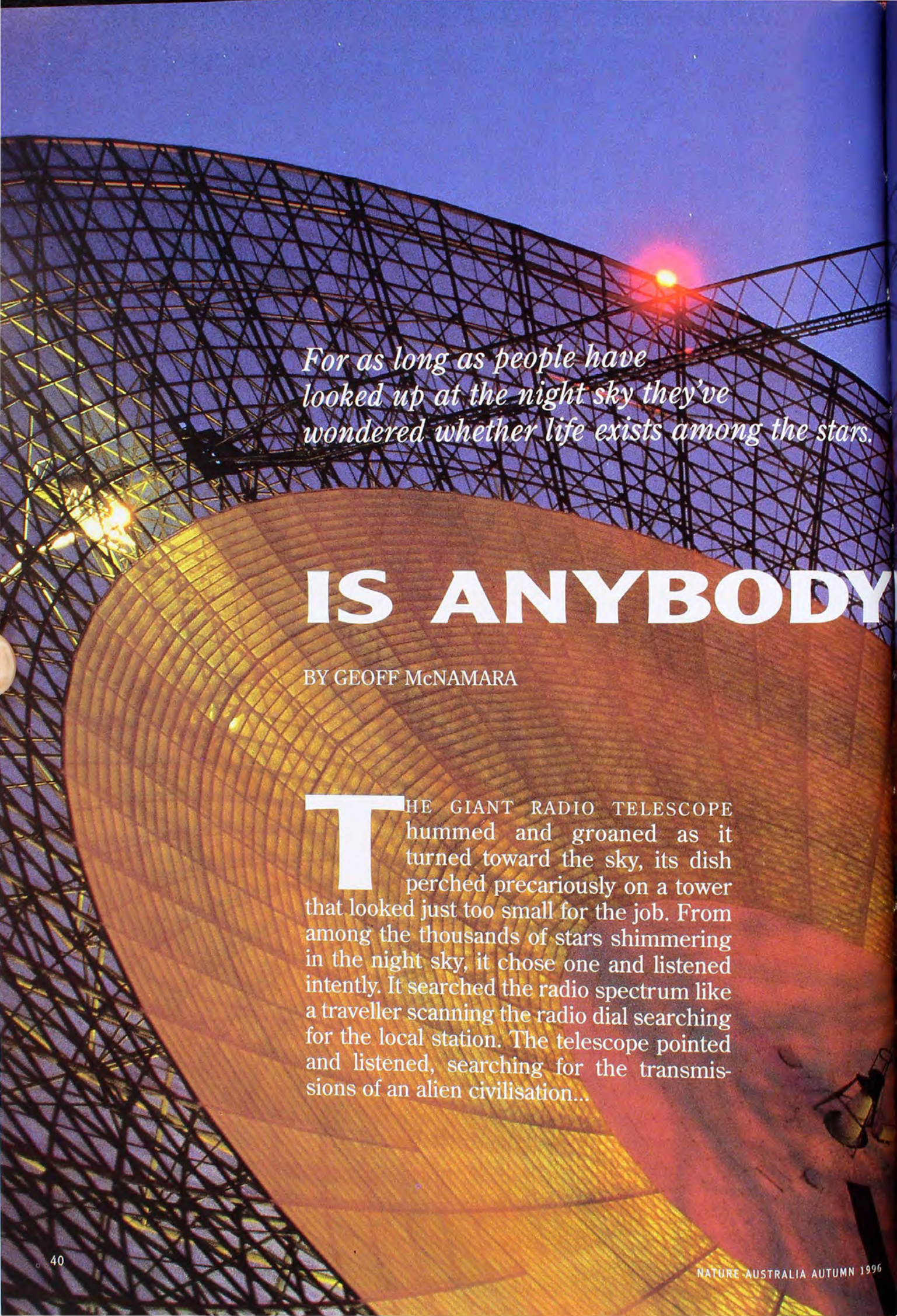
Name _____

Address _____

_____ Postcode _____

Telephone: Home _____ Work _____

Please return to WWF Australia, GPO Box 528, Sydney NSW 2001



For as long as people have looked up at the night sky they've wondered whether life exists among the stars.

IS ANYBODY

BY GEOFF McNAMARA

THE GIANT RADIO TELESCOPE hummed and groaned as it turned toward the sky, its dish perched precariously on a tower that looked just too small for the job. From among the thousands of stars shimmering in the night sky, it chose one and listened intently. It searched the radio spectrum like a traveller scanning the radio dial searching for the local station. The telescope pointed and listened, searching for the transmissions of an alien civilisation...

OUT THERE?

For five months in 1995, the giant radio telescope at Parkes searched the southern sky for extraterrestrial intelligence. This was stage one of Project Phoenix.

This might sound like science fiction, but it's just what the 64-metre radio telescope at Parkes in New South Wales did for the first five months of 1995. After decades of debate and uncertainty, the latest and most sophisticated search for extraterrestrial intelligence, or SETI, had begun. The first stage of the current search used the Parkes telescope to listen in to nearby stars with similar properties to the Sun. The telescope wasn't listening to the stars themselves, but listening for the radio transmissions from alien civilisations that might live on a planet orbiting around individual stars the same way that Earth orbits around the Sun. The aliens' transmissions could be either a deliberate beacon advertising their presence to the cosmos or even directly to us, or simply their equivalent of radio and TV broadcasts accidentally leaking into space. Either way, astronomers can now distinguish between known natural and artificial radio signals. It's the artificial signals that SETI astronomers are looking for.

SETI is not a recent inquiry. For as long as people have looked up at the night sky they've wondered whether life exists among the stars. Even in pre-telescopic times many great thinkers concluded that it's unlikely humans are the only sentient creatures in the universe. As Metrodorus of Chios, a student of the Greek philosopher Democritus in the fifth century BC, put it "To consider the Earth as the only populated world in infinite space is as absurd as to assert that in an entire field of millet, only one grain will grow."

As we learned more about our cosmic environment, extraterrestrial life seemed more logical. In 1543, Copernicus expressed the long-held

Within the Orion nebula, many of the young stars are surrounded by discs of dust and gas. From these protoplanetary discs, planets may form that could support life.

C. R. O'DELL/RICE UNIVERSITY

belief that the Earth was not the centre of the universe. Galileo proved that fact in the next century when he showed that the planets in the sky were worlds in their own right. Since then, the Earth—and we on it—have taken an increasingly minor position in the cosmos.

Two relatively recent discoveries strengthened the argument for extraterrestrial life. The first was the realisation that the origin of life on our world could be the result of a series of, admittedly complex, chemical reactions. After centuries of accepting that life must have been the result of a divine act, now life's origins could be seen as a natural process. The second was evidence that planets might be forming around other stars. Despite the best wishes of Star Trek script writers, planets beyond our solar system were, until recently, mere fantasy. The problem with finding extrasolar planets is a simple one: glare. Stars like the Sun are very bright, while planets like Earth are relatively faint. Seen from deep space, the Earth would be lost in the blinding glare of the Sun. However, a number of young stars are surrounded by large discs of dusty material from which astronomers suspect planets may form. While planets are invisible, these protoplanetary discs are large enough to be seen beyond the glare of the star. But even more important is just how common the process of planetary formation may be: recent observations with the Hubble Space Telescope of a star-forming region in the constellation of Orion show that, of over 100 newly forming stars there, more than half are surrounded by protoplanetary discs. After years of unfounded speculation on their existence, 'extrasolar planets' could turn out to be downright common. If planets turn out to be a natural by-product of star formation, it seems reasonable that at least some of those planets will have the right conditions for life.

Even before any of these facts were in, however, people believed so strongly in life beyond the Earth that they came up with some fascinating ways to communicate with it. Nineteenth-century astronomers knew they had no way of travelling to the other planets in our solar system. They also knew the mere existence of extraterrestrial life was not enough; after all, a planet may be teeming with daisies, and we'd never know they were there. In order to make contact with an extraterrestrial species, it would have to be intelligent enough to interpret Earthlings' attempts at communication, and maybe even respond. So, believing that not only life, but intelligence, had evolved elsewhere in the solar system, scientists set to work designing ways to advertise themselves to their interplanetary siblings.

The most obvious place to look for life was the Moon, or perhaps the nearest of the planets, Mars. In the 1820s, Karl

CARL BENTO/NATURE FOCUS

Engineer Bud Hill emerges from the Mobile Research Facility or MRF (pronounced 'murf'). The equipment inside the MRF has been attached to the Parkes radio telescope to enable it to search for radio transmissions from alien civilisations.

Friedrich Gauss suggested planting pine trees in formation in Siberia. By constructing right-angled triangles of Pythagorean ratios large enough to be visible from the Moon, not only would lunar inhabitants conclude that intelligent life existed on the Earth, but that it was mathematically literate! In 1840, the Viennese astronomer Joseph von Littrow proposed a less ecologically minded method of advertising our existence to Martians: fill a 32-kilometre wide ditch in the Sahara Desert with kerosene and ignite it. The resulting linear inferno would be clearly visible from space! Other suggestions included building huge mirrors across Europe to reflect the Sun in a form of cosmic Morse code, or using large motors to drive great black cloths over light-coloured surfaces so that the Earth winked at its nearest celestial neighbours.

A planet may be teeming with daisies, and we'd never know they were there.

One of the most popularised attempts at communication was made only a few years ago. A plaque and a gold-plated copper phonograph record that explained how to find Earth and what it's like here were attached to the Pioneer and Voyager spacecraft now speeding into deep space. But even at their tremendous speeds it will be tens of thousands of years before these interstellar billboards reach even the nearest stars.

By the middle of this century, astronomers had given up on the idea of finding intelligent life within our solar system. But the search for even primitive forms of life was (and is) still taken seriously. In the 1970s two robot spacecraft called Viking 1 and Viking 2 were sent to Mars to search for life. The results of the Viking experiments were at first inconclusive, but later, more detailed analyses of the results convinced most scientists that there is no life on Mars...at least in the areas sampled.

It now seems unlikely that life exists on any of the other planets in our solar system, so what made the Earth so special? The Earth orbits the Sun at just the right distance—any closer and we'd cook, any farther away and we'd freeze. Further, the chemical and physical conditions here are now perfectly suited to our needs. This makes some people think that the Earth is just a freak of nature and tailor-made for us. Others look at it the other way around, pointing out that, if the conditions were any different, we wouldn't be here debating the matter because we'd never have evolved in the first place. Either way, the question arises: are there any other planets in the Galaxy capable of supporting life and, if so, how do we find out?

JUST AS THE EARLY SETI RESEARCHERS realised they couldn't travel to the planets, modern researchers find themselves similarly bound to the solar system. While interplanetary travel is possible, if expensive, interstellar travel is likely to remain impossible for the foreseeable future. The problem is distance: our fastest rockets would take tens of thousands of years to travel to even the nearest stars. But while we can't travel among the stars, perhaps our words and images—or those of an extraterrestrial—can. After all, you don't need to travel to Europe to know there are, indeed, Europeans: even a simple shortwave radio lets you listen in on countries on the other side of the globe. Assuming that extraterrestrials are also intelligent enough to build radio transmitters, why can't we listen out for their transmissions?

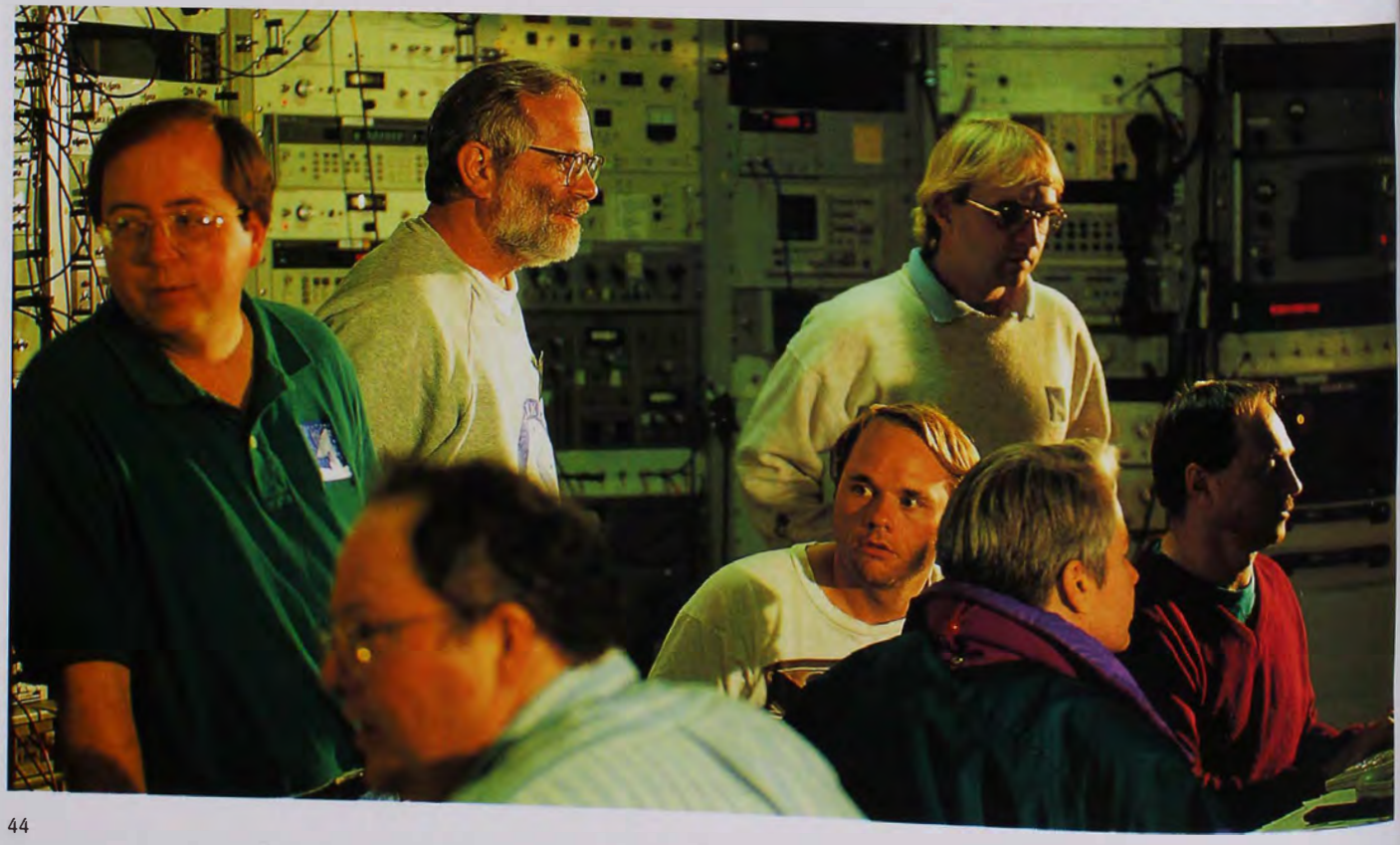
The first suggestion that radio signals from extraterrestrial civilisations could be detected using existing radio telescopes was made by Giuseppe Cocconi and Philip Morrison in a now historic paper published in the British journal *Nature* in 1959. By carefully examining the signals received from space, artificial signals should be distinguishable from the natural background 'radio noise' of the Galaxy. Sure it was a long shot, but as Morrison and Cocconi point out, "The probability of success is difficult to estimate, but if we never search, the probability is zero."

Quite independently of Cocconi and Morrison, a young American astronomer by the name of Frank Drake had thought of the same idea, and a year later pointed a 26-metre radio telescope at two arbitrarily chosen stars, Tau Ceti and Epsilon Eridani. At Tau Ceti he found nothing and, although he found a series of pulses apparently coming from Epsilon Eridani, this later turned out to be interference from a man-made source. However, Drake had shown how to listen to the stars. Modern SETI was born.

After three decades of independent and under-funded searches, the American space agency NASA finally committed itself to a ten-year search of the entire sky. On the 500th anniversary of Columbus' arrival at the New World, the search called the 'High Resolution Microwave Survey' (HRMS) was begun. The HRMS involved two search methods. One group of scientists was to con-

The probability of success is difficult to estimate, but if we never search, the probability is zero.

Inside the control room of the Parkes radio telescope before the launch of Project Phoenix. In order to test the SETI equipment, scientists instructed it to pick up the distant signal from the Pioneer 10 spacecraft. Here, they anxiously wait while the computers conduct their search.



CARL BENTO/NATURE FOCUS

CARL BENTO/NATURE FOCUS

On the enormous dish of the Parkes radio telescope.

duct a 'targeted search' of 1,000 nearby stars, while a second team was to conduct a systematic survey of the entire sky. But SETI is a controversial issue among politicians and scientists alike. The politicians argued that SETI was an expensive indulgence with practically no chance of success, while even fellow astronomers argued that it wasn't 'real science' and was a waste of limited scientific funding. Finally, faced with a $US4 trillion foreign debt, the US Congress pulled the plug on the HRMS less than a year after it had begun. The HRMS was dead.

Immediately after hearing of Congress' decision, the SETI Institute set about raising funds from private sources. On top of the HRMS equipment that was generously donated by NASA, over $US4 million were raised within three months, enough to keep the targeted search going. The new, privately funded SETI was appropriately called Project Phoenix (after the mythical bird that rose from the dead). The first stage of Project Phoenix was a survey of stars in the southern sky conducted with the Parkes radio telescope. A second telescope at Mopra, near Coonabarabran in northern New South Wales, was used to verify any suspect signals picked up at Parkes in order to rule out local interference.

ASSUMING THAT INTELLIGENT LIFE DOES exist out there, what should we do if it's discovered? Should we respond? To this question, several countries, including Australia and the United States, say no! Of course, nobody really believes in aliens coming down and destroying our world: interplanetary travel is extremely difficult and expensive; interstellar travel even more so. But what if? The chances of aliens visiting the Earth are remote, but nobody's willing to gamble. While there have been deliberate past attempts to advertise ourselves to the cosmos, including the Voyager plaques, such activities are now frowned upon.

There are a number of other reasons why we as a species need to be cautious about communicating with extraterrestrials (as opposed to simply detecting them). For example, think about how we're able to search at all. We're the dominant species on the planet; at the


PROJECT
PHOENIX

CARL BENTO/NATURE FOCUS

Success. The computers have picked up the Pioneer 10 transmission and all is now ready for the launch of Project Phoenix. Engineer Gary Helligman attempts to explain just how faint and distant the Pioneer 10 signal is.

top of the food chain; at the top of the evolutionary tree. The way we got here is by being incredibly ruthless and self-centred: nothing matters except our survival. If another race of beings elsewhere in the Galaxy has managed to get to the top of their evolutionary tree, they'll have made it for the same reasons. Michael Archer notes in his article "Slime Monsters Will Be Human Too" (*Nature Aust.** Autumn 1989) that the horrific creatures depicted in "Alien" and "Predator" may be exactly what we'll find out there: "ETs and ALFs may be more appealing to us...but they are most unlikely to be the products of competition for survival on another world".

The chances of Earth being invaded by an 'alien nation' are slim if for no other reason than the fact that interstellar travel is just about impossible. But there are other dangers in making contact with an advanced civilisation, even if just by radio. At a 1992 Horizons of Science forum held at the University of Technology, Sydney, Ray Norris from the Australia Telescope National Facility notes what happens when even benevolent cultures on Earth encounter primitive tribes: the culture of the more primitive tribe tends to disappear. One of the major cultural activities in Western society is science—trying to find answers to 'life, the universe, and everything'. Now suppose a more advanced extraterrestrial civilisation contacts us and tells us the answers to all those questions that our science is currently trying to answer. Overnight the role of scientists changes from one of unravelling the secrets of the universe to interpreting the knowledge handed down by the more advanced aliens. "In short scientists become priests, and science becomes a religion," said Norris.

Norris is doubtful that anything like this scenario could ever happen, and believes that, if a detection is made, it'll be a simple tone or pulse like a beacon. But even the passive discovery of an advanced civilisation has tremendous implications for how we view ourselves. Bobbie Vaile from the University of Western Sydney, one of the principle researchers in Project Phoenix, points out that discovering extraterrestrial intelligence could have a uniting effect on the people of the Earth. "What we're doing to our own environment may be relevant to another," said Vaile. Even a negative result to the search will have tremendous consequences for the way we view ourselves and planet Earth. It could be that, as far as we can tell, the Earth is the only life-sustaining planet in this Galaxy and so we should take a long, hard look at what we're doing to it.

We have discovered that the stars in the sky are simply distant suns, and there is now at least some evidence that many of those suns might have planets orbiting around them. Isn't it a logical next step to assume that, on at least some of those worlds, life has evolved into thinking beings? When you next look up into the night sky, remember there may be an alien creature on some distant world looking in the direction of Earth, wondering if we exist.

...So the Parkes telescope pointed and listened. After a while the computers decided there was nothing they could hear and told the radio telescope to move on to the next star. ■

If the Parkes radio telescope does discover life on another planet, should we make contact?

Further Reading

Davies, P., 1995. *Are we alone?* Basic Books: New York.

McDonough, T., 1987. *The search for extraterrestrial intelligence.* John Wiley & Sons Inc.: New York.

Sagan, C., 1983. *Cosmos.* Futura: London.

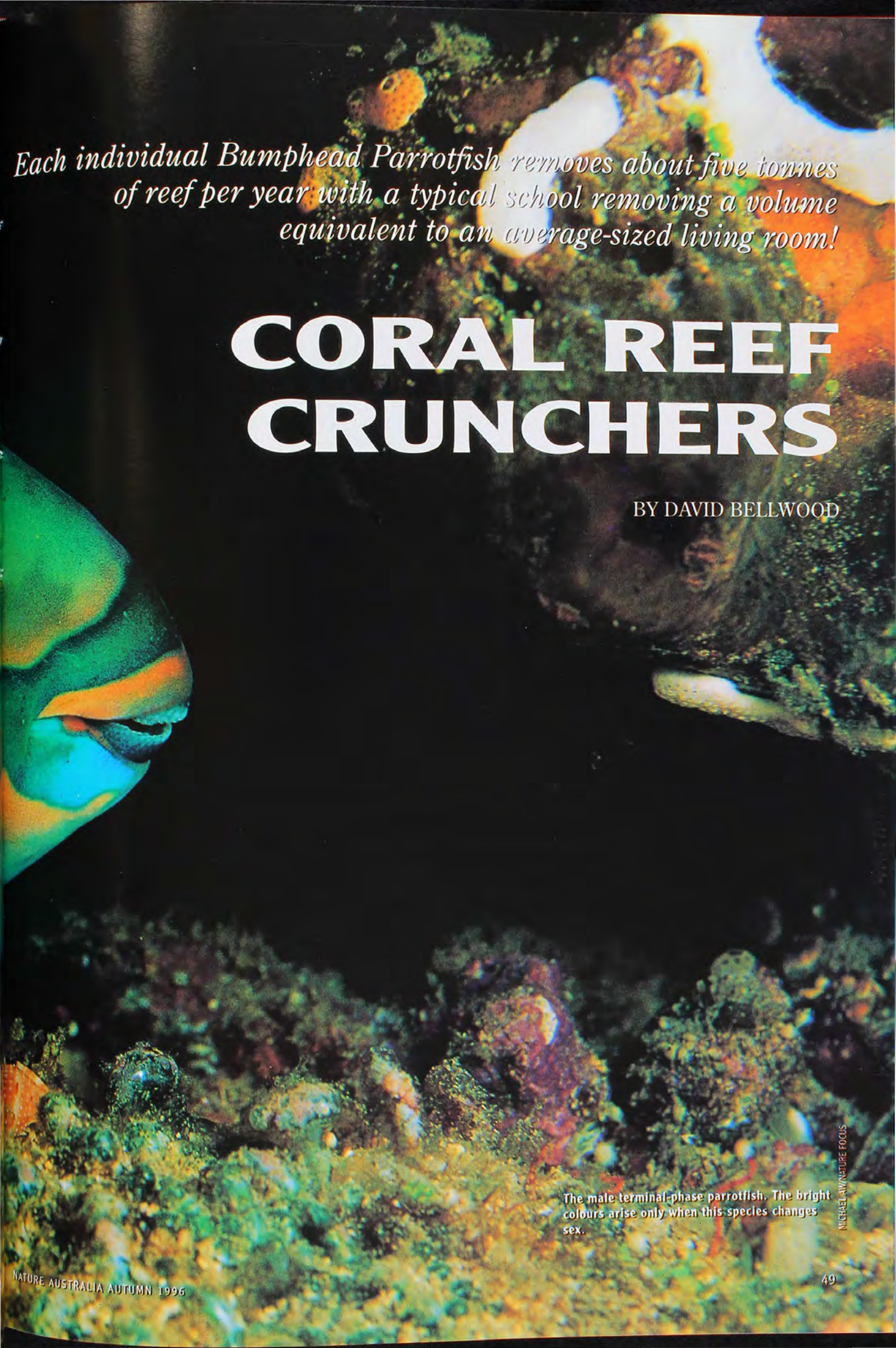
Geoff McNamara is Associate Editor for Sky & Space *magazine, and a regular contributor to several popular science magazines.*

**Previously ANH.*

Each individual Bumphead Parrotfish removes about five tonnes of reef per year with a typical school removing a volume equivalent to an average-sized living room!

CORAL REEF CRUNCHERS

BY DAVID BELLWOOD



The male terminal-phase parrotfish. The bright colours arise only when this species changes sex.

MICHAEL AW/NATURE FOCUS

ON CALM DAYS ON THE OUTER face of the northern Great Barrier Reef, divers regularly hear a distinctive cracking sound in the distance. Those who wait may be lucky enough to see a huge school of large grey-green fishes slowly swimming along the reef biting off chunks of coral and leaving in their wake a cloud of sediment. These are Bumphead Parrotfishes (*Bolbometopon muricatum*), the largest parrotfishes in the world.

The Bumphead Parrotfish is only one of the 28 species of parrotfishes that inhabit the Great Barrier Reef. Although well known for their changes in sex and colour pattern (see box), the effects of their feeding activities have received less attention. The role of parrotfishes as 'bioeroders' (biological agents that remove material) has been known since the days of Charles Darwin, who first recorded their erosion of the reef during feeding. But far from being a threat to the reef (like a fish equivalent of the Crown-of-thorns Starfish), recent studies have shown that they play a central role in the dynamics of the reef system.

Quantifying the extent and importance of this role has been a major part of my research over the last 14 years. In collaboration with Howard Choat, a colleague in the Department of Marine Biology at James Cook University, most of the field work has been based at Lizard Island Research Station, a facility of the Australian Museum. This has involved following known individual parrotfishes for days on end and recording details of their feeding activities. We were in the water before sunrise to record the first parrotfish bite and continued observations until dusk when the last parrotfish dived into a hole to sleep. Their every moment was recorded, from the number and exact location of individual bites to the location and time of each defecation event. From these observations, a detailed picture of their lives has now been constructed.

PARROTFISHES START THE DAY BY LEA ing their sleeping site and swim ming to their feeding area. Some parrot fishes are protected by a mucous 'sleep ing-bag' in which they spend the night This mucous bag is secreted by glands around the head and spreads down over the body. Its chemical composition dif fers from normal body mucus and is believed to be unpleasant to taste or smell, thus deterring nocturnal pr ed tors such as sharks and moray eels that hunt mainly by scent. A similar bag is secreted by wrasses, which sleep in the sand at night. As parrotfishes evolved from a lineage of wrasses, this bag may have initially served to protect wrasses from the sand but has been retained by parrotfishes for a different purpose. Each morning the bag is left behind as

The Bumphead Parrotfish nibbles plate corals like a child nibbles the edges of a biscuit until only a small disk remains.

COLLARD/THE BLUE WATER CO.

At approximately 80 centimetres long this is a young Bumphead Parrotfish. It is the only species for which a large part of the diet is live coral. This individual would consume around one tonne of live coral per year.

the parrotfish swims out of hiding and up onto the reef to feed.

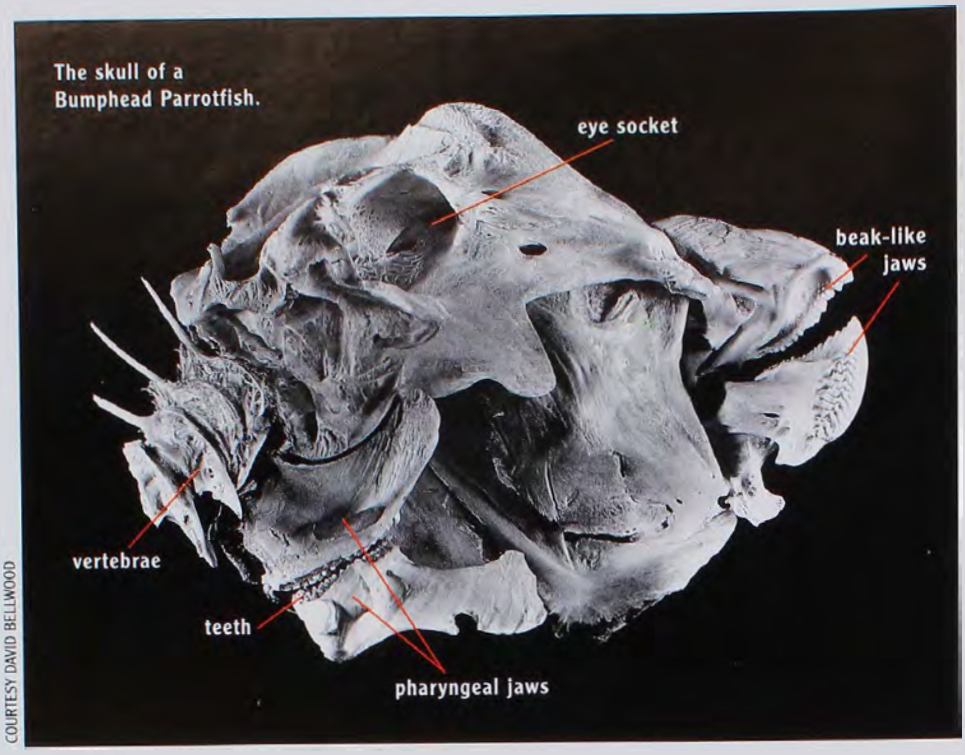
Some parrotfishes such as the Steephead Parrotfish (*Chlorurus microrhinos*, formerly known as *Scarus gibbus*) migrate between their feeding and sleeping sites, swimming more than half a kilometre each way. They can be seen streaming up and down the reef like commuters going to and from work. Others, such as the Bridled Parrotfish (*Scarus frenatus*), have a life-long attachment to specific sites. Newly settled individuals arrive at the reef base and slowly migrate to the reef crest over the next few months. Here they spend the rest of their lives (up to seven years of age), within 100 metres of the point where they first settled.

But it was the observations on the feeding behaviour of these fishes that enabled us to clarify their ecological role on coral reefs. For a long time it was assumed that parrotfishes were a uniform group of scraping grazers, removing algae from the reef with their parrot-like jaws, and taking a little bit of the reef with each bite. However, our work on the Great Barrier Reef revealed two distinct groups of parrotfishes: the 'scrapers' and the 'excavators'. The latter group contains species that, instead of scraping algae off the reef, actually bite chunks out of the reef. It is these excavating forms that are actively eroding the reef. For example, each individual Bumphead Parrotfish removes about five tonnes of reef per year with a typical school removing a volume equivalent to an average-sized living room! The smaller Steephead Parrotfish removes about 1,000 kilograms (one tonne) every year.

The differences between the two groups of parrotfishes are reflected in their jaw structure and muscles. The 'scrapers' have relatively small muscles that can efficiently deliver an even, weak bite. 'Excavators', on the other hand, have muscles that deliver a short powerful bite, with all the force focussed on just a few points on the jaw. This bite cracks rather than scrapes the substratum.

Observations of the feeding patterns of excavating species have shown that, like most parrotfish species, they feed on algal-covered reef surfaces. This includes dead corals, which are quickly covered in algae. In this way, excavating parrotfishes are constantly removing or 'cleaning up' dead corals from the reef. Any coral that dies in the reef crest region is rapidly eroded by excavating parrotfishes. Only the Bumphead Parrotfish frequently feeds on live corals. It nibbles plate corals like a child nibbles the edges of a biscuit until only a small disk remains; the large finger-

A Steephead Parrotfish feeding on algal-covered coral rock. Each bite excavates one to two millimetres from the surface of the reef.



COURTESY DAVID BELLWOOD

like processes of staghorn corals are consumed by directly biting off up to five centimetres at a time.

In some species a feeding behaviour restricted to the excavation of protruding coral rock is matched by very characteristic defecation habits. One of the dominant bioeroding species, the Steephead Parrotfish, has very exacting toilet requirements. If you observe individuals feeding on the reef flat for any length of time, you begin to notice that individuals take turns at going 'missing'. By concentrating on a given individual for a long time, the reason for this behaviour becomes apparent: they are going away to defecate. Individuals suddenly stop feeding and swim off, often at speed, into the distance. Their destination is a defecation site, either a pit in the reef flat or an indentation in the reef front. Here the fish defecates heavily before returning to the exact same spot where it was feeding.

By sitting at a defecation site one can observe an amazing phenomenon: a fae-

COLOURFUL SEX

Parrotfishes are closely related to the wrasses (family Labridae) and with the wrasses they share one of the most complex series of colour patterns of any fish. The relationship between sex and colour is complicated. Most parrotfishes are protogynous hermaphrodites, that is they start life as females before changing sex to males, with an associated change in colour pattern. Others start off as males and remain male, changing their colour pattern but not their sex.

Parrotfishes have three basic colour phases: the juvenile phase, initial phase (IP) and terminal phase (TP). The juvenile phase is often unlike the IP or TP. Some juveniles are brightly coloured but most are uniformly coloured or striped. The initial phase (IP) is characterised by drab colours, predominantly shades of brown. Most IP individuals are females and remain reproductively active as females for approximately three to five years. In those species where the IP may be male, the IP males and females look the same. The final colour pattern is the terminal phase (TP). This is the most memorable one, with bright gaudy colours, dominated by reds, blues and greens. TP individuals are invariably male.

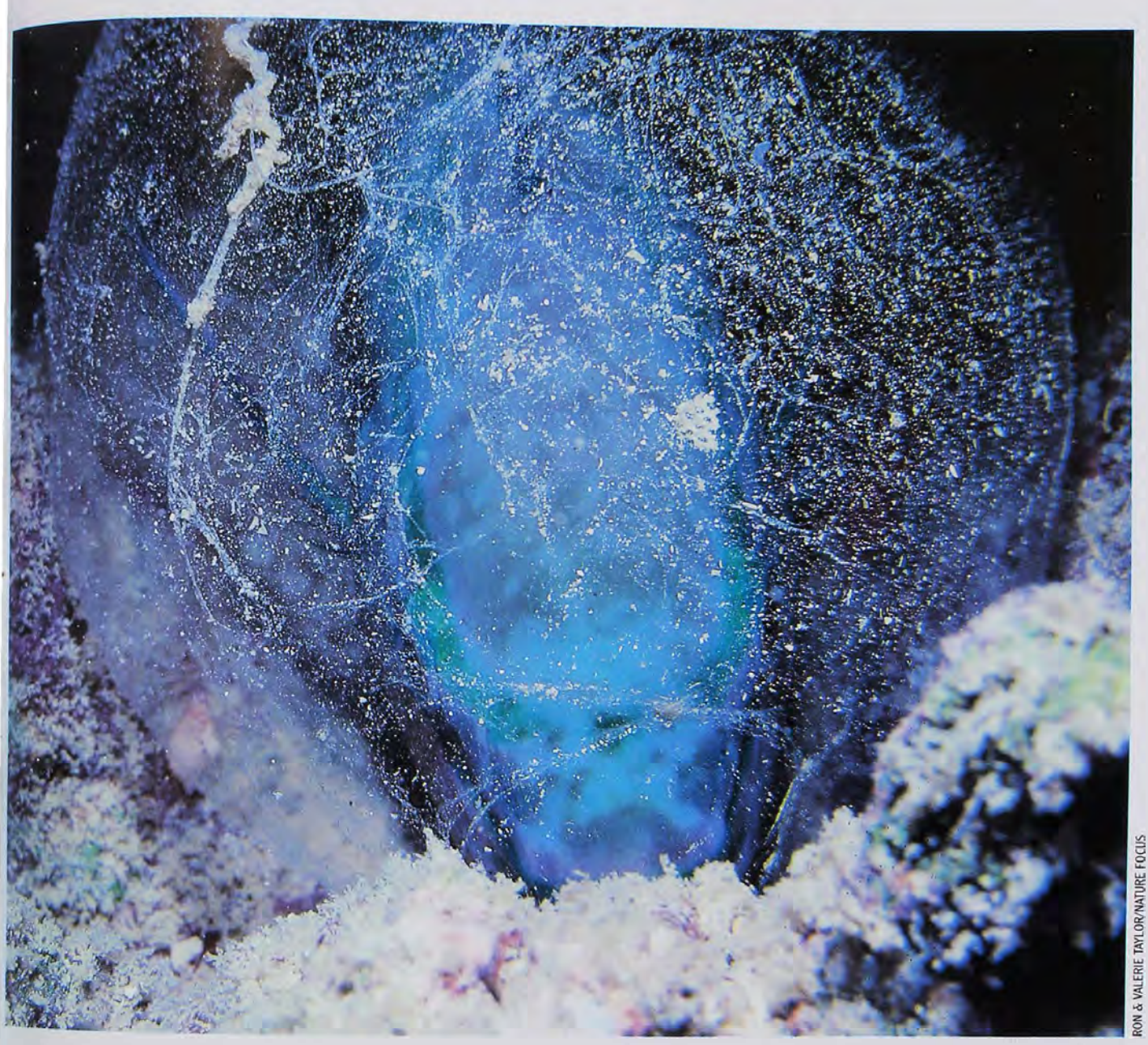
KEVIN DEACON

The jaws of this initial-phase Blue-barred Parrotfish (*Scarus ghobban*) clearly show the individual teeth that are coalesced to form the parrot-like beak.

There are two sexual strategies for parrotfishes. Some individuals follow the conventional protogynous hermaphroditism path with a female IP stage followed by a near simultaneous change in colour and sex to a male TP (called a secondary male). The alternative is to remain male throughout, first as an IP male then changing colour to become a TP male (called a primary male). The only sexual change is a shrinking of the testes.

All established TP males have small testes. In IP males the testes are huge, with a large central sperm duct. The two types of males compete for reproductive success in two different ways. TP males fight for exclusive reproductive access to females. They hold permanent or temporary reproductive territories, displaying to and actively excluding other males. The bright colour patterns of TP males are presumably directly related to this visual competition, proclaiming possession of territories and advertising possession and availability to females. These TP males usually mate with one female at a time. The small testes are presumably sufficient for these intimate encounters. However, they may mate with numerous females over the reproductive season.

IP males do not hold territories nor do they display. They typically mate in large mixed groups (of male and female IPs). Competition for reproductive success is at a sperm level. The spawning group swims rapidly up and away from the reef, releasing their gametes at the farthest point, before diving back to the reef. The structure of the testes suggests that the males rapidly expel large quantities of sperm during spawning, so that he who releases most fertilises most. Success for IP males, therefore, is determined by gonad size, sperm output and good timing.



RON & VALERIE TAYLOR/NATURE FOCUS

This parrotfish will spend the night completely encased within its mucous cocoon. The cocoon is reputed to deter nocturnal predators that hunt by scent.

cal air raid. A school of Steephead Parrotfishes at one location on Lizard Island repeatedly used a small 2 x 3 x 0.3-metre-deep depression in which to defecate. They would cruise in one to two metres above the reef and, without stopping, descend into the hole releasing their 'load' like World War 2 bombers with perfect aim. This defecation site received approximately 30 kilograms of faeces over a four-day period.

This exacting defecation pattern may have unforseen implications. For several years it has been observed that some territorial surgeonfishes defended their territories against all herbivores except some parrotfishes. It was always assumed this aggression was directed to species that competed for food. Why some parrotfishes failed to elicit this aggression was a mystery, until now. It appears that toilet manners have a lot to do with it. Fish that defecate where they feed are vigorously excluded; those with 'manners', that is fish that feed but go elsewhere to defecate, are permitted entry. The territorial surgeonfishes simply may not appreciate others defecating on their feeding areas!

By sitting at a defecation site one can observe an amazing phenomenon: a faecal air raid.

HOW DO PARROTFISHES MANAGE TO EAT whole chunks of coral and large quantities of reef rock each day? The answer lies in the possession of a second set of jaws in their throat (pharynx). This is a highly specialised pharyngeal jaw apparatus, comprising three tooth-bearing bones and their associated musculature. The upper two bones articulate

directly with the base of the skull while the lower bone is slung beneath these two. Powerful muscles pull the lower jaw bone upwards, crushing or shredding material between the opposing teeth on the upper and lower bones.

Although this type of jaw is present in damselfishes, wrasses and the freshwater cichlids, the pharyngeal jaws of parrotfishes are highly modified. The teeth are broad and rounded and grow in long rows. During feeding, the teeth on the upper bones and lower bone are pulled past each other, grinding any material into a fine paste. In fact, the parrotfish pharyngeal jaw apparatus is best likened to a cement mixer in reverse: solid reef matrix is taken in and ground into a slurry with the consistency of wet cement.

Passing this type of material through the gut would present something of a problem for most fish as the bulk of the diet is calcium carbonate (limestone). This would buffer the acid in the stomach and interfere with normal digestive processes. Parrotfishes, however, lack a stomach (having evolved from wrasse-like ancestors that also lacked a stomach) and so the problem of neutralising stomach acid does not arise. Instead, they have a highly modified gut that looks similar to our colon with a series of sacs or pouches along its length. This is probably for sorting out particles by size and enables the fish to deal with large volumes of coarse thick digesta. Once a large part of the organic material has been removed, the remainder and all carbonate sediment is passed out as a thick slurry. Basically, the faeces are little more than mud and fine sand.

The parrotfish pharyngeal jaw apparatus is best likened to a cement mixer in reverse.

Parrotfishes are major contributors to reef sediment. As all coral eaten eventually comes out as sediment, the contribution of each species can be easily measured. Basically, what goes in comes out. Each Steephead Parrotfish therefore contributes about a tonne a year and each Bumphead Parrotfish about five tonnes! If you ever have the chance to cover yourself in the beautiful warm coral sand on Green Island or Heron Island, you might like to think about where all that sand came from...yes, you're up to your neck in it!

Parrotfishes are beautiful animals, but this belies the importance of their role on the Great Barrier Reef. As bioeroders and herbivores, they shape both the reef and the sedentary communities living on it. Overfishing of herbivorous fishes, and parrotfishes in particular, has been identified as a major factor leading to reef degradation, with the resulting

RON & VALERIE TAYLOR/NATURE FOCUS

The Blue-barred Parrotfish (*Scarus ghobban*) is one of the most widespread parrotfish species, extending from the east coast of Africa, through the Indian and Pacific Oceans across to the Gulf of California.

RON & VALERIE TAYLOR/NATURE FOCUS

The male terminal-phase Surf Parrotfish (*Scarus rivulatus*) has a striking colour pattern. As an initial phase this individual would have been uniformly pale brown. It probably spent several years as a female before changing its sex and colour pattern.

PARROTFISHES

Classification
Order Perciformes, suborder Labroidei, family Scaridae (sometimes placed in the Labridae), with 80 species in 10 genera. Largest is Bumphead Parrotfish (*Bolbometopon muricatum*) at 120 cm total length; smallest is Caribbean Slender Parrotfish (*Cryptotomus roseus*) at 11 cm total length.

Distribution and Habitat
Widespread in all tropical seas including the Red Sea, Indian Ocean, Great Barrier Reef, Indo-Australian Archipelago, the Pacific Ocean and the Caribbean. Found in some subtropical areas such as the Mediterranean Sea (larvae also often present in Sydney harbour during summer months). Although they live in many coastal habitats including seagrass beds, rocky shores and mangroves, they are most abundant on coral reefs.

Biology
Characterised by gaudy colours and a beak-like pair of jaws that is used to feed on algal-covered reef substrata. Usually found in schools, either with other parrotfishes or with herbivorous surgeonfishes. Complex series of colour patterns usually linked with change in sex. Mostly protogynous hermaphrodites, starting life as female and changing to male; others start and finish as male.

Status
Although no species are endangered, parrotfishes are heavily fished throughout most of their range. In many areas they have been overfished.

algae smothering the corals. Our understanding of coral reef systems is rudimentary, with management strategies still in an experimental phase. We cannot predict the consequences of many types of exploitation or overfishing. However, one thing is clear: in terms of their role on the reef, not all fishes are equal. Some are more important than others. ■

Further Reading

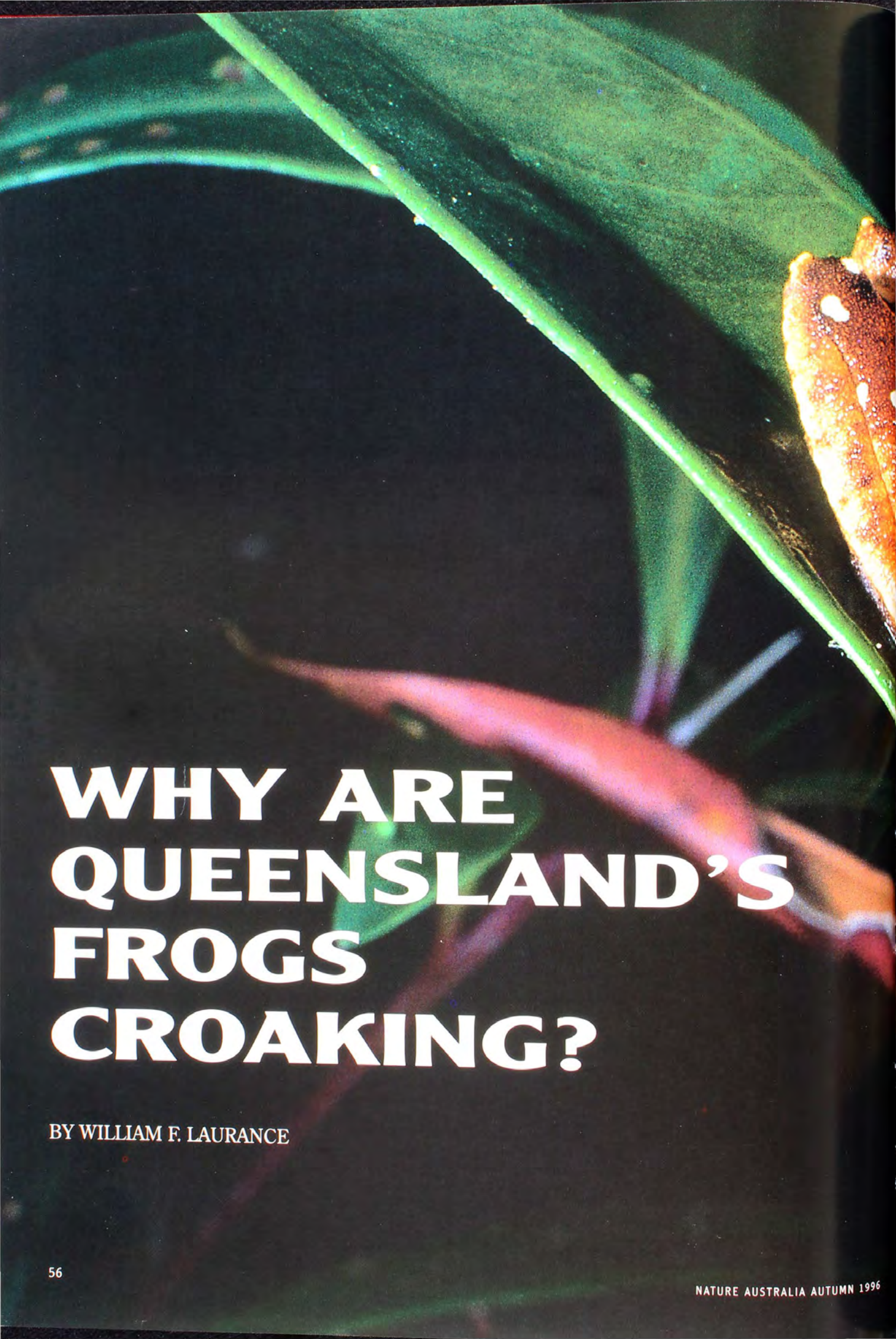
Bellwood, D.R. & Choat, J.H., 1990. A functional analysis of grazing in parrotfishes (family Scaridae): the ecological implications. *Environ. Biol. Fishes* 28: 189–214.

Bellwood, D.R., 1994. A phylogenetic study of the parrotfishes family Scaridae (Pisces: Labroidei), with a revision of genera. *Rec. Aust. Mus. Suppl.* 420: 1–84.

Bellwood, D.R., 1995. Carbonate transport and intra-reefal patterns of bioerosion and sediment release by parrotfishes (family Scaridae) on the Great Barrier Reef. *Mar. Ecol. Prog. Ser.* 117: 127–136.

Bellwood, D.R., 1995. A direct estimate of bioerosion by two parrotfish species *Chlorurus gibbus* and *Chlorurus sordidus* on the Great Barrier Reef. *Mar. Biol.* 121: 419–429.

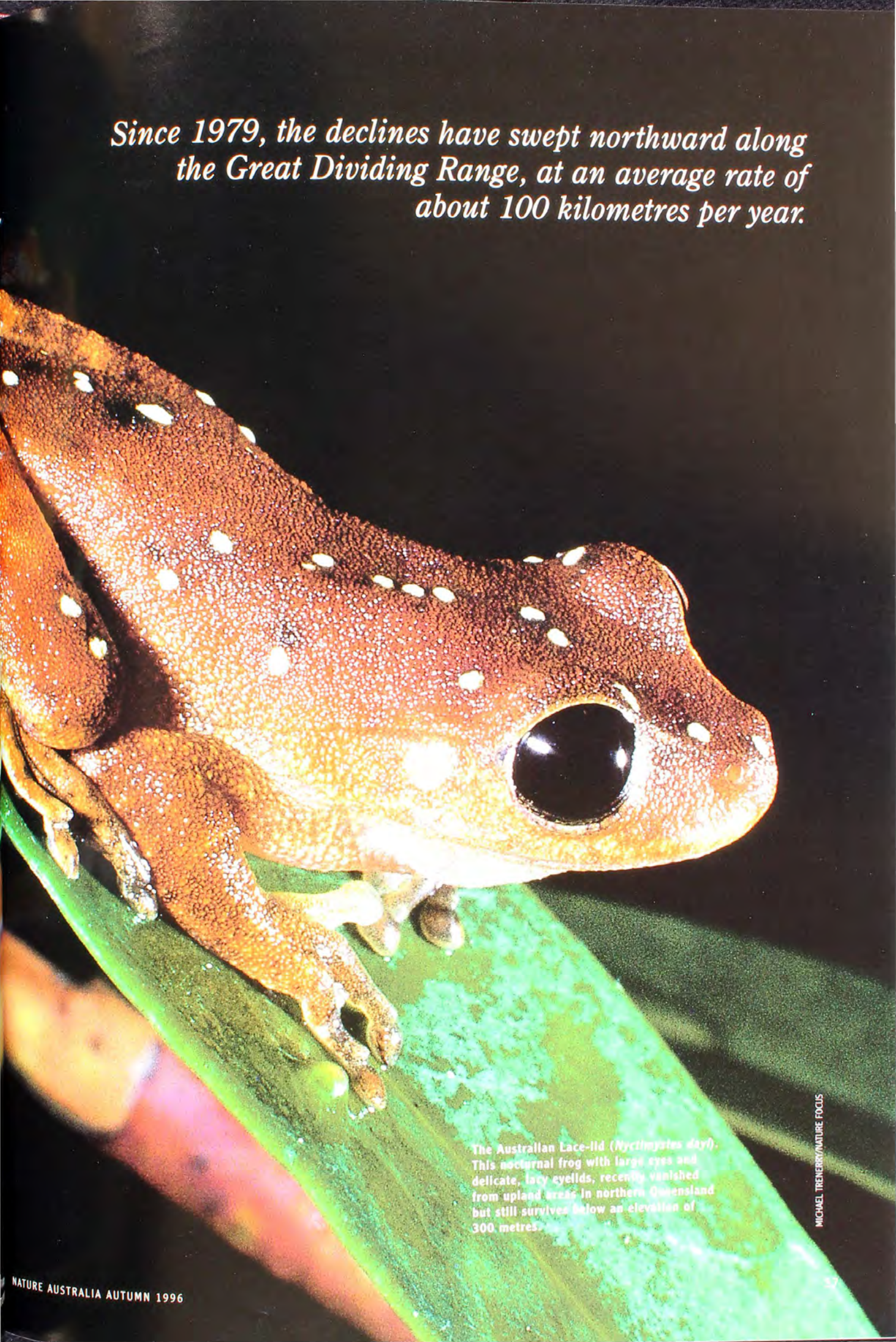
Dr David Bellwood is a Senior Lecturer in Ichthyology in the Department of Marine Biology at James Cook University, Townsville. His primary research area is the biology of reef fishes, including their ecology, evolution, biogeography and role on coral reefs.



WHY ARE QUEENSLAND'S FROGS CROAKING?

BY WILLIAM F. LAURANCE

Since 1979, the declines have swept northward along the Great Dividing Range, at an average rate of about 100 kilometres per year.



The Australian Lace-lid (*Nyctimystes dayi*). This nocturnal frog with large eyes and delicate, lacy eyelids, recently vanished from upland areas in northern Queensland but still survives below an elevation of 300 metres.

MICHAEL TRENERRY/NATURE FOCUS

H. & J. BESTE/NATURE FOCUS

THERE IS NO DOUBT THAT FROGS, toads and other amphibians are declining rapidly all over the world. Often the causes are obviously the result of human activities—the loss and degradation of critical streams, ponds and other habitats, water pollution, and widespread introductions of exotic predators and competitors are among the prime factors.

But during the past two decades or so biologists have been witnessing what seems to be an extraordinary and entirely different kind of decline—the sudden disappearances of frogs and toads in remote mountainous areas, often in seemingly pristine habitats. These declines differ from those caused by humanity's massive disruption of habitats, in that the cause (or causes) of the declines have been a profound biological mystery.

Dramatic crashes of mountain frog populations have now been documented by biologists on six different continents, including Australia. Typically, the frogs were locally common, then without warning their populations plummeted or disappeared, often so suddenly that local biologists were caught entirely off-guard. In some areas, such as northern Queensland, mountain frog populations have declined drastically, while nearby lowland populations of the same species are still persisting at normal densities. In only a few instances were alert scientists lucky enough to witness the actual declines.

Fortunately, in Queensland, during the past two decades a small handful of highly dedicated frog biologists such as Keith McDonald (Queensland Department of Environment and Heritage) and Glen Ingram (Queensland Museum), have spent countless cold, rainy nights wading through remote mountain

The Northern Tinker-frog (*Taudactylus rheophilus*), a distinctive inhabitant of steep mountain streams in north-eastern Queensland, seems to have disappeared entirely in the past few years.

We now know that seemingly healthy frog populations can sharply decline and disappear within a period of only a few weeks.

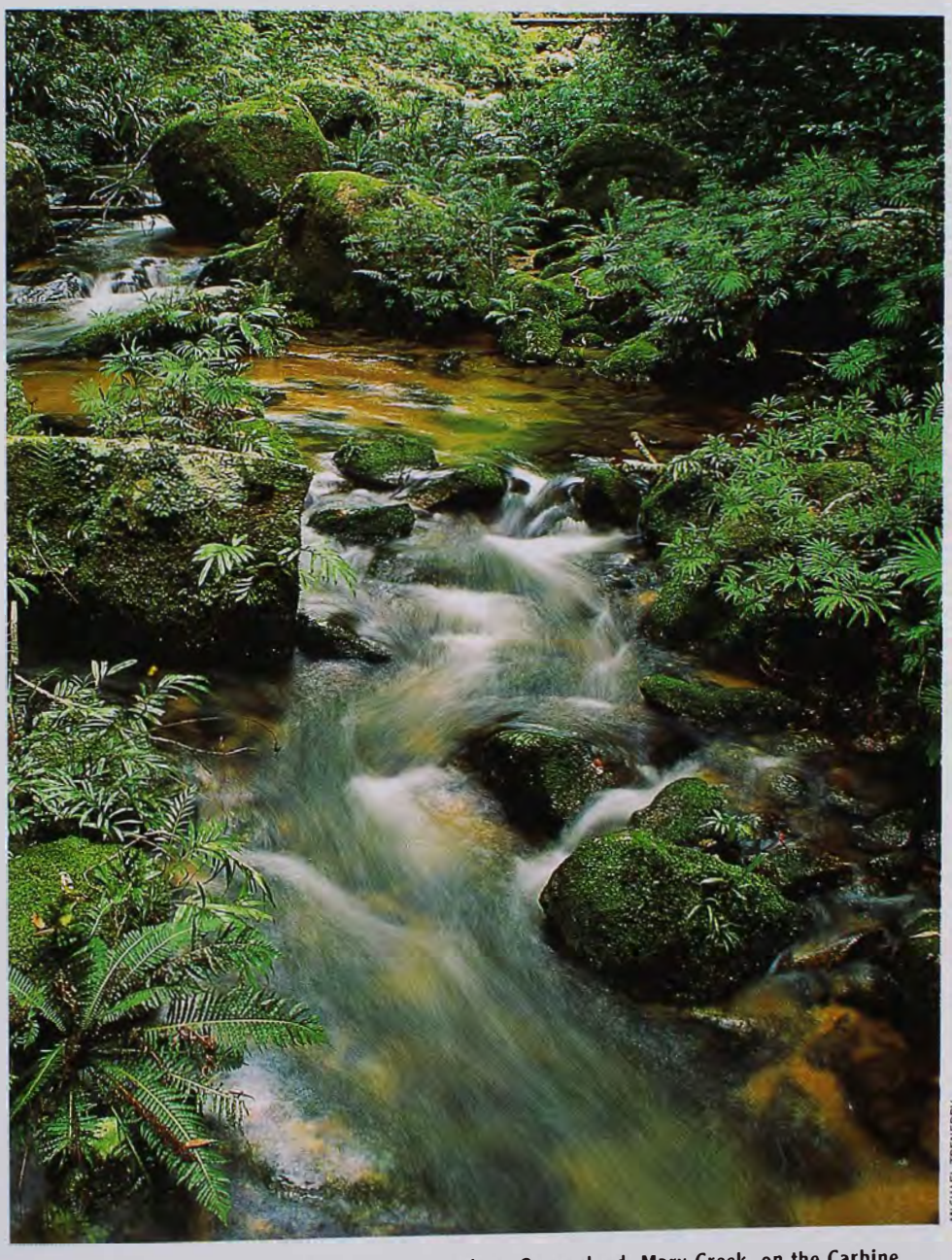
streams with flashlights in hand, meticulously identifying and counting each frog they encountered. Without at first realising it, they have now compiled what is probably the world's most exhaustive record of declining frog populations. This information has been crucial in allowing us to document the decline of Queensland's frogs, and has provided vital clues in our attempt to solve this mystery.

WHY ARE THE MOUNTAIN FROGS declining? Biologists throughout the world have suggested that these frogs may be acting like 'canaries in a coal mine'—warning humans of some sort of subtle but large-scale deterioration of the environment. A bevy of possible causes has been explored (for example, see the articles by Michael Tyler in *Nature Aust.** Autumn 1991 and Winter 1993). Initially, many scientists became convinced that acid rain must be playing a role, because this could explain why frogs were declining in rainy mountain areas. Recent research by David Bradford (UCLA) in California, however, clearly indicates that acid rain was not a factor there, despite the fact that many local frog populations have been decimated.

In the tropical rainforests of Costa Rica, where the beautiful Golden Toad (*Bufo periglenes*) and Harlequin Frog (*Atelopus varius*) have mysteriously disappeared, Martha Crump (University of Florida) and her colleagues have suggested a novel theory: 'killer fog' may be responsible. Their theory proposes that pesticide residues or other contaminants become concentrated in fog, and are eventually deposited in mountain areas as mist droplets. Following a heavy rain, the toxins may suddenly be flushed into streams, killing off the frogs. This theory also has its problems however, perhaps the most important of which is the fact that the adult frogs often seem to die off several months before their tadpoles. If a water pollutant is involved, it seems likely that the vulnerable tadpoles, which breathe through gills and are in intimate contact with the water, would be the first to go.

A third suggestion, by Andrew Blaustein (Oregon State University) and colleagues, is that harmful UV radiation has increased in recent years as a result of depletion of the ozone layer, and that frogs or their eggs are especially vulnerable. In the mountains, the theory goes, the air is thin, and thus solar radiation is more intense. While this idea sounds appealing, it also breaks down upon close examination, at least as a general explanation for the worldwide decline of mountain frogs. In Queensland, for example, many of the disappearing frogs are nocturnal and deposit their eggs beneath logs or debris that provide shelter from UV radiation. Moreover, there is no evidence that UV has increased recently in tropical and subtropical areas, although the ozone shield clearly is getting thinner in temperate and polar regions.

Several other factors, such as unusual weather or predation by feral pigs, have been suggested, but in Queensland we have been able to discount nearly all of these possibilities. The frog declines here are as dramatic as those witnessed at any high-elevation region worldwide—at least 14 species have declined sharply, with half of those now believed to be extinct. The first declines were



MICHAEL TRENERRY

Typical habitat of stream-dwelling frogs in northern Queensland, Mary Creek, on the Carbine Tableland, is at about 1,000 metres elevation. Only a few years ago mountain streams like this sustained a cacophony of chirping and trilling frogs—a distinctive feature of the rainforest—but today they are nearly silent.

*Previously *ANH*

ROBERT W. G. JENKINS/NATURE FOCUS

documented in 1979 by Glen Ingram at the aptly named Tragedy Creek, in the Connondale Ranges near Brisbane. Five species declined in that area, with the Southern Gastric-brooding Frog (*Rheobatrachus silus*), regarded as one of the world's most unusual amphibians for its habit of swallowing its eggs or larvae and brooding them in its stomach, disappearing entirely.

Since then, the declines have swept northward along the Great Dividing Range, at an average rate of about 100 kilometres per year, according to our calculations. At Eungella in east-central Queensland, two species, including the Northern Gastric-brooding Frog (*Rheobatrachus vitellinus*), crashed in the mid-1980s. In the tropical rainforests of northern Queensland, seven additional species declined or disappeared in the late 1980s and early 1990s. As a result of the careful monitoring of populations in Queensland, we now know that seemingly healthy frog populations can sharply decline and disappear within a period of only a few weeks.

VANISHING FROGS

At least 14 species of Queensland frogs have disappeared or become extremely rare during the past 17 years. All these frogs breed in small rainforest streams, usually in cool, mountainous areas.

COMMON NAME	SCIENTIFIC NAME	RANGE	STATUS
Armoured Mistfrog	*Litoria lorica*	NE Qld	Endangered/Possibly Extinct
Waterfall Frog	*L. nannotis*	NE Qld	Very Rare
Mountain Mistfrog	*L. nyakalensis*	NE Qld	Endangered/Possibly Extinct
Cascade Treefrog	*L. pearsoniana*	SE Qld	Very Rare
Common Mistfrog	*L. rheocola*	NE Qld	Very Rare
Australian Lace-lid	*Nyctimystes dayi*	NE Qld	Very Rare
Fleay's Barred-frog	*Mixophyes fleayi*	SE Qld	Very Rare
Giant Barred-frog	*M. iteratus*	SE Qld	Very Rare
Southern Gastric-brooding Frog	*Rheobatrachus silus*	SE Qld	Endangered/Possibly Extinct
Northern Gastric-brooding Frog	*R. vitellinus*	Eungella	Endangered/Possibly Extinct
Sharp-snouted Dayfrog	*Taudactylus acutirostris*	NE Qld	Endangered/Possibly Extinct
Southern Dayfrog	*T. diurnus*	SE Qld	Endangered/Possibly Extinct
Eungella Dayfrog	*T. eungellensis*	Eungella	Very Rare
Northern Tinker-frog	*T. rheophilus*	NE Qld	Endangered/Possibly Extinct

Fleay's Barred-frog (*Mixophyes fleayi*). This poorly known frog has declined sharply throughout its native range in north-eastern New South Wales and south-eastern Queensland.

What has caused these dramatic crashes? This question has been mesmerising a small research team, comprised of Keith McDonald, Rick Speare (James Cook University) and me, for the past two years. Finally, we feel we are close to solving the enigma.

THE MOST PLAUSIBLE EXPLANATION, WE believe, is that a highly virulent pathogen—possibly an exotic virus—is responsible. Several lines of evidence support this idea. For example, the obvious wave-like spread of the declines, and the very sudden disappearances of monitored frog populations, are entirely consistent with the expected effects of an exotic disease. The disappearing species all live in or near streams, which suggests the pathogen is being carried by water, although it is possible that certain animals such as aquatic birds, Cane Toads (*Bufo marinus*) or biting insects may also carry the disease over longer distances. Sick and dying frogs from several different areas have exhibited similar symptoms, including extreme sluggishness, a pale, anaemic appearance, and tiny lesions on the skin and internal organs. This suggests that a single disease is responsible, and post-mortem examinations of these animals support the notion that a virus may be the cause of their illness. In fact, we suspect the disease is caused by a type of iridovirus (a family of viruses that affects amphibians, fish and insects), although no specific virus has yet been isolated and identified by biochemical tests.

One of the most intriguing patterns we have witnessed is that the declines have been highly selective. In most areas the majority of species have disappeared, but one or two species have almost always remained unaffected. In northern Queensland, for example, the Green-eyed Treefrog (*Litoria genimaculata*) has persisted in the region's streams while most other stream frogs have disappeared. This pattern is consistent with the action of viruses, which often exhibit extreme host selectivity.

A second interesting phenomenon is the fact that, in the tropics of northern Queensland, several species have disappeared from cool mountain areas but are still surviving in the warmer lowlands. We suspect this may occur because higher temperatures increase the ability of cold-blooded animals like frogs to combat disease. When a frog becomes ill, it will often seek a warm place in order to raise its body temperature, effectively 'running a fever' until it begins to feel better. In the mountains, however, this may not be possible, and frogs there may be more susceptible to disease. In addition, viruses often have specific temperature tolerances, and the tropical lowlands may simply be too warm for the virus to grow and persist.

H. & J. BESTE/NATURE FOCUS

The Cascade Treefrog (*Litoria pearsoniana*) has declined by about 99 per cent throughout its native range of north-eastern New South Wales and south-eastern Queensland.

If we are right about the deadly frog virus, then a key question remains. Where did it come from in the first place? We do not know, but the striking similarities of the Queensland frog declines to those occurring overseas cannot be ignored. We suspect that the virus is exotic to Australia, and that it may have been introduced as a result of the thriving international trade in aquarium fish. Although many aquarium fish are bred in captivity, a number of beautiful South American and Asian species breed only in the wild—where they would be exposed to myriad diseases—and are caught and exported worldwide by the thousands. Unfortunately, quarantine procedures for aquarium fish are quite minimal, and in several cases exotic bacteria or viruses have been found in fish that were due to be imported into Australia. In Queensland, as elsewhere, misguided aquarium owners have released exotic fish into the wild on many occasions.

Our conclusions highlight a kind of environmental problem that may be widely underestimated: the global spread of foreign pathogens. This problem may be magnified by the remarkable ability of pathogens to evolve quickly, and to jump from one species to another. The AIDS virus, for example, originally infected African monkeys, but has spread to humans worldwide with devastating effects. Given the rapid evolution of pathogens and the astonishing mobility of modern industrial society, exotic diseases may increasingly threaten the integrity of natural ecosystems. As the nearly silent mountain streams of Queensland

ANTHONY HEALY/NATURE FOCUS

Only a few years ago, the Sharp-snouted Dayfrog (*Taudactylus acutirostris*) was common in northern Queensland's rainforests, but today it may be extinct.

LABAT-LANCEAU/AUSCAPE INTERNATIONAL

If released into the wild, aquarium fish like these Neon Tetra (*Hyphessobryson innesi*) could easily transmit exotic diseases to aquatic wildlife.

now attest, such pathogens could irretrievably alter our environment. ■

Further Reading

Bradford, D.F., Gordon, M.S., Johnson, D.F., Andrews, R.D. & Jennings, W.B, 1994. Acidic deposition as an unlikely cause for amphibian population declines in the Sierra Nevada, California. *Biol. Conserv.* 69: 155–161.

Ingram, G.J. & McDonald, K.R., 1993. An update on the decline of Queensland frogs. Pp. 297–303 in *Herpetology in Australia: a diverse discipline*, ed. by D. Lunney and D. Ayers. Royal Zoological Society of New South Wales: Sydney.

Laurance, W.F., McDonald, K.R. & Speare, R., (in press). Epidemic disease and catastrophic decline of Australian rain forest frogs: support for the epidemic disease hypothesis. *Conserv. Biol.*

Richards, S.J., McDonald, K.R. & Alford, R.A., 1993. Declines in populations of Australia's endemic tropical rainforest frogs. *Pacif. Conserv. Biol.* 1: 66–77.

Dr Bill Laurance is a senior research fellow at the CSIRO Tropical Forest Research Centre in Atherton, Queensland. His research is focused on the ecology and conservation of tropical mammals, birds and frogs.

Anemone Crab (*Neopetrolisthes* sp.) by Wendy Cufer.

SEVEN SEAS

A COMPETITION OF UNDERWATER PHOTOGRAPHY

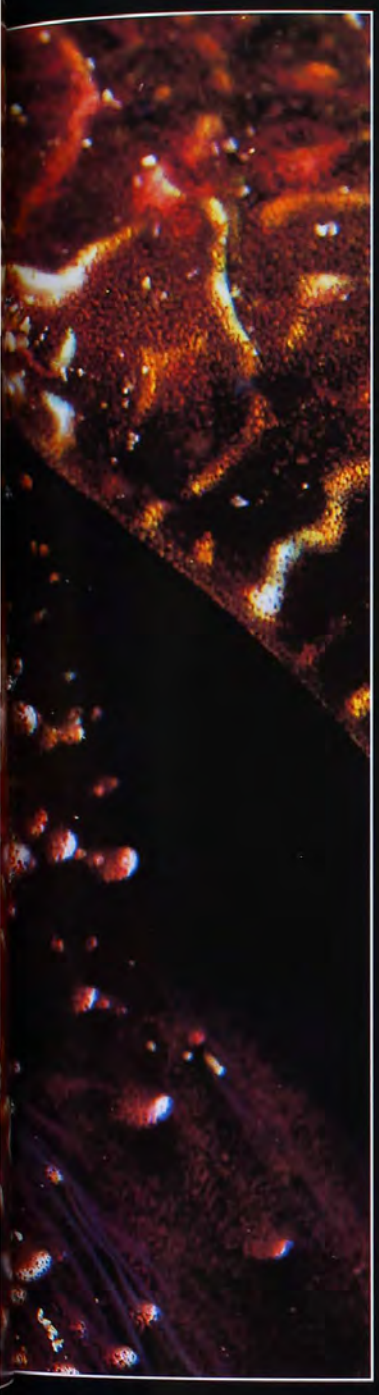
PHOTOART

Squid by Michael Aw.

Often it is only pictures that can describe the unknown world of the sea. Hidden beneath the surface, the immense colour, drama and life within our oceans and lakes remain largely unknown—even to scientists. There is no other place where nature's great diversity and stunning artistry is better expressed. Seven Seas is a collection of underwater photographs taken by divers who want to share with others the wonders of the ocean. To find out where to see the 1995 Seven Seas exhibition or how to enter the 1996 Seven Seas competition, contact the Australian Underwater Photographic Society, PO Box 350, Harbord, 2069.

Crustacean (family Palaemonidae) by Mark Welsh.

Devil rays (family Mobulidae) by Michael Cufer.



Cuttlefish (*Sepia* sp.) by John Gordon.

PHOTOART

SEVEN SEAS

Scalefin Anthias (*Pseudanthias squamipinnus*) by Kevin Deacon.

PHOTOART

SEVEN SEAS

Scorpionfish by Paul Wakely.

Leafy Seadragon (*Phycodurus eques*) by Bill Boyle.

Yellow-banded Snapper (*Lutjanus adetii*) by Darryl Torckler.

The diverse lifestyles of these early crocs, many of which hunted on land, would have made life for early mammals singularly hard to hang on to.

CROCODILE DINNERS AND DINERS

BY MICHAEL ARCHER

IT'S ONE THING FOR A HUMAN TO BE caught by a big-brained mammalian carnivore with enormous teeth; it's quite another to be outwitted by one that's got little more IQ than a frog. But the dismembered and partly digested pieces of a woman, unmistakable in the photograph shown to me of stomach contents of a large Saltwater Crocodile (*Crocodylus porosus*) caught near Weipa, northern Queensland, were a graphic reminder that brains are no antidote to becoming dinner. None of us who saw that photograph felt like eating, let alone being, lunch that day. Yet for more than 200 million years this dinner–diner relationship has bonded mammals and crocodilians.

Perhaps as a rationale for their capacity to frighten mammals spitless, crocodiles are sometimes said to be, like birds, living descendants of the dinosaurs—which they are not. Although they are archosaurs ('ruling reptiles') along with dinosaurs, pterosaurs and birds, crocodiles are better regarded as distant cousins of dinosaurs.

The oldest crocodilians, such as the 235-million-year-old *Barbarenasuchus* from Brazil, are only slightly older than the oldest known mammals, which suggests an uncomfortable bit of coevolutionary history. The diverse lifestyles of these early crocs, many of which hunted on land, would have made life for early mammals singularly hard to hang on to. The heart-stopping moment in "Crocodile Dundee", when Linda Kozlowski is snapped at by an unexpected set of teeth, replays what must have happened to countless millions of mammals before her.

The biggest crocodiles from the world's fossil record, however, make Linda's attacker look like a gecko. *Purussaurus brasiliensis*, from a ten-million-year-old deposit in the Amazon, may have reached 12 metres in length and would have weighed 11 to 13 tonnes. *Deinosuchus hatcheri* from an 80-million-year-old deposit in Montana has been interpreted to have reached 16 metres in length, longer than *Tyrannosaurus rex*, and may well have dined on the largest dinosaurs that shared its world.

Measured against these giant crocs of the past, modern Saltwater Crocodiles seem a bit on the runty side. Recent records suggest 'normal' big ones are about five metres long, the largest rarely exceeding seven metres. Even 'Sweetheart', the famous Northern Territory croc that had a bad habit of tearing outboard motors off the back of boats, was only 5.1 metres long. These substantiated records, however, may not be the whole story. Crocodile authority Graham Webb (Wildlife Management International) was given a reliable report of one killed in the Staaton River in the Gulf of Carpentaria, Queensland, that measured 8.5 metres. More awesome still is an account of a 10.4-metre croc shot on the banks of the Pioneer River, at Mackay, Queensland.

Australia's fossil crocodile record also includes a few jumbos but it is becoming better known for its weirdos. In 1975, while chiselling lumps of bone breccia from a cave near Texas, Queensland, a strange skull fragment, unlike that of any crocodile I'd ever seen before, dropped into my hand. In contrast to modern crocodiles, which have rounded teeth and a flattened skull, this thing had flattened, serrated teeth rather like steak knives and a steep-sided muzzle. In some ways it looked more like a small dinosaur than a conventional crocodile. Ralph Molnar (Queensland Museum) named it, and another specimen from Chillagoe, north-eastern Queensland, *Quinkana fortirostrum*. He suggested that these strange, deep-headed, narrow-toothed crocs may have been similar to extinct forms known from North America and Europe that were thought to have been terrestrial, hunting prey on land rather than lying in wait at the water's edge. This would explain why both specimens had been found in high and dry cave deposits alongside the remains of only terrestrial animals. Although perhaps no more than three to four metres in length, this late Pleistocene croc was probably a fast and agile predator, possibly even a connoisseur of Australia's earliest humans.

Distinctive differences in tooth shape that characterise these possibly terrestrial crocodiles could reflect differences in killing strategies. A crocodile that lives primarily in water needs rounded, stout teeth to seize and hold large, struggling prey under water until it drowns. In contrast, a terrestrial predatory crocodile would need teeth that inflicted lethal wounds without the assistance of water to finish the job. With teeth like steak

JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

For over 200 million years, this has been the end of the line for countless thousands of mammals.

knives and deep, powerfully muscled heads, *Q. fortirostrum* would have had no problem in tearing the throats or bellies out of larger mammalian prey.

Paul Willis' PhD thesis (University of New South Wales) documents a wide range of newly discovered Australian fossil crocodiles. He concludes that the ancestor of Australia's two living crocodiles entered Australian waters from the north perhaps no more than five million years ago. Before its arrival, a toothsome army of far more bizarre kinds, all more closely related to *Q. fortirostrum* than to crocs from anywhere else in the world, filled this continent. These may be descendants of an as yet unrecognised group that was confined to ancient Gondwana. The only non-Australian representative of this group, *Mekosuchus inexpectatus* from New Caledonia, is another terrestrial form that survived long enough to end up as shish kebab on New Caledonian cooking fires. Paul gave this distinctively Australian (and New Caledonian) group of crocodiles the name Mekosuchinae.

A few of the larger, more generalised mekosuchines, such as *Palimnarchus pollens*, reached impressive lengths of perhaps ten metres. Paul recently speculated that a few of the smaller, more specialised forms from Riversleigh, north-western Queensland, might even have been arboreal, climbing trees to grab unwary birds or their even more unwary eggs. Discovery of claws would help to test this intriguing possibility.

What caused the demise of these strange, terrestrial and possibly even arboreal crocs? One possibility is competition from another group of Australian reptiles—goannas, which are aquatic, terrestrial and arboreal lizards of the genus *Varanus*. All have deep heads and flattened, serrated teeth, which in many ways resemble some of the mekosuchine crocs. Is it just a coincidence that, in Riversleigh's older mekosuchine-rich deposits, goannas are extremely rare? Did goannas, which are now common throughout Australia, outcompete mekosuchine crocs after invading Australia from the north, or did they manage to secure a toe-hold on the continent only after mekosuchines declined? Mysteries of prehistory waiting to be solved.

It is impossible for me to think of crocodiles and Paul Willis without recalling a memorable evening at Riversleigh. The previous year Paul had master-minded a classic practical joke that had me staring in confusion at what looked like a fossilised tooth of a very modern human (his own wisdom tooth) embedded in a piece of 20-million-year-old limestone (*Nature Aust.** Autumn 1990). The next year, as payback, several of Paul's 'friends' fixed two eight-centimetre, red bicycle reflectors to a huge log and moored their awesome creation about a kilometre upstream from our camp. Paul was invited to join in a pleasant night of Freshwater Crocodile spotting while canoeing on the Gregory, all of us having long since been convinced that Saltwater Crocodiles did not occur this far upstream. I nobly offered to paddle while Paul used the torch to spot the telltale red eye shine that betrayed a croc. At some distance from the place where the 'thing' was moored, Paul picked up the red flash and urged me to move in slowly. But as we came steadily closer, he began to realise that this croc was not at all what he had expected. "I'm not sure we should get any closer", he whispered hoarsely over his shoulder. "Why?" I asked. "Um, this one seems to be *very* big—much too big for any Freshie I've ever seen!" With that, and encouraged by Paul's screams to "Stop, you mad bastard!", I dug the paddle in deep and charged towards the fiery-eyed apparition. Then, when only five metres from what Paul reasonably concluded to be the mother of all Saltwater Crocs, I rolled the canoe, pitching us both into the dark waters. When I finally hauled myself up onto the bank, having very nearly drowned from laughing, Paul was already standing there swearing revenge, surrounded by camera flashes and his mates splitting their sides with laughter. Some of them swore later that when the canoe turned over, he was moving so fast that his feet never touched the water. (His revenge now has me very nervous.)

I took another bite of the 'crocburger' on my plate in the Alice Springs restaurant, wondering about the chances of encountering the toe nail of a missing tourist. "Tastes a bit like chicken", Sue said, a tad disappointed that the taste didn't somehow reflect the croc's high-profile lifestyle. Although perhaps not quite on a par with fillet mignon, there was still something very comforting about biting into that bland burger—a mouthful of sweet revenge after 200 million years of being 'mammalburgers' on the crocodile's plate. ■

* *Previously ANH*

Further Reading

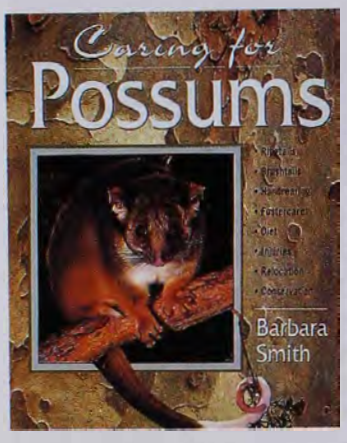
Molnar, R.E., 1993. Biogeography and phylogeny of the Crocodylia. Pp. 344–348 in *Fauna of Australia. Vol. 2A. Amphibia and Reptilia.* Australian Government Publishing Service Press: Canberra.

Willis, P.M., 1993. The Australian palaeoherpetological renaissance: a review of Australian palaeoherpetology, 1990–1993. Pp. 17–34 in *Herpetology in Australia: a diverse discipline*, ed. by D. Lunney and D. Ayers. Royal Zoological Society of New South Wales: Sydney.

Willis, P.M., 1995. Crocodiles? Where? Look!—Up in the trees! *Riversleigh Notes* 26: 8–9.

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



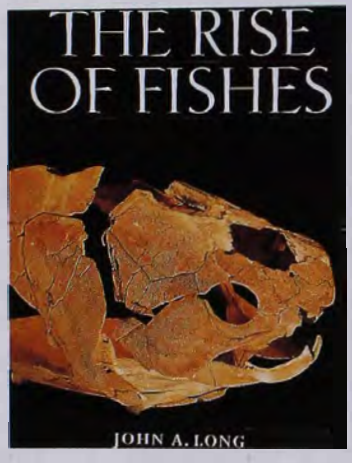
Caring for Possums

By Barbara Smith. Kangaroo Press, NSW, 1995, 69pp. $19.95rrp.

This is an excellent book for anyone, be they suburban, inner city or rural dwellers, who appreciates native animals for, as is pointed out in the book, possums inhabit all three areas. The book is well layed out and comprehensive, covering ringtails, brushtails, handrearing, foster care, diet, injuries, relocation and conservation. Despite being very detailed, the text is not overly technical. It is easy read and practical, with both an index and an expanded contents list for easy location of subject matter. The book is also well illustrated with colour photos and a few graphs and tables where necessary.

As indicated by the title, there is more emphasis on foster care, injuries and rehabilitation than there is on possum biology or ecology. For this reason alone, *Caring for possums* should receive a place in the libraries of any animal shelter, wildlife carer, zoo, animal park and naturalist. It even gives you useful tips on how to make a ringtail possum let go when it bites your hand, and how to stop brushtails from making a problem in roofs and gardens. The book is 69 pages long and thoroughly recommended to anyone interested in, or involved with, these widespread nocturnal marsupials—one of the few we're likely to find close to home!

—Martyn Robinson
Australian Museum



The Rise of Fishes

By John A. Long. New South Wales University Press, NSW, 1995, 223pp. $59.95rrp.

In any list of popular publications on prehistoric animals, the tetrapods (amphibians, reptiles, birds and mammals) dominate the field. Dinosaurs have been done to death, so to speak, and fossil birds and mammals are well covered. Surprisingly, the most abundant and diverse category of backboned animals on Earth, the fishes, have been largely ignored, or treated superficially as a brief preamble to the emergence of vertebrates on land as air-breathing, four-legged amphibians.

Fishes, in the broadest sense, have been around for nearly 500 million years and have left a very good fossil record for most of that time. It is a common misconception that the Age of Fishes was succeeded, in turn, by the Ages of Amphibians, Reptiles and Mammals. With over 23,000 living species of fish in the world's oceans, lakes and rivers today (more than amphibians, reptiles, birds and mammals combined), strictly speaking, we still live in the 'Age of Fishes'.

Apart from some technical treatises, aimed mainly at students and research specialists, no comprehensive, well-illustrated account of fish history has been available to the general public. A reappraisal of the fascinating story of fish evolution through geological time is long overdue.

John Long's *The rise of fishes* fills this gap superbly. Although it looks like a coffee-table book, it is far more than that. It is profusely illustrated with over 200 colour photographs and reconstructions, and some 100 clearly labelled line drawings, most of them by the author himself. Unlike conventional textbooks, which focus heavily on fossil finds from Europe and North America, *The rise of fishes* describes and illustrates a spectacular array of discoveries from Australia, Antarctica, South America and Asia.

With over 23,000 living species of fish in the world's oceans, lakes and rivers today (more than amphibians, reptiles, birds and mammals combined), strictly speaking, we still live in the 'Age of Fishes'.

This is not merely the bias of an 'Australo-centric' author but reflects the spectacular range of discoveries over the last 25 years from the southern continents that were once part of Gondwana, as well as the many remarkable new discoveries from China and South-east Asia.

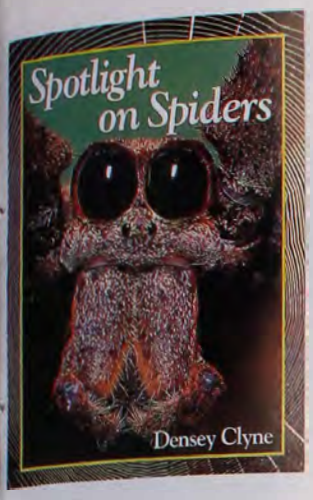
The rise of fishes thus provides a broad overview of fish evolution, from their origins over 500 million years ago up to the emergence of vertebrates on land. The main fish groups are traced, class by class, from their first appearance to the present. Various, often conflicting, theories and controversies concerning their interpretation and relationships are clearly and concisely discussed and illustrated. As John Long points out, most of the major structural advances in backboned animals (backbone, skull, teeth, four limbs with toes) were all achieved in the fishy condition—everything since then has been a variation on a theme.

Given the technical nature of the subject, the text is concise, clear and remarkably jargon-free. However, the main value of this book lies in its illustrations—numerous colour photographs of original, often unique, specimens, up-to-date reconstructions and clearly labelled line drawings. Together they make the *Rise of fishes* an extremely valuable resource for students and the public alike.

As a Museum scientist actively involved in fossil fish research, I am well aware that most of the superb specimens illustrated in *The rise of fishes* are not on public display, even in the widely scattered museums that house them. They are thus only directly accessible to a handful of specialists. By bringing them together and making them available in book form, John Long has done a great service to both scientists and the general public. As an active research worker on many of the fish groups covered in the book, John Long is also ideally qualified to present an authoritative first-hand account of work in progress.

It is not possible to do justice to such a comprehensive, fact-packed account as *The rise of fishes* in a brief review. This book is recommended to anyone with an interest in fishes, living or dead.

—Alex Ritchie
Australian Museum



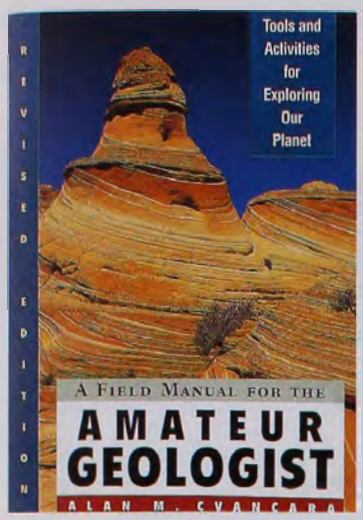
Spotlight on Spiders and It's a Frog's Life

By Densey Clyne. Allen & Unwin, NSW, 1995, 33pp. and $10.95rrp each.

Here are two more Densey Clyne books in the Small World Series. They are classed as juvenile literature and for this they are admirably suited. Both books are lavishly illustrated with Densey's excellent-quality colour photographs and the text, although informative, is not technical nor difficult to understand. Young readers (and their parents) will have no problem following the text, and the accompanying photos further demonstrate the points being read.

The books are divided loosely into subject headings detailing various aspects of the lives of spiders and frogs. There is no contents page, so you can't go directly to the topic that interests you, however, as the books are only 33 pages long, it is a small matter to flip through the pages or look up the index to find what you want. An added bonus is some of the fascinating incidental photos, like the frog croaking away while two mosquitoes bite his eyelids, or the unfortunate Spiny Spider that was stung by a Honey Bee caught in its web. There are a couple of minor errors in the frog book but these do not detract from its overall value. And remember, they are both Australian books on Australian subjects by an Australian author! All in all a welcome addition to any young naturalist's library.

—Martyn Robinson
Australian Museum



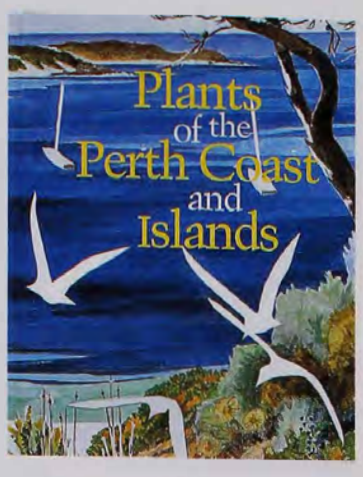
A Field Manual for the Amateur Geologist: Tools and Activities for Exploring our Planet

By Alan M. Cvancara. Jacaranda Wiley, NSW, 1995, 335pp. $29.95rrp.

The subtitle *Tools and activities for exploring our planet* is an apt summary of this practical and very readable guide. Of the 24 chapters and 335 pages, about one-third deals with landforms of various environments. The remainder covers concepts of geological time; rocks, minerals and fossils; and practical geology, geological maps and collecting. The appendix, which details geological aspects of America and Canada, is probably of less relevance to Australian readers.

The writer's style is enthusiastic and lucid, reflecting his obvious love of the subject. The book is well illustrated and, although the photographs of (mainly American) geological sites lack the impact of colour, they help to keep the book affordable. Unfortunately this also impairs some of the rock and mineral photos, making them difficult to recognise. Technical terms are always explained and a pronunciation guide is given. The handy pocket size is convenient for the traveller or hiker. As a layman's guide to practical geology this book certainly fulfils its author's aims and teaches in an entertaining way.

—Ross Pogson
Australian Museum



Plants of the Perth Coast and Islands

By Elizabeth Rippey and Barbara Rowland. University of Western Australia Press, WA, 1995, 292pp. $49.95rrp.

In *Plants of the Perth coast and islands*, the authors present a fresh, accessible guide with illustrations that make this publication a joy to peruse.

The book covers the area north of Perth and south to the Cape Leeuwin region. Some 120 species of plants have been included. Drawing on their combined training and experience in ecology and geography, the authors have set the flora in the context of its history, prevailing conditions and survival strategies. The pleasant writing style, makes for easy reading.

Of particular value is the inclusion of succulents, grasses, sedges and sea grasses—groups that rarely receive attention in generalist literature.

Most species are given full-page watercolour illustrations with text, maps and additional line drawings on the facing page. There are no keys to species, identification being a matter of matching specimen to painting in the first instance. Descriptions are not overburdened with technical jargon and, where used, terms are explained in the appended glossary. A bibliography is also provided for further reading.

This hard-cover version is quite heavy, which may discourage use as a field guide. However, its clarity and scope of information makes this work a valuable resource.

—Lynne Ho
Australian Museum

SOCIETY PAGE

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

ANIMAL WELFARE

FAWNA - For Australian Wildlife Needing Aid NSW Inc.
PO Box 41, Beechwood, NSW 2446. Ph: (065) 856 470
F: (065) 856 528
Contact: Amanda Boardman, Secretary
Membership fee: $17.00 (single); $22.00(double); $7.00 (jr)

Wildlife Information & Rescue Service, Dubbo Branch (WIRES)
PO Box 1456, Dubbo, NSW 2830. Ph: (068) 871 235;
Mobile (24 hrs) 019 181 475
Contact: Margarette Edwards, Coordinator
Membership Fee: $17.00; $20.00 (animal rescue authorisation) (conc. avail.)

CONSERVATION

Australian Trust for Conservation Volunteers
PO Box 423, Ballarat, Vic. 3353.
Ph: (008) 032 501
Contact: Colin Jackson, Exec. Director
Membership fee: $25.00

Victorian National Parks Association Inc.
10 Parliament Place, Melb., Vic. 3002. Ph: (03) 9650 8296
F: (03) 9654 6843
Contact: Doug Humann, Director
Membership fee: $36.00 (single); $46 (household); $23 (conc.)

EARTH SCIENCES

Dinosaur Club (NSW) Australian Museum
6 College Street, Sydney, NSW 2000. Ph: (02) 320 6236
Contact: Jenny Nancarrow
Membership fee: $12.00; $20.00 (family/group)

Dinosaur Club (Qld) Queensland Museum Assoc.
PO Box 3300, Sth Brisbane, Qld 4101. Ph: (07) 3840 7555
or (07) 3840 7641
Contact: Donna Miles
Membership fee: $12.00 (senior/jr); $20.00 (group)

Dinosaur Club (SA) Earth Sciences Resource Centre for Schools
Dept Geology & Geophysics, Univ. of Adelaide, Adel., SA 5005. Ph: (08) 303 5959
Contact: Christine Staples
Membership fee: $12.50

Dinosaur Dlub (Nth Qld & NT)
Dept of Earth Sciences, James Cook Univ. Nth Qld., Townsville, Qld 4811.
Ph: (077) 81 4796
Contact: Greg McNamara, Earth Sciences Curator
Membership fee: $12.00; $20.00 (groups/families)

Dinosaur Club (Vic.) Earth Sciences Dept
Monash University, Clayton, Vic. 3168. Ph: (03) 9905 1370
Contact: Jennifer Monaghan
Membership fee: $12.00; $20.00 (families/school)

Dinosaur Club ACT National Dinosaur Museum
Barton Hwy, Gungahlin, ACT 2912. Ph: (06) 230 2655
Contact: Jeff Death, Mgr
Membership fee: $20.00

EDUCATION

CSIRO's Double Helix Science Club
PO Box 225, Dickson, ACT 2602. Ph: (06) 276 6643
Contact: Lynn Pulford, Memb. Secretary
Membership fee: $19.50

Gould League Vic.
Genoa Street, Moorabbin, Vic. 3189. Ph: (03) 9532 0909
Contact: Gayle Seddon, Educ. Officer
Membership Fee: $25.00

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

Science Teachers' Assoc. NT
PO Box 41809, Casuarina, Darwin, NT 0811.
Ph: (089) 886 000
Contact:Tony Copland, Secretary
Membership fee: $75.00

Science Teachers' Assoc. of Vic.
PO Box 190, Richmond, Vic. 3121. Ph: (03) 428 2633
Contact: Julie Mills, Educ. Officer
Membership fee: $84.00 (second); $64.00 (prim.)

ENVIRONMENTAL

Conservation Council of SE Region & Canberra
GPO Box 1875, Canberra, ACT 2601. Ph: (06) 247 7808
F: (06) 248 5343
Contact: Craig Darlington, Director
Membership fee: $30.00; $15.00 (conc.)

The Society for Growing Australian Plants (NSW) Ltd
3 Currawang Place, Como West, NSW 2226.
Ph: (02) 528 2683
Contact: Allan Woollett, Secretary
Membership fee: $26.00; $20.00 (conc.)

MUSEUM

Friends of the Qld Museum
PO Box 3300, Sth Brisbane, Qld 4101. Ph: (07) 3840 7641
Contact:Sandra Mann, Exec. Officer
Membership fee: $25.00; $30.00 (family); $20.00 (conc. & country)

TAMS, The Australian Museum Society
Australian Museum, 6 College St, Sydney, NSW 2000. Ph: (02) 320 6225
F: (02) 320 6051
Contact: Carole Bibby, Exec. Officer
Membership fee: $50.00; $65.00 (family/dual); $40.00 (conc.)

The Waterhouse Club
SA Museum, North Terrace, Adelaide, SA 5000.
Ph: (08) 2077 389
Contact: Mary Lou Simpson, Exec. Coordinator
Membership fee: $50.00

NATURAL HISTORY

Darling Range Branch WA Naturalist Club
PO Box 348, Kalamunda, WA 6076. Ph: (09) 295 3344
Contact: Eric McCrum, Chairman
Membership fee: $48.00 (family); $38.00 (single/senior); $48.00 (two seniors)

SCIENTIFIC RESEARCH

The Australian Entomological Society Inc.
c/- Dept of Crop Protection Waite Campus Univ. of Adel. PO Glen Osmond, SA 5064.
Ph: (08) 303 7264
Contact: Gary Taylor, Hon. Secretary
Membership fee: $45.00

ANZSES, Aust. & New Zealand Scientific Exploration Society Inc.
PO Box 174, Albert Park, Vic. 3206. Ph: (03) 9866 8699
Contact: Colleen Lazenby, Exec. Director
Membership fee: $30.00; $50.00 (with Nature Australia*)*

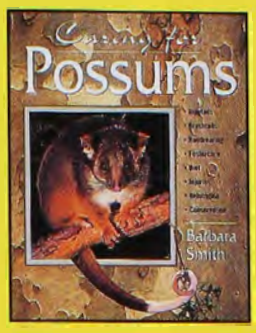
Are you a Club Secretary?

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

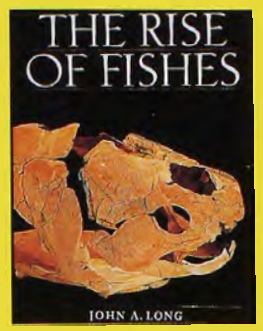
Newsletter/Journal, Monthly meeting, Bi-monthly meeting, Annual meeting/conference, Weekly meeting, Quarterly meeting, Field outings/Tours, Conservation Working programs, Discounted Goods, Magazine, Social/Education Activities, *Nature Australia* magazine, Seminars

Visit the best Museum of Natural History shop in Australia

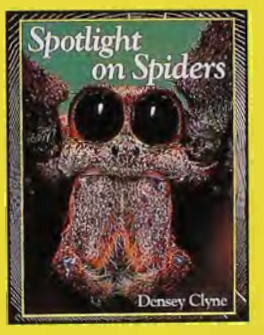
THE AUSTRALIAN MUSEUM SHOP



Caring for Possums
by B. Smith
Retail Price $19.95
* Museum Society members $17.95



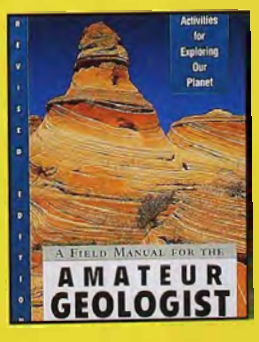
The Rise of Fishes
by John Long
Retail Price $59.95
* Museum Society members $53.95



It's a Frog's Life &
Spotlight On Spiders
by Densey Clyne
Retail Price $10.95 each
* Museum Society members $9.95

The Volcanic Earth
by Lin Sutherland
Retail Price $49.95 *Museum Society members $44.95

The Mammals of Australia
edited by Ron Strahan
Retail Price $75.00 *Museum Society members $67.50

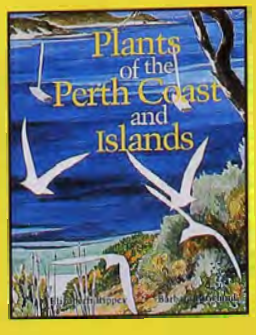


A Field Manual
for the
Amateur Geologist
by A. Cvancara
Retail Price $29.95
* Museum Society members $26.95

Profits from the Australian Museum Shop help to fund research by the Museum's Scientists.

Museum Gift Vouchers in denominations of $25 and $50 are also available.

For enquiries about membership to The Australian Museum Society phone (02) 320 6225



Plants of the Perth Coast and Islands
by E. Rippey &
B. Rowland
Retail Price $49.95
* Museum Society members $44.95

AM

Please post or fax orders to this address:
Mail Order Shop
Australian Museum
6 College St Sydney NSW 2000
Fax: (02) 320 6066 Phone: (02)320 6363

Payment should be made in **Australian dollars** by Visa, Bankcard, Mastercard, American Express, or by personal shopping only. Postage and packing (surface mail only):
Up to $29.95 = $3.50 $30 to $49.95 = $5.00 $50 to $69.95 = $6.50 $70 to $89.95 = $8.00 $90 to $109.95 = $9.00 $110 to $150.00 = $12.50

The Guide

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

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

Call Sari Järvenpää on (02) 339 8179 for full details.

Cassowary House

A small lodge *for up to 8 guests* bordering World Heritage rainforest. We are known for our comfortable accommodation, good food and personal service. John operates birdwatching tours to the Cairns coast and the Atherton Tablelands.

BROCHURES FROM
Rita & John Squire

THE CASSOWARY HOUSE
KURANDA 4872
Telephone **070 93 7318**

The Baby Jogger®
Combine fitness, family and fun!

Made in USA

Walk, hike or jog along sandy beaches, snow packed roads, bush tracks, gravel paths or grassy paddocks. Choose from 12 models.

LIFETIME GUARANTEE

RACING STROLLERS AUSTRALIA

307 Serpells Road Templestowe
Phone/Fax: (03) 9844 1344
or (03) 9842 6699

ecos

Special offer for Nature Australia readers!

A free copy of *Ecos*, CSIRO's quarterly full-colour magazine about science and the environment.

Ecos features articles, photographs and illustrations that explain environmental research for non-scientists.

Don't miss out!
Phone 1800 626 420 toll free in Australia, (613) 418 7265 (international) fax (613) 419 0459

CSIRO AUSTRALIA

or write to Ecos (NA6/95), PO Box 89, East Melbourne, Victoria 3002, Australia

I want to invest with confidence in over 70 different

ethical investments!

You can invest your savings and superannuation in:

- **Saving Habitat and Rare Species**
- **Low Energy Technologies**
- **Clean Water**
- **Affordable Housing**
- **Recycling**

and earn a competitive financial return from investing in the Australian Ethical Trusts:

- **conveniently**
- **with confidence**
- **for a competitive return**
- **with as little as $1,000**
- **monthly savings plan option**

For full details, make a free call to
1 800 021 227.

The Australian Ethical Trusts are managed by Australian Ethical Investment Ltd, ACN 003 188 930, which was established in 1986 to pool investor savings to create a more fair and sustainable society. Investment can only be made on the application form bound into the lodged and registered prospectus dated 25th October, 1994, available from:

Australian Ethical Investment Ltd
Suite 66, Canberra Business Centre
Bradfield Street, Downer ACT 2602

for investors, society and the environment

Q&A

A Silvereye (*Zosterops lateralis*) suffering from avian pox.

Avian Pox

Q: *A magpie family that lives locally has recently produced two offspring, one around September that later died from a road accident, and another later last year that is now afflicted with large, red, wart-like protrusions. They first appeared above one eyelid and have rapidly spread and enlarged. The eye is now closed and the warts have spread across the beak and are beginning on the other eye, as well as on the feet. One of the parents is now also affected with a wart on its left eye. Can you please explain the cause of these warts and any way that we could help to cure them or prevent further spread?*

—Heloise Gibb
Woolwich, NSW

A: The growths on the legs and face of the Australian Magpies sound like avian pox. This ailment results from a virus, transmitted between birds by mosquitoes. During extended periods of wet weather the pox can spread quickly, and members of a family of birds roosting together can be easily infected in a short period. Because mosquitoes bite exposed parts of the body, the feet and face are usually the first areas affected. On the legs, the growths can cause problems if they interfere with the function of the foot, and once they affect the head, they can sometimes grow so enlarged that they become debilitating. The virus is not susceptible to antibiotics, but can sometimes be killed by disinfectants. In aviary birds the best prevention is to clean and disinfect the cages to prevent further spread. With wild birds, unless it is possible to catch and treat them, there is little that can be done. There are few alternatives other than to let nature take its course and hope that the disease will pass of its own accord.

—Walter E. Boles
Australian Museum

MIKE SCOTLAND/SEVEN SEAS

P I C T E A S E R

Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, *Nature Australia* Magazine. Please don't forget to include your name and address. The first correct entry will win a $20 gift voucher for the Museum Shop Book Catalogue. Summer's Pic Teaser was a close-up of the eggs carried by a male Weedy Seadragon (*Phyllopteryx taeniolatus*).

Toxic Toadfish for Dinner

Q: *Recently I observed a Pelican on my oyster lease with a toadfish in its beak. It was at Lugarno, half way between Como Railway Bridge and the old ferry ramp at Forest Road on the Georges River. The river toadfish that grow to 150 millimetres are toxic to humans and kill cats if left dead on the shoreline for them to forage. The Pelican was standing in the shallows, tossing the fish from the tip of his beak to his bag and back again. He did this four or five times before swallowing it, which gave me time to positively identify the fish and to wonder if he had caught it intentionally, or if he was playing with it and would discard it soon. I've been oyster farming on the Georges River for 30 years and it is the first time that I have seen anything eat a toadfish. I always thought they had the luxury of having no enemies. My question is, are toadfish natural food for Pelicans?*

—Len Drake
Oatley, NSW

A: A check of the literature does not reveal any previous mention of toadfish (Tetraodontidae) as food for Pelicans. The records, however, are rarely detailed beyond the general category 'fish'; only four fish species have been cited by name, and the Pelican certainly eats more than just those.

Whether the bird you saw had intentionally chosen the toadfish for food is uncertain. Many birds are able to eat with impunity items that would leave us in a bad state, so the possibility that toadfishes are natural Pelican food cannot be dismissed. Obviously there is much more to learn about this familiar bird.

—Walter E. Boles
Australian Museum

Plants *versus* Pests

Q: *I was interested to read the short note in the Autumn 1995 issue about the use of marigolds. I knew about planting them around other plants so that they act as a pesticide, but is there a way to use the flowers as an insecticide without extracting, distilling and isolating chemicals from the flowers? If so, how would they be used? Since dried tobacco leaves also are a good pesticide around plants, might tobacco also be a good insecticide?*

—M.L. Cunningham
Cairns Beaches, Qld

MICHEL VIARD/AUSCAPE INTERNATIONAL

Marigolds are popular plants to use in companion planting as they have insecticidal properties.

A: Marigolds, tansy and pyrethrum daisies have all been grown with some success as insecticides. A good book on companion planting will usually contain a chapter on the insecticidal qualities of some of the more common sorts. Marigolds also act as decoy plants for snails and slugs—they eat them rather than your more valuable plants. Tobacco could indeed be used as an insecticide but, in keeping with the saying "one man's meat is another man's poison", there are some insects that are not only immune to tobacco but will seek it out to eat, particularly the Tobacco Beetle, which is a pest of the stored product. Just out of interest, in the past, many museum collectors used to smoke a pipe and use the tobacco to help them in their work. A drop of the brown liquid from the bowl or stem of the pipe applied by matchstick to the tongue of an unfortunate small vertebrate would render it dead and suitable for taxidermy in a minute or so!

—Martyn Robinson
Australian Museum

Answers to Quiz in Nature Strips (page 16)

1. Commonwealth Scientific Industrial Research Organisation
2. Asia
3. Sue
4. Radio waves
5. Cave-dwelling organisms
6. 18
7. The study of ancient disease
8. Feathers
9. Darling River
10. *Iron Baron*

The truth is, we don't know if feral cats have caused or are causing any extinctions.

CATS: SCOUNDRELS OR SCAPEGOATS?

BY TIM LOW

THE CAMPAIGN AGAINST CATS HAS become so exaggerated it has lost its focus. Much energy that could be put to good use is being wasted on futile campaigns that do little more than aggravate cat owners.

It is widely believed that because cats prey on native birds they could bring about their extermination. But predation seldom leads to extinction in such a simplistic way. If it did, there would be no animals left in Africa, as those big cats called Lions would have eaten them all up.

Enormous numbers of birds are killed by pet cats in gardens, it is true. But while this may sound alarming, ecologically there is nothing wrong with it—predation is a fact of life. Birds are killed in forests too, by a whole gamut of predators including snakes, goannas, falcons, butcherbirds, quolls, Dingoes and even spiders. Pet cats are the urban counterparts to a range of native predators.

Hunting by pet cats would only be a problem if the rate of predation, combined with other deaths, exceeded the breeding rate of the birds. This does not seem to be the case. Several studies show that urban environments actually support a higher density of birds than native forests, despite all the cats. This is partly because of all the garden plants with berries and nectar-rich flowers.

The native garden birds killed by cats are nearly all widespread adaptable species that are thriving in response to urbanisation. Some of them are probably more abundant now than they were before European settlement. This definitely seems to be the case for the common garden skinks that cats often kill.

Feral cats are a much greater threat to wildlife than pet cats, and in some situations they are a serious hazard. But not usually to birds, which they seldom eat. Studies of their diet confirm what cartoonists have always known: that cats prefer rats, mice and other small mammals. In a major article on cats (*Nature Aust.** Winter 1993) Chris Dickman stated: "In most Australian studies, rabbits constitute the single most important prey".

It is thought that, if everyone would only spay their cats, string bells around their necks and keep them in at night, cats would no longer kill wildlife.

Dickman argued plausibly that cats may have caused many small mammal extinctions in central Australia last century. Even if he is right, this does not necessarily justify a campaign against cats today. After all, the extinctions happened a century or so ago, in remote woodlands where cat campaigning can have little or no effect. And he may be wrong. Dickman admits that, "Despite the abundance of observations linking cats to extensive losses of native species, other evidence suggests that their impact has been minimal".

The truth is, we don't know if feral cats have caused or are causing any extinctions. The catastrophic extinctions in inland Australia could have been triggered by a combination of things: changed fire regimes, drought, defoliation by introduced stock, and predation by foxes and cats. Cats were just part of this complex picture of ecological collapse. By singling them out as a scapegoat we run the risk of blinding ourselves to the true threatening processes. As an example of this, I have written recently (*Nature Aust.** Spring 1994) of how the Noisy Miner (*Manorina melanocephala*), an aggressive native honeyeater, can cause other birds to disappear, leaving cats to cop the blame.

Anti-cat campaigns often feature the Eastern Barred Bandicoot (*Perameles gunnii*), a small mammal once widespread in Victoria but now restricted to a colony near Hamilton, where cat predation is a threat. Yet Eastern Barred Bandicoots thrive in Tasmania, an island that has cats but no foxes. The decline of this bandicoot in Victoria probably owes more to foxes than cats. Cats are a problem there now because the last surviving colony is near a town.

I would suggest that foxes pose a greater problem, yet there is no passionate public campaign to oust foxes, presumably because it is obvious we can never eliminate the millions of wild foxes in Australia**. Yet the same commonsense thinking is not applied to cats. It is thought instead that, if everyone would only spay their cats, string bells around their necks and keep them in at night, cats would no longer kill wildlife. But what of the millions of feral cats in our deserts and woodlands? They are the bigger problem, but they are no more controllable than foxes or Cane Toads.

To be useful, the anti-cat campaign should focus on specific situations where cats are a proven problem, and where something can actually be done about it. Obvious examples are Hamilton's Eastern Barred Bandicoots and the Superb Lyrebirds (*Menura novaehollandiae*) of Sherbrooke Forest. But to make the sweeping claim that "Cats threaten the future survival of most wildlife", as the Victorian Department of Environment does in a leaflet, is to exaggerate the case so badly that it probably does more harm than good, by pitting cat owners against conservationists, instead of bringing them together as allies. ■

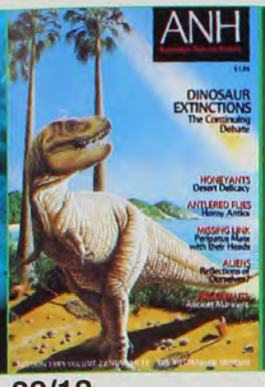
The Last Word is an opinion piece and does not necessarily reflect the views of the Australian Museum. This issue's contributor, Tim Low, is a consultant biologist, conservationist and writer who contributes regularly to Nature Australia. *He has never owned a cat.*

*Previously ANH

**There is, however, a federally funded body—the Cooperative Research Centre for Vertebrate Biocontrol—that is studying methods of immunocontraception for foxes.

BACK ISSUES & SUPPLEMENTS

2/11



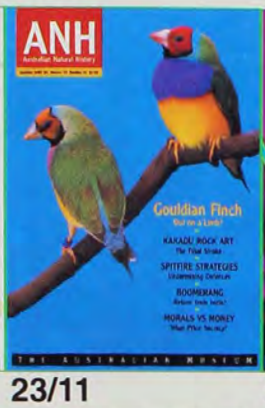
22/12

23/5

23/6

23/7 23/8

3/9 23/10

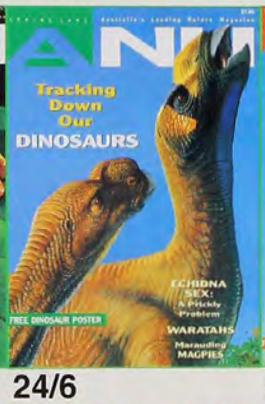


23/11

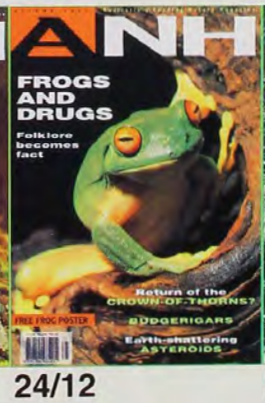
23/12

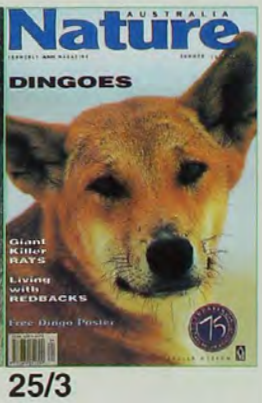
24/1

24/2



/3 24/4 24/5 24/6 24/7 24/8





/9 24/10 24/11 24/12 25/2 25/3

U P P L E M E N T S

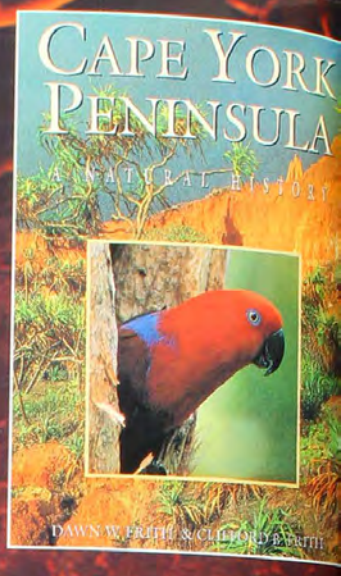
ces of
radise

S2
Tracks
Through
Time

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

To order use the form opposite

CAPE YORK PENINSULA



A NATURAL HISTORY

The north-eastern tip of the Australian continent is a seldom-explored paradise. This splendid book, fully illustrated with more than 390 colour photographs, takes the reader on an enchanted journey to one of the world's most colourful and diverse wilderness areas. From the mossy swamps of Gondwana, to the treetops of today's rainforest, the life and landscape of this area is explored and explained in fascinating detail.

FIRST IN NATURAL HISTORY

REED

CAPE YORK PENINSULA — *A Natural History*
Dawn W. Frith and Clifford B. Frith, wilderness photography by Kerry Trapnell
256 pp • 390 magnificent colour photographs • 5 maps • hardcover
ISBN 0 7301 0469 9 RRP $45.00