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ANH

FROGS AND DRUGS

**Folklore
becomes
fact**

**Return of the
CROWN-OF-THORNS?**

BUDGERIGARS

**Earth-shattering
ASTEROIDS**

FREE FROG POSTER

ISSN 0004-9840

01

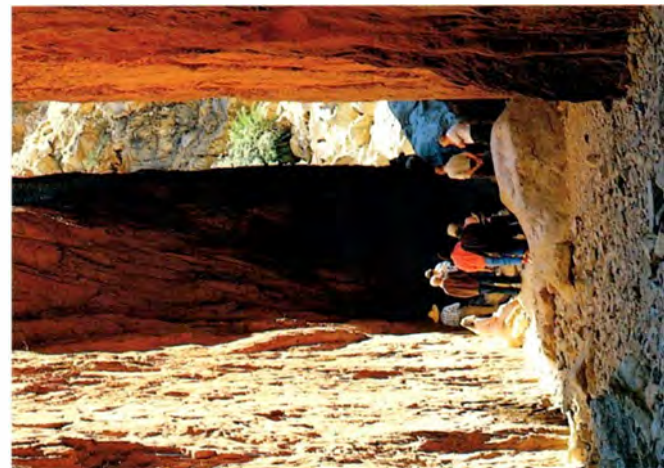


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Dear Daryl,
The Outback
looks enormous.
Will it fit into
seven days?



DAY 1. Arrive, and take a deep breath. Don't worry if you feel giddy, you're probably not used to such fresh air. Discover what a town like Alice is really like. Visit the School of the Air and the Royal Flying Doctor base. Do the rounds of the Aboriginal art galleries.



DAY 2. Head for the hills - the magnificent MacDonnell Ranges. Pack a picnic or plan to reach Glen Helen Gorge around lunchtime. The roads are excellent and uncrowded, so take your time and enjoy the many dramatic gaps and gorges - (Standley Chasm is so narrow you may have to turn sideways).



DAY 3. Learn how to see the country through the eyes of its original inhabitants. Take an Aboriginal tour. Learn about bush tucker, native medicines, local history, rock art, hunting techniques. Share some of the traditions of hunting and gathering and hear traditional songs and stories of the Dreamtime.



DAY 4. Hop on a train, a camel train and go on safari; ideally overnight. It's the true way to experience the beauty and serenity of the Outback. At dusk and dawn meet some of the locals at the watering hole - wallabies, parrots, maybe dingoes. P.S. Don't sleep downwind of camels.



DAY 5. Off to King's Canyon, the Territory's most spectacular gorge, midway between Alice and Uluru. The more energetic can scale the rim and peer over the sheer 100 metre high walls. Or take a leisurely sunset tour with local Aboriginal people. Overnight at the new Lodge.



DAY 6. Drive to Uluru (Ayers Rock). After lunch take a guided tour around Uluru and learn about the local Aboriginal culture, geology, flora and fauna. Return later for the sunset show when the Rock glows deep red. Pop into the Observatory after dinner. I guarantee you'll be star struck.



DAY 7. Up early to scale Uluru, an exhilarating climb that guarantees you'll demolish breakfast. Then over to the Olgas which many say is equally as spectacular (as Uluru, not breakfast). Finally, home, which after the vastness of the Outback suddenly seems crowded and small.

Name _____

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This is only a guide to get you going. You'll find there are endless variations when you read the N.T. Information Pack. To receive your copy please phone 1 800 621 336 or send the completed coupon to Northern Territory Holiday Centre, PO Box 2532, Alice Springs NT 0871. Hope you enjoy holidaying there as much as I do.

ANHSAR



"You'll never never know,
if you never never go."

Daryl Bruce

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Up Front

Like so many other people around the world, I love frogs. I enjoy sitting quietly at night and just listening to their amazing array of calls. Those clicks and croaks remind me that there's still hope for our battered environments. To celebrate these wonderful amphibians, we have devoted a number of this issue's features to them.

In one of our main articles, Associate Professor Michael Tyler, from Adelaide University, writes on the role of frogs in medicine and, in doing so, takes us on an intriguing journey that begins in 79 AD and ends with some amazing revelations about the properties of humble frog skin. These discoveries will hopefully advance both frog conservation and human medicine.

We know from your continuing correspondence that, like us, you think the photography is a very important part of this magazine. For each issue we endeavour to locate the best images worldwide. This issue is no exception. Dedicated nature photographers Kathie



Platymantis guppyi from the Solomon Islands.

PAVEL GERMAN



The Green Tree Frog (*Litoria caerulea*).

Australasian frogs. Pavel goes to a lot of trouble to photograph his subjects in a calm and relaxed state, believing this will ultimately provide a more accurate record of the animal.

Finally, your next issue will be our 75th birthday issue and we've got plenty of surprises in store. For a sneak preview turn to page 19.

In the meantime, I hope you enjoy this issue as much as we did putting it together for you.

—Jennifer Saunders

BE TEMPTED
TO ISLANDS NEAR AND
FAR OF SPECTACULAR
UNTOUCHED BEAUTY
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CULTURAL ALLURE AND
UNCLUTTERED
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L.H.I. FASTBOOK VACATIONS PTY LTD

LIC: 2TA003131

ACN: 003926369

Published by
The Australian Museum Trust
6 College Street,
Sydney, NSW 2000.
Phone: (02) 339 8111
Fax: (02) 339 8313
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

Mike Field

Phone: (02) 339 8331
ADVERTISING

Sari Järvenpää

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SUBSCRIPTIONS

Mary Pollinger

Phone: (02) 339 8119

Toll-free (08) 028 558

Fax: (02) 339 8313

Annual subscription (4 issues)

Within Australia \$A30

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Two-year subscription (8 issues)

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Three-year subscription (12 issues)

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Other countries \$A108

New subscriptions can be made by credit card
on the ANH toll-free hotline (08) 028 558
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ANH is printed on archival quality paper
suitable for library collections.

Published 1995
ISSN-0004-9840



Australian Natural History is proud winner of
the 1987, '88, '89, '90, '91, '92 & '93 Whitley
Awards for Best Periodical.

Front Cover

From drug companies to the writers of chil-
dren's fairytales, everyone seems to be fascinat-
ed by frogs. This Red-eyed Tree Frog (*Litoria*
chloris) is one of the most photogenic of these
amazing amphibians. Photo by Kathie Atkinson.

Articles



THE BAT WITH THE STEREO NOSE

*Recent observations on the
behaviour of Queensland
Tube-nosed Bats seem to
indicate that their appearance
is not the only remarkable
thing about them.*

BY LES HALL &
JACK PETTIGREW

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CROWN-OF-THORNS

*In the 1980s, while scientists
argued and the media had a
field day, millions of Crown-of-
thorns Starfish ate their way
through sections of the Great
Barrier Reef. And then as
quickly as they arrived, they
seemed to leave. Or did they?
Are we currently witnessing
the beginnings of another
devastating outbreak of those
dreaded thorned starfish?*

BY KAREN MCGHEE

30

SEARCH FOR THE CENTRAL ROCK-RAT

*It's 101 years since the first
specimen of the Central
Rock-rat was discovered and 35
years since the last one was
found. In a bid to rediscover
this rare mammal, and find out
what's going on in the rocky
habitats of central Australia,
an expedition covering an area
of 52,000 square kilometres
was launched.*

BY DAVE WURST

38



FROGS AND DRUGS

*It seems that modern medicine
is finally catching onto what
'folk' medicine has known for
thousands of years—there is
much more to frogs and toads
than warts and fairytales.*

BY MICHAEL J. TYLER

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THE COSMIC SHOOTING GALLERY

Sixty-five million years ago a ten-kilometre-wide asteroid wiped dinosaurs from this planet. Now scientists are discovering that this was not the only time a major cosmic collision occurred on Earth and the chances of it happening again are higher than you might like to think.

BY GEOFF McNAMARA

52



GUMS AND GALLS

While on a field trip through north-western Australia, two entomologists track down the elusive scale insect that was responsible for a peculiar gourd-shaped gall collected over a century ago.

BY PETER CRANSTON & PENNY GULLAN

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Regular Features

THE BACKYARD NATURALIST

BUDGERIGARS: MINI AUSSIE MEGASTARS

Ever since John Gould became fascinated with Budgies back in 1840, these abundant little parrots have become the world's most popular caged bird. But out in the bush their behaviour might surprise even the most experienced Budgie fancier.

BY STEVE VAN DYCK

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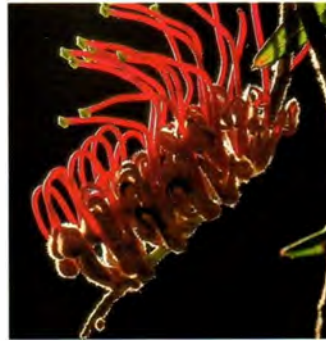
RARE & ENDANGERED

CALEY'S GREVILLEA

Grevillea caleyi is a spectacular grevillea and one of the Sydney region's most threatened plant species—a situation that could have been made all the more desperate by last year's disastrous bush fires.

BY NICK WILSON

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W I L D F O O D S VIEWS FROM THE FOURTH DIMENSION

INSECT DINNER: THE BIG TABOO

Hungry? How about snacking on a nice cockroach, or what about a March fly? No? Why not? Lots of other cultures do. Or is this one taboo that's proving hard to beat?

BY TIM LOW

24



FROGS

Step into the world of frogs as seen through the lens of Pavel German's camera.

BY PAVEL GERMAN

60

DEVILS, DUGITES & 'DIRT BRAINS'

The discovery of the remains of a 15-million-year-old fossilised cave at Riversleigh has Michael Archer once again sliding down the slippery slope of time.

BY MICHAEL ARCHER

68

THE LAST WORD

PIN PRICKS & VERDANT VISTAS

Agriculture versus mining. Which industry is less environmentally destructive and which is more financially rewarding? You might be shocked by the statistics.

BY MICHAEL ARCHER

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LETTERS

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

Astronomical Error

An error occurs in Geoff McNamara's article "Where is the Rest of the Universe?" (ANH Winter 1994) where a light year is described as "about a billion kilometres". The speed of light is approximately 3×10^5 kilometres per second and there are about 3.15×10^7 seconds in a year. Therefore a light year is about 9.45×10^{12} kilometres or roughly 10 billion kilometres (old British style) or 10 trillion kilometres (American style). Even using the old British style, the article's definition is out by a factor of ten.

—Michael Vnuk
Annerley, Qld

Keep it Clean

I am not trying to be capricious or critical but in the otherwise very good article on bush soap by Tim Low (ANH Winter 1994) I found one slip and a point that always makes me, as a

chemist, concerned. The slip is the statement that, "if the leaves...are finely crushed in water, they increase the water's surface tension...". Wetting agents and detergents (not necessarily the same) *decrease* the surface tension of the water, and this is the reason they are able to wet the soil and float it off the soiled surface.

The other matter that concerns me is the statement that "Nowadays chemical alkalis are used". Regardless of how these alkalis are obtained, they are all chemical, whether they are obtained from industrial processes or by extraction from plants. Indeed, there is nothing in this world, this universe or any conceivable universe that is not chemical. It would be unexceptionable if Tim Low had stated that 'stronger' alkalis are used, such as sodium hydroxide (caustic soda).

I don't think that these

points really damage the interest of the article, or the information it contains, but a practising consultant ought not to use incorrect or vague terms in his writing.

—W.J. Bliss
Mosman, NSW

The Human Fish

Further to Alex Bortoli's short article on the Irrawaddy Dolphin in the Winter 1994 issue of ANH, your readers might find the following information interesting. Liesbeth Sluiter's recent book, *The Mekong currency: lives and times of a river* (International Books, Utrecht, The Netherlands, 1993) describes the occurrence of the Irrawaddy Dolphin in the Mekong River and its tributaries in Indochina, localities that were not included in the range of the dolphin in Bortoli's article. In the chapter entitled "The Human Fish", Sluiter describes how an Irrawaddy Dolphin died in nets in the Mekong River in Laos; her photographs of the dolphin are included in the chapter. She reports that it was one of perhaps only 30 or 40 that survive in a large, deep pool (60 to 70 metres deep) in the Mekong. Between December 1991 and April 1992, eight of these dolphins died in a similar fashion. The Laoighis call the dolphin the human fish and Sluiter recounts two different

legends concerning the origin of the dolphin. The local people also hold a strong belief that the dolphin helps people to fish.

Grave concerns are held for the survival of this small group of Irrawaddy Dolphins. Sluiter reports that there is an increasing use of dynamite to stun and kill fish, particularly, she says, by Cambodians who have picked up the technique after years of war and easy access to explosives. She even reports the death of a second dolphin in her time at the locality, as a result of dynamiting. The use of dynamite is rapidly causing depletion of fish stocks and the Laoighis are having to use bigger and bigger nets to obtain the same catch. Both trends do not bode well for the Irrawaddy Dolphin.

—Paul Bishop
Monash University, Vic.

Anyone for Scorpions?

"Night Stalkers" (ANH Winter 1994) was an excellent and informative article on these remarkable creatures. I was surprised to read that scorpions were not eaten by humans, as my Australian-Chinese friend recently told me he consumed scorpions at a Cantonese-style restaurant in Henan (central China) in the Zhengzho Province.

He was offered scorpions (species unidentified) as a delicacy and was assured by his hosts that all overseas guests should at least taste them once! A choice of a dozen fresh and fried scorpions was offered to him, each about the size of a medium-sized prawn, and consumed either deep fried, which turned them from a pale pink to a cockroach brown colour when cooked, or freshly drowned in a large glass of strong clear alcohol.

My friend enjoyed the deep fried scorpions saying "they tasted just like crispy deep fried prawns", but had significant trouble with the supposedly freshly drowned scorpions as they were still alive and kicking after 15 minutes in the alcohol. After some fuss they were whisked away by the waiter and later returned, minus



Although this Australian *Urodacus* scorpion probably won't make it to our dinner plates, scorpions from other countries, it seems, are definitely on the menu.



JEAN-PAUL FERRERO/AUSCAPE INTERNATIONAL

their claws (what about the stinger?). They were a little crunchy and had a potent alcoholic tang. Mind you the locals did not eat any as they were apparently a "delicacy reserved for guests"!

So for all of those epicurean chefs, maybe we could soon be devouring scorpions *à la* Kilpatrick or chargrilled scorpions on the barbecue. Silurian competition for the Aussie prawn?

—Antony Fabbro
Bondi, NSW

Earthwatch and Burrowing Bettongs

For readers of ANH who were interested in the Rare & Endangered article by Jeff Short about the Burrowing Bettong (ANH Winter 1994), Earthwatch provides a unique opportunity to learn more about this work. This year (1995), Earthwatch will be supporting Jeff Short's research work as he monitors the survival rate of the reintroduced bettongs of Heirisson Prong in Western Australia. Teams of Earthwatch volunteers will assist the scientists as they

assess the anti-predator responses of the bettongs, and monitor their reproductive status and body condition at three-monthly intervals. The teams will go into the field for two weeks and will be involved in all aspects of the field research from animal observation to radio-tracking.

Further information about this project is available from Earthwatch, 457 Elizabeth Street, Melbourne, Telephone (03) 600 9100, Fax (03) 600 9066.

—Jane Gilmour
Earthwatch

Palm Power

Dan Etherington, in referring to the village-based production of coconut oil for use as a fuel (QQC, ANH Spring 1994), highlights one of the many practical uses for the coconut palm. Apart from the production of copra, and to a much lesser extent the processing of coconut husk as a fibre for decorative and horticultural end-use purposes, the potential of the coconut palm remains largely untapped.

We are of the opinion that

a lot more time, effort and money should be directed by research bodies and industry into the processing of tropical palm products at the village or plantation level into raw materials suitable for incorporation in more elaborate industrial processes.

Palms grown for the sole specific purpose of producing vegetable oil occupy much of the arable coastal land throughout the Pacific and, as Dan Etherington points out, the viability of these plantations relies on the fluctuating world prices paid for the end product. If the plantation palms could generate income from products other than copra and oil, villages and plantation economies would be able to diversify their palm-based incomes.

Given that worldwide there is a potential surplus of waste paper (which has limited practical possibilities for recycling), coupled with a looming shortage of raw material for the manufacture of cardboard, might we suggest that research be conducted into the possibility of processing waste coconut

Help monitor the Burrowing Bettongs of Heirisson Prong.

husk, palm fronds and the trunks of old unproductive palms into a long-stapled fibre wood chip or pulp that could be used as an additive to short-stapled fibre recycled paper to make it suitable for use in the manufacture of cardboard? Such an end use for what now has little if any economic value would have the potential to supplement or replace, on a sustainable basis, the export of rainforest timber used for pulping and help conserve the threatened tropical rainforests.

—Peter & Jeanne Edwards
Langwarrin, Vic.

ANH welcomes letters for publication and requests that they be limited to 250 words and typed if possible. Please supply a daytime telephone number and type or print your name and address clearly on the letter. The best letter in each issue will receive a \$20.00 gift voucher from the Museum Shop catalogue. The winner this issue is Antony Fabbro.

QUOTES & CURIOS

QUIPS

COMPILED
BY
GEORGINA
HICKEY

Blue Genes for Blue Jeans

Blue genes for blue roses and now for blue jeans! Previously we 'quipped' about Calgene Pacific, an Australian biotechnology company that is genetically engineering the world's first blue rose (ANH Summer 1992-93). Well, now two American companies, Agracetus and Calgene, have turned their sights to our jeans and are trying to make them blue...by green means. Instead of colouring the cotton with conventional, environmentally unfriendly dyes, the companies intend to use cotton that grows blue on the

plant. This they hope to achieve by inserting the gene from the indigo plant (the original source of blue dye) into the cotton plant.

Although there are certain colours of cotton that do occur naturally, like rust colour, these have short, coarse fibres that are hard to spin on commercial machines and must be spun by hand. Experimental cross-breeding has resulted in the development of a range of natural brown and green cottons suitable for machine spinning. But as far as blue cotton is concerned, this can only be produced by genetic engineering.

—C.B.

The Drink of the Devil

In the desert, water is a rare and precious commodity. To increase their chances of survival, many animals have evolved interesting ways to collect water for drinking. Some lizards, such as the Australian Thorny Devil (*Moloch horridus*), have fine channels running between their body scales that carry drinking water to their mouths. A similar desert dweller, the Texas Horned Lizard (*Phrynosoma cornutum*), even adopts a special flattened posture to capture the maximum amount of rain on its back (see ANH Winter 1992).

Wade Sherbrooke, from the American Museum of Natural History, was the researcher who studied this rain-harvesting stance in Texas Horned Lizards. And, on a recent trip to Australia, he decided to investigate whether Australian Thorny Devils did the same. Although none of his study lizards was seen to adopt any particular body orientation during either light or heavy rainfall, he did observe something that has never been reported before.

Following light rain, disturbed patches of sand were found near the lizards. One lizard was found lying on its stomach with its sandy feet raised, so that the maximum amount of skin was in contact with the damp substrate. Although they weren't actually seen in the act, it appears the lizards deliberately rub their bellies on the damp sand. This supports recent work by Phil Withers at the University of Western Australia that showed that the capillary forces in the Thorny Devil's skin are enough to absorb water from a damp substrate. There was no apparent disturbance of the sand after heavy rainfall, suggesting the lizards only use their bellies to collect water when not enough has been channelled from their backs.

—R.S.

Genetic engineering may one day enable cotton to grow blue on the plant.



JILL LOCHMAN/LOCHMAN TRANSPARENCIES



KATHIE ATKINSON

Desert Mutualism

Extrême environments can encourage unusual alliances in the pursuit of survival. On a clear day in Brazil's coastal Linhares Nature Preserve, just north of Rio de Janeiro, temperatures can soar to over 50° C by late morning. While few creatures could withstand such conditions, the lizard *Tropidurus torquatus* scurries about upon the baking desert sand eating ants.

This little reptile's ability to stay out and exploit food resources, while most of its competitors are waiting in the shade for the cooler late afternoon or nightfall, appears to rely on a close relationship it has developed with a botanical ally. João Vaconcellos-Neto and colleagues from the State University of Campinas have observed the lizard climbing up onto the cactus *Malocactus violaceus* and tak-

ing its small pink fruit. The researchers believe these fruit, with their high water content, may be crucial to the daytime activities of *Tropidurus*.

This association is, however, far more intricate and exclusive than many herbivore-plant relationships. The cactus produces up to four fruit each day. These mature within it and are then pushed up to appear externally about mid-morning, at the time of the lizard's peak period of activity.

In return for the moisture resource, the lizard provides the plant with a dispersal mechanism for its seeds. In fact, the lizard's consumption of the seeds is probably crucial to their viability: they seem to remain dormant until they have passed through the lizard's digestive tract. The Brazilian researchers were unable to germinate seeds collected straight from the cactus but had no problems germinating the

cactus seeds collected from the lizard's faeces.

—K. McG.

Lizards with Mites in their Pockets

A debate has erupted in zoology over the function of 'mite pockets' in lizards. These are invaginations in the skin of some lizards that tend to house chiggers—the larvae of mites of the family Trombiculidae, which in Australia can transmit the disease scrub typhus.

Nick Arnold, a herpetologist at London's Natural History Museum, has suggested that mite pockets limit the damage that chiggers may do by concentrating them away from other more vulnerable sites on the lizards. However, Aaron Bauer, from Villanova University in Pennsylvania, and colleagues, after examin-

The Thorny Devil may use its belly to absorb water from a damp substrate.



This giant New Caledonian gecko (*Rhacodactylus* sp.) has folds in its skin that are often home to mite larvae.

ing the giant geckoes of New Caledonia and Australia (*Rhacodactylus* and *Pseudohacodactylus*), maintain that there is no evidence to support this claim. They argue that mite pockets have evolved for another reason,

not for their own sake, but because they are the necessary result of having arms. Such structures may subsequently evolve a function, but this would not be related to the trait's origin. Discovering which traits are

of mite pockets: lizards without mite pockets weren't able to pass on their genes as successfully as lizards that possessed these structures, because lizards without mite pockets suffered more from the infestation of chiggers. In contrast, Bauer *et al.* suggest that, at least in the geckoes they studied, mite pockets are simply a result of the formation of folds of skin on their bodies. These folds may help to camouflage the lizards by breaking up their outline, making them more difficult for predators to see. And the mites live inbetween the folds because these pockets provide them with food and shelter, and because the lizards cannot easily remove them. Arnold doesn't deny that some lizards may have mite pockets for the reason that Bauer

and his colleagues state, but believes that other lizard species without skin folds may have evolved mite pockets in order to stem damage by chiggers. Arnold also suggests that, even if the large geckoes had evolved skin folds (and hence mite pockets) for crypsis, the mite pockets may still function to reduce damage by chiggers.

The evidence for the damage limitation hypothesis seems slim at present. Little is known about the relationship between chiggers and lizards, or even whether chiggers usually have a detrimental effect on lizards. What is certain is that, if the mite pockets of lizards do have a function, it will only be discovered by further detailed research.

—Simon Blomberg
University of Sydney

Armpits exist not for their own sake, but because they are the necessary result of having arms.

totally unrelated to the presence of chiggers. Why might the relationship between lizards and their parasites cause so much controversy?

Since the publication of Darwin's *Origin of species* in 1859, the most popular explanation for the evolution of complex structures has been that they evolve as adaptations by natural selection: individuals possessing the genes for the useful trait were able to produce more offspring than individuals without those genes. Consequently, more of those genes would be passed on to the next generation and more individuals would have that characteristic. However, evolutionary biologists agree that traits don't necessarily arise through natural selection. Organisms may possess characteristics that are simply products of developmental design constraints. Armpits, for example, exist

adaptations and which are not has become an important, and often difficult, problem for evolutionary biologists.

Arnold's damage limitation hypothesis is adaptationist. He invokes natural selection as the agent for the evolution

Waste...Not

The caterpillars of many Australian mallee moths (family Oecophoridae) have a distinctly Antipodean diet of dead vegetation from eucalypts and related plants. Leaf litter beneath the ubiquitous gum tree is the most obvious supply of such food. However, two recently discovered species satisfy their appetite for eucalypts via a far less direct route.

Adults of the new-found moths emerged, in the Canberra office of CSIRO



Few things could be more Australian than a moth whose caterpillars dine exclusively on Koala scats.

AUSTRALIAN BOOKS ON OUR ASIAN REGION

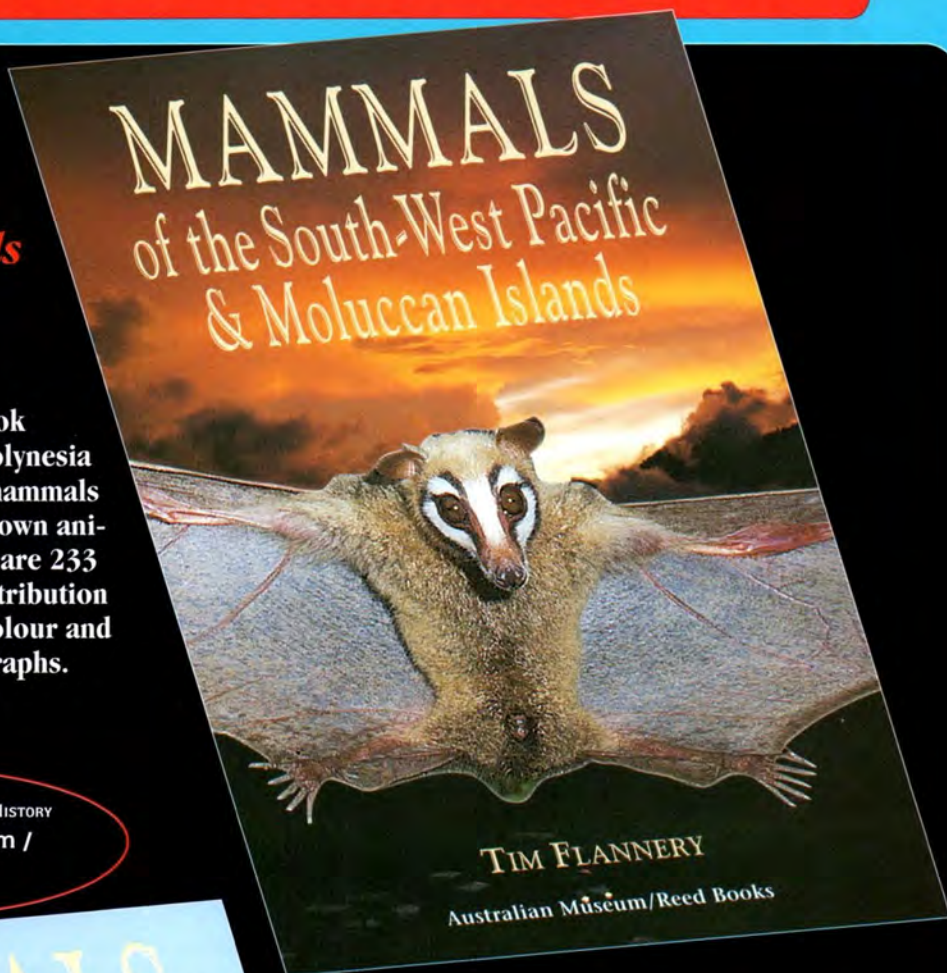
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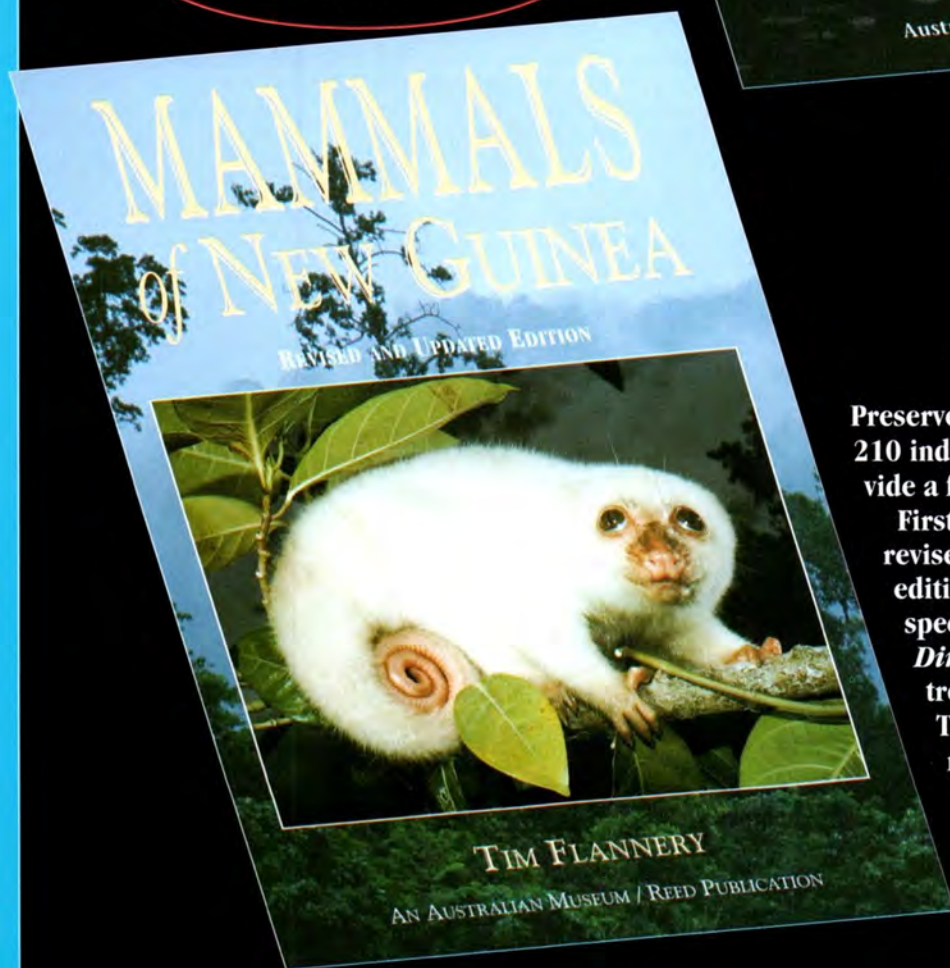


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Dung beetles play an important role in the breakdown of dung.

entomologist Marianne Horak, from Koala droppings (known as scats) found in the Tantawangalo State Forest in south-eastern New South Wales. The larvae from which they developed appeared to live entirely within the scats, feeding on compressed and undigested portions of eucalypt leaves and ejecting their own faecal pellets through small openings in the Koala waste. Once feeding was complete, the caterpillars lined the insides of the hollowed-out scats with silk and constructed intricate one-way, anti-predator escape hatches for adult moths. They then entered a quiescent period before pupating.

Discovery of the moths could have implications for the conservation and management of the Tantawangalo State Forest as they indicate that the Koala-eucalypt ecosystem in the area is more complex than previously imagined.

The degree of niche specialisation observed in the new mallee moths is not unusual for the group to which they belong. Because

of the vast amounts of eucalypt leaves available in Australia, mallee moths have greatly diversified: for some their leaf supply is the old foliage that banks up behind bark, while others live on the dead leaves that have not yet fallen from dead branches. Where there's a niche, it seems, these lovers of leaf litter will find a way.

—K.McG.

Permanent Pats

What would happen if cow pats did not disintegrate but lay undisturbed for long periods? Permanent pats are becoming a genuine problem in some cattle farming regions of the world. The situation is caused by the use of a drug, Ivermectin, to treat intestinal parasites in cows, sheep and horses. The drug is very effective in protecting the animals but it is not altered by the process of digestion and thus renders their dung toxic, and in some cases repellent, to insects that are normally attracted to it.

Some might think this is a good thing as far as certain insect pests are concerned, but some of the insects

affected, such as dung beetles, play an important role in the breakdown of dung. No one is quite sure why many species of dung beetle turn their 'proboscises' up at the sterile dung. Collaborative research by Peter Holter (University of Copenhagen) and colleagues indicates that the effect is only indirectly related to Ivermectin since beetles cannot discriminate between dung from untreated animals and dung that has had the drug added to it after being dropped. It seems that some, as yet unknown, side effect of the treatment is responsible for the change in dung beetle behaviour.

Sterile dung causes pats to pile up, stifling the grass underneath and reducing valuable fodder. This may not be such a problem in areas with high rainfall and an abundance of earthworms, which help decompose the pats quickly. But in drier climates, such as Australia's, sterile dung can lie in the paddock for several years.

The situation is further complicated by the finding that some dung beetle species are not repelled by dung from Ivermectin-treated cattle and in some cases

appear to be even more attracted to it. Either way, it is clear that Ivermectin, like many drugs, has an effect on more than just the animals it was designed for.

—Susannah Eliott

University of Technology, Sydney

Floral Insecticide

Insect control is the best way to limit the impact of debilitating mosquito-borne diseases such as malaria and yellow fever. Unfortunately, however, the most widespread and successful methods used in recent decades have included synthetic insecticides, such as DDT, which are now known to wreak long-term ecological havoc and have since been banned or restricted.

Researchers investigating natural insecticides as more environmentally friendly alternatives have now found that marigolds (genus *Tagetes*), long regarded in folklore and wives' tales for their insecticidal properties, could turn out to be the scourge of mosquitoes.

Carl Wells and colleagues from the University of Alabama carried out chemi-

cal investigations into three species of this common garden flower. After distilling essential oils from extracts of the plants' roots, leaves and flowers, the researchers separated individual chemicals using chromatography. Among several of the compounds isolated were the volatile chemicals known as thiophenes, which have been well studied because of their toxicity to mosquitoes.

The chemists found that extracts from all three marigold species killed the larvae and adults of *Aedes aegyptii* and *Anopheles stephensi*—the mosquitoes that transmit malaria and yellow fever, respectively.

However, Wells and his colleagues found that the insecticidal properties of the marigold species *Tagetes minuta* were more effective than those from *T. patula* and *T. erecta*. And in other comparisons of the extracts, flowers were revealed to be more potent against insect pests than roots or leaves.

—K.McG.



Volatile extracts from marigolds are effective at killing mosquitoes that carry malaria and yellow fever.

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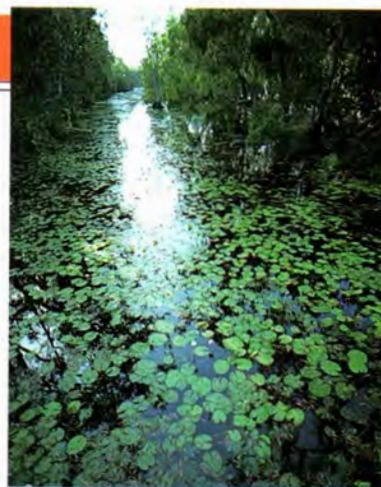
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DRAWING ROOM (NT)

Murder on the Nile?

The firm fillets of Nile Perch that have become common in fish shops around the country over the last few years may be welcomed by fish eaters but they reflect an ecological disaster occurring in eastern Africa's Lake Victoria. Nile Perch (*Lates niloticus*), closely related to Australia's Barramundi (*L. calcarifer*), grow to a length of almost two metres and can weigh in at 200 kilograms. Their natural distribution is in the large rivers and lakes of northern and western Africa.

In the late 1950s they were introduced into Lake Victoria but remained in low numbers until the 1980s when they started to dominate the fishing catch, making Lake Victoria one of the most productive fisheries in the world with catches of 200,000–300,000 tonnes each year. The fish are rapidly filleted and frozen for export overseas, earning valuable foreign exchange. Australia's imports of frozen fish from Kenya and Uganda, consisting largely of Nile Perch, have shown a marked increase over the past six

years going from 100 tonnes in 1986/1987 to 1,095 tonnes in 1992/1993.

However the population explosion of Nile Perch has also brought major problems. Lake Victoria had a tremendous diversity of small cichlid fishes, perhaps as many as 400 species, many of which were endemic to the lake. These provided the primary prey for the Nile Perch and it is estimated that up to 50 per cent have become extinct. The IUCN is supporting a project to maintain a captive breeding population of some of these fish but only about 40 are currently in captivity and it is probably too late for most of them. This has been called the greatest mass extinction of vertebrates this century.

The local fishermen who used to harvest the rich cichlid fish stocks now face starvation unless they invest in the larger gill nets and larger boats needed to catch the Nile Perch. Thirty million people depended on local fisheries as a protein source and they now have to rely on the scraps discarded from the factories (the fillets are far too expensive for the locals to buy).

Could this happen in Australia? Well, there were plans to introduce Nile Perch to Queensland waterbodies

in the early 1980s. The rationale was that Nile Perch would provide a fine eating and sporting fish in the large artificial impoundments where local Barramundi couldn't breed. Because Barramundi and Nile Perch were fairly closely related it was suggested that the Nile Perch wouldn't cause too much harm to native fish! Fortunately investigations by Christopher Barlow and Allan Lisle in Queensland and Uganda's Richard Ogutu-Ohwayo showed that Nile Perch took a wider range of prey and had a much greater temperature tolerance than previously thought, allowing it to survive even in New South Wales waters. Also, because artificial breeding of our own Barramundi became successful, the project was scrapped—but perhaps we don't know how close we came to another disastrous introduction.

—Peter Woodall
University of Queensland

Moths that Go Click in the Night

To avoid being eaten by bats, if they can, most moths rely on evasive flying manoeuvres. But moths of the family Arctiidae employ a

less energetic tactic. When they hear a bat's echolocation cries, they respond with a series of clicks that makes the bat stay away.

Several hypotheses have been proposed to explain how the clicks work. One is that they jam the bat's echolocation system so that the bat can't find the moth. Another is that they startle the bat so that it goes away. A third hypothesis is that the clicks warn predators that the moth tastes nasty. To investigate this last hypothesis, Dorothy Dunning (West Virginia University) and colleagues presented bats with a variety of moths.

The number of arctiid moths killed by the bats was significantly less than was available to them and, of the moths killed, the bats ate fewer arctiids than moths of other families. Also, muted arctiid moths (those with punctured tymbal organs, which they use to make their clicks) were caught more often but were usually dropped.

These experiments indicate that the clicks of arctiid moths warn predators they don't taste good and to stay away. In other words, they appear to be the auditory equivalent of bold warning colours.

—C.B.



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Quick-stinking Birds

While espousing the importance of local folk knowledge in the quest for beneficial new chemicals, Jared Diamond (UCLA) related the "Case of the Stinking Birds". Two New Guinea birds—the Orange-footed Scrubfowl (*Megapodius freycinet*, which also occurs in the Solomons and Australia) and Menbek's Coucal (*Centropus menbeki*)—stink much sooner after death than other birds. In fact, some Solomon Islanders swear that the only way to prepare the scrubfowl for human consumption is to have the billy boiling underneath a roosting bird so that, when it is shot, it falls straight into the pot before it has a chance to start stinking.

"Why does *any* dead animal smell bad?" you might ask. What could be the possible function of this wretched



HANS & JUDY BESTE/AUSCAPE INTERNATIONAL

stench? Biological poisons, bad tastes and smelly gases are all products produced by microbes to ward other microbes or scavengers away from the feast. Penicillin, produced by a mould to kill bacteria, is

Why does the Orange-footed Scrubfowl start stinking after death much sooner than most other birds?

probably the most well-known chemical weapon of this sort. But how might a dead animal benefit by smelling bad sooner than later? What possible benefit could it confer?

As Diamond noted, the two quick-to-stink birds are big, clumsy, noisy and slow, and would find it difficult to avoid predators. To stink while the birds were alive would require them to develop resistance to the noxious stinking chemicals. Perhaps they instead developed a means of harbouring potentially stinking microbes or enzymes that only became active when the host animal was dead. (The exact mechanism by which these birds start to stink as soon as they are dead is unknown.) If a predator killed and ate one of these birds, it would get sick and learn to avoid them in the future.

Only careful experimentation will tell whether this functional explanation can account for the quick-stinking phenomenon, if indeed a functional explanation exists for it at all. But a chemical company would be wise to follow up on this bit of local knowledge—after all, the stinking chemical might well be another penicillin-like drug just waiting to be discovered.

—G.H.

HOT BEE BALLS



MASATO ONO/TAMAGAWA UNIVERSITY

A defensive ball of Japanese honeybees surrounds and kills an intruding hornet.

defenders grab and hold a hornet, while 200 to 300 more bees clumped into a ball around the trespassing predator. In 20 separate incidents, the researchers noted that the balls persisted for an average of about an hour. Without exception, each bee cluster eventually broke away to reveal a dead hornet.

Using tiny thermometers, the Japanese researchers found that, by huddling as a quivering and shivering collective, the bees raised the temperature inside the balls to as high as 47° C, which is enough to kill the hornets, whose lethal temperature range is 45–47° C. The Japanese honeybees, by contrast, only succumb when temperatures exceed 48–50° C.

These honeybee balls are the first recorded example of so-called 'cold-blooded' animals using heat production as a defence against predators.

—K.McG.

No, this is not an account of some new and exotic gastronomic delight. It's a tale of a small but resourceful insect, the Japanese honeybee *Apis cerana*, and its extraordinary battles with an intimidating foe, the hornet *Vespa simillima*.

The hornets hunt the bees to feed to their larvae; they linger-in-wait around hive entrances during summer and autumn, at the ready to

snatch their prey. Heavily armoured and seemingly impervious to bee stings, the hornets are efficient predators capable of totally depopulating weakened hives.

However, the bees have found that in numbers they can muster an effective defence. Entomologist Masato Ono and colleagues, from Tokyo's Tamagawa University, reported frequently observing one or two hive

Loving Embrace or Enemy Conflict?

The aerial cartwheeling or whirling flight of many raptors, particularly the eagles, is a breathtaking spectacle. Witness the flurry of feathers as two large birds of prey meet mid-air, clasp and lock talons, and spiral dramatically downwards with wings outstretched, and it is not hard to understand why the behaviour has been romanticised as an act of courtship.

In his 1881 verse "The Dalliance of Eagles", the great American poet Walt Whitman described the extraordinary sight as "rushing amorous contact high in space together". And, despite the injuries and occasional fatalities it can cause, courtship has persisted as the popular explanation for aerial cartwheeling.

A recent critical review, however, provides solid support for a very different interpretation. When investigating the current scientific literature describing whirling contact flights between birds

of prey, Namibian Government conservation biologists Rob Simmons and John Mendelsohn found deficiencies in most accounts. And so they solicited and received further information (much of it previously unpublished) from 20 raptor biologists covering 18 species and thousands of observation hours.

Altogether, Simmons and Mendelsohn reviewed reports on 39 species of birds of prey ranging from small falcons to the largest eagles and vultures including detailed observations of 107 cartwheeling events for 29 species. Of these, only a small number (11 per cent) could realistically be interpreted as courtship-related and a few (seven per cent) were probably play interactions between juvenile birds. The majority (82 per cent), however, could only be interpreted as aggressive combat, mostly over territories or food.

Simmons and Mendelsohn believe that observer-expected bias led to past misinterpretations of whirling flight. It seems that once one esteemed researcher had classified the behaviour as a courtship display, other researchers were loathe to disagree.

—K.McG.

A grappling pair of Northern Harriers (*Circus cyaneus*).



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Universal Antivenom for Snake Bite

How do snakes protect themselves from the effects of their own toxic venom or from the venom of other snakes on which they might sometimes feed? This question has led to the discovery of a protein that could play a significant role in the future treatment of snake bites.

Peter Mirtschin (Venom Supplies, South Australia), my postgraduate students at the University of Technology, Sydney, and I found that serum from the blood of four different species of Australian snakes could each protect experimental mice from the neurotoxic effects of all four snake venoms. We studied in detail the protective agent in the blood of one of these snakes, the Eastern Tiger Snake (*Notechis scutatus*), and showed it to be a complex protein that acts as a neurotoxin inhibitor; that is, it grabs the venom neurotoxin and prevents it from attacking the nerves of the snake bite victim.

Similar proteins have been identified in the blood of the



Milking a Taipan (*Oxyuranus scutellatus*) for its venom.

Japanese Habu Snake (*Trimeresurus flavoviridis*), the Chinese Mamushi (*Agkistrodon blomhoffi siniticus*) and the South American Rattlesnake (*Crotalus durissus terrificus*) but in each of these cases the protective protein only stops the toxic activity of its own venom and not that of other snakes. However, our team found that the protective protein from Australia's Eastern Tiger Snake can neutralise the venom from a wide range of snakes, including the Eastern Brown Snake (*Pseudonaja textilis*), Russell's Viper (*Vipera russelli*), Central American Moccasin (*Agkistrodon bilineatus*), Forest Cobra (*Naja melanoleuca*), Western Diamondback Rattlesnake (*Crotalus atrox*) and Half Moon Viper (*Bothrops alternatus*). This amazing cross-reactivity suggests that this snake's protective protein has the potential to be developed into a universal antivenom.

Conventional antivenoms have been produced since the turn of the century by injecting large animals, usually horses, with increasing doses of venom and collecting the animal's blood as a source of venom-neutralising antibodies. These products have been very successful in the treatment of snake bites but suffer from two major disadvantages. The first is that they are highly specific for each snake species. This means that the venom or snake must be identified

before the correct antivenom can be administered. When this is not possible polyvalent antivenoms, which are a mixture of the antivenoms of commonly found snakes in a particular region, can be used. However, these are more expensive and usually require a much greater dose than specific antivenoms, increasing the risk of severe allergic reaction. The other major problem in Australia with conventional antivenoms is one of storage. They must be kept cool, which restricts their availability in isolated country regions. Antivenoms made from synthetic or genetically engineered proteins, on the other hand, can be freeze-dried and stored on the shelf. With further research, we hope we will be able to manipulate the snakes' own protective mechanism into a readily available and cost-effective antivenom for all snake bites.

—Kevin Broady
University of Technology, Sydney

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QUICK QUIZ

1. What astronomical feature is made up of WIMPs and MACHOs?
2. Name the ship that spilt 17,280 tonnes of oil off Western Australia in July 1991.
3. What does ANCA stand for?
4. The nests of which birds are used to make birds' nest soup?
5. What should you put on Box Jellyfish stings?
6. Which mammals sport a four-headed penis?
7. Name the comet that collided with Jupiter in July 1994.
8. What is Australia's most easterly point?
9. How many species of wombat are there?
10. What is the term given to the study of fossil pollen?

(Answers in Q&A)

Carrie Bengston (a science communicator for the CSIRO), Karen McGhee (a freelance science writer living in Newcastle, NSW) and Rachel Sullivan (Taronga Zoo) are regular contributors to Q&C.

become and the kind of articles we publish. All of us who work on the magazine, and at the Australian Museum, are very excited by this name change. We look forward to bringing you the very best of nature, wildlife, the environment and all the latest discoveries in the natural sciences as NATURE AUSTRALIA.

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BUDGERIGARS: MINI AUSSIE MEGASTARS

BY STEVE VAN DYCK

MY BROTHER HAD A PET Budgerigar (*Melopsittacus undulatus*) that finally went to the grave without ever causing us to suspect that Budgies had any redeeming features. It hated everybody, bit the fingers that changed its husks, and reserved all its energy and affection for its mirror, on which it lovingly regurgitated and pounded all day.

In its sunset years it took to having fits, where in the black of night, it would fall off its perch and flap around on its back screeching, until someone (my father) got out of bed, reinstated it on its perch, then attended his bleeding finger. Until the night my dad slept through the bird's final fit, Bill, as the

Budgie was imaginatively known, had managed to smoulder his way through about eight long years of unrequited love.

Thinking the unsavoury relationship between Bill and the spotty mirror was just a by-product of boredom, we had no idea that Budgies craved company, and that to deny one a companion (and an appreciative audience) was like denying a politician the press. This was unwittingly demonstrated again a few years later when I tried my hand at breeding an isolated pair. The birds may as well have been hand-picked for a Vatican aviary such was their seminarial disdain for Budgie business. Thirty years later I read that being naturally gregarious it is usually quite hopeless to try to breed from single pairs of Budgies...the bells just don't ring loudly enough for them unless they can draw on the inspiration generated by their copulating neighbours. Then, given some rain and seed, the whole flock plunges into a chatter-

Widely distributed throughout the interior of Australia, Budgies are probably one of our most abundant native birds.

ing frenzy of passion that would leave the herds of the Serengeti blushing.

Such a flurry of fecundity made December of 1989 an unforgettable Christmas for Ross and Yvonne Borlace of "Ryreem", 50 kilometres north of Ceduna at the top of the Great Australian Bight. Budgerigars, which are widespread throughout mallee, mulga, saltbush and grasslands in the interior of Australia, are not commonly seen at "Ryreem", and the Borlases, who had childhood memories of some large flocks in the 1930s, could not believe what was going on up in the scrub north of their wheat-sheep farm. Over what seemed like only a few months they had noticed a blistering build-up in the number of Budgerigars breeding everywhere in the mallee.

Then, toward Christmas, when the temperature rose to a staggering 46° C under the Borlace's verandah, the simmering Budgie jamboree up in the mallee boiled over. Those that didn't die to form a thick green carpet covering the floor of the scrub moved down to the shade, moisture and reflective surfaces of the Borlace's farm buildings. "We got home from town to find mobs of them, mostly young'ns, under the verandah, all over and under a car. The ones that weren't dead paid no attention to us trying to pick our way through them to get to the front door", Ross told me. Daily, for two weeks, he raked dead Budgies out from grain stored in shaded holding sheds and carried them away in countless 20-litre drums.

"They were so desperate for moisture they just threw themselves into our 60 by 20 foot in-ground water tank. We put planks on the water to let them get out, but on at least two occasions the tank was completely covered with dead birds...you talk about deadly algal blooms up your way...". (Budgerigars are the only parrot known to land on water, drink while floating with wings outstretched, then fly up from the surface.)

Paul Brown and Allison Smythe, neighbours of the Borlases, remember the Budgies clambering over greasy drums, trying to drink spilled oil, and others forcing their way into the children's aviary to get at the pets' drinking water.

"For weeks it really stunk right through the scrub, so thick were the bodies of the little green beggars."

There are numerous early reports of the sky turning almost black with flying Budgies. Ornithologist Alec Chisholm reported that after a heat wave in 1931, one resident of southern Central Australia removed and burned almost five tonnes of dead birds from one of his dams. Another man recorded 60,000



BOB WALDEN/AUSTRALIAN PICTURE LIBRARY

Budgies can raise up to eight young per brood and have several broods per year.



C. ANDREW HENLEY/AUSCAPE INTERNATIONAL

dead Budgies that had smothered or drowned during their frenzied use of one of his waterholes.

In spite of such monumental local disasters, the Budgerigar is still probably one of the most abundant of Australian birds. Part of the secret of such success lies in its uncanny ability to follow rain and grain, and its lightning capacity to knuckle down to parenting at the drop of a shower-cap. If winter rains in the

south, or summer monsoons in the north bring a flush of seeding grasses, the Budgies breed. But in times of drought they will nest after any substantial deluge. Each pair of Budgies selects a hollow in a living tree, dead stump or in a log on the ground. Inside, the brown-nosed female (her mate's nose, or 'cere', is blue) may lay up to eight eggs over alternate days. She begins incubation almost immediately so growth of the nestlings may be staggered by up to a fortnight. If the tables turn and poor conditions suddenly prevail, at least some of the more advanced chicks might survive rather than the whole brood die. Both parents feed the young for about 35 days. They need only small dry seeds (of grasses, salt-bush, spinifex) to rear the chicks and can raise several broods per year. On top of this, when water is very scarce, a Budgie can survive up to 30 days without drinking.

The other part of its success story is behind bars. John Gould, who was fascinated by this tiny parrot, managed to take some hand-reared nestlings back to England in 1840, and these were purportedly the first Budgerigars to reach Europe alive. Bird lovers over there were enraptured with their miniature beauty. They were hardy and as easy to feed as they were to house and breed, and many became excellent mimics (although one author observed "Strangely enough, unlike human beings, male Budgerigars are far more talkative than females!"). During the next decade thousands more were shipped to Europe. But the little green birds bred so freely in captivity that by 1859 it was cheaper to buy a Budgie in London than to pay the ten shillings

being asked in the Sydney markets. Yellow forms appeared in the Belgian markets in 1872, 'Skyblues' in 1910, and thereafter almost every imaginable colour, except red. The brilliant scarlet individuals from India that appeared in London shortly before World War II were paled by the faces of their new owners who watched the birds' (died) feathers fall out during the annual moult to reveal ho-hum white birds!

Today, although Canaries (originally from the Canary Islands), African Peach-faced Lovebirds and our own wolf-whistling Cockatiels try to steal the cage-bird limelight, the Budgerigar still ranks deservedly as the most popular caged bird of all time. Totally adaptable, all forgiving, non-demanding and ever ebullient, this little parrot brings uninhibited *joie de vivre* to millions around the world.

I sometimes wince at the memory of old finger-crunching, brain-damaged Bill skidding around the cage floor demolishing his coprolitic stalagmites, but the morning chatter of my children's pet Budgie rising above their violin practice, and the inspiration he draws from his mirror where I now draw only desolation, is sweet testimony to why Budgerigars made it to the top of the ladder! ■

Further Reading

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

BUDGERIGAR

Melopsittacus undulatus

Classification

Family Psittacidae (parrots)

Identification

Small, lime-green parrot with yellow face and crown; 18 cm long (of which 9 cm is tail); males with blue cere, females with brown, immatures with mauve ceres and black forehead bars; no significant variation in wild population.

Distribution and Habitat

Endemic, from open arid grasslands, mulga, mallee and spinifex; Australia-wide but absent from Top End, southwest, and east of Great Dividing Range and Tasmania.

Behaviour

Eats small seeds of grasses and herbs; gregarious and nomadic, usually in flocks of less than 100; breeds after rain, most nesting August-January in south, June-September in north; 4-8 white eggs; female incubates 18 days; young fledge after 35 days.

Grevillea caleyi exemplifies those species that can be eliminated from an area by the too-frequent use of fire.

CALEY'S GREVILLEA

BY NICK WILSON

MOTORISTS WHIZZING over the crest of Tumbledown Dick Hill on Mona Vale Road in Sydney's north may be unaware that one of the Sydney region's most threatened plant species, *Grevillea caleyi*, is just metres away. The close proximity of the road is emblematic of the precarious status of the species. *Grevillea caleyi* is restricted to patches in the Belrose/Ingleside district, on the

row distribution. Its '2ECi' Code on the Rare or Threatened Australian Plant (ROTAP) data base means that the species has a distribution range under 100 kilometres, is endangered (likely to go extinct, in one or two decades, if causal factors continue to operate) and is conserved, although inadequately (there is one small population in Kuring-gai Chase National Park).

Within its range, *G. caleyi* is restricted to patches of deeply weathered lateritic shale soil over the more usual Hawkesbury Sandstone. Why it is so specific in its habitat needs is unclear. There are fascinating parallels in ecology and rarity with another 'toothbrush' grevillea, *G. beadleana*, from the New South Wales Northern Tablelands. It

The role of fire in the *G. caleyi* story was dramatically underscored by the devastating January 1994 bushfires that engulfed much of its habitat.

broad ridge that is also the preferred site for both road builders and residential developers.

Grevillea caleyi is a sprawling shrub, growing to three metres. It is distinguished by its deeply divided, fern-like leaves and the fact that much of the plant is covered by a dense felt of soft rust-coloured hairs. New growth is a beautiful red colour. The inflorescences (flower clusters) have dark red styles and are of the 'toothbrush' grevillea type, with the flowers developing on just one side of the inflorescence axis.

The name celebrates its European discoverer, George Caley, who collected the first specimen in 1805. Since then it has been mostly downhill for a species that has always had a very nar-

row distribution. Its '2ECi' Code on the Rare or Threatened Australian Plant (ROTAP) data base means that the species has a distribution range under 100 kilometres, is endangered (likely to go extinct, in one or two decades, if causal factors continue to operate) and is conserved, although inadequately (there is one small population in Kuring-gai Chase National Park).

Judging by the distribution of suitable lateritic soils in the area, and some limited knowledge of prior populations, up to 70 or 80 per cent of the species' original habitat has been destroyed, espec-

ially by residential development in the suburbs of French's Forest, Belrose and Duffy's Forest, and by the building of Mona Vale Road.

Apart from habitat loss, the other principal threat to the survival of *G. caleyi* is an inappropriate fire regime. The role of fire in the *G. caleyi* story was dramatically underscored by the devastating January 1994 bushfires that engulfed much of its habitat. According to Tony Auld, a research scientist at the New South Wales National Parks and Wildlife Service, about 70 per cent of the known population were killed.

Grevillea caleyi's fire ecology is a familiar one to plant ecologists: adults are killed by even low-intensity burns, but the fire initiates a pulse of germination from the soil seed bank that eventually replaces, provided all goes well, the original population. There does appear to have been good germination and survival of seedlings produced after the 1994 fires, allaying concerns that those disastrous fires had devastated the species.

The story does not end here though, as it is the pattern of fire over a period of time that is crucial. Species such as *G. caleyi* require a significant fire-free period (at least 10–12 years) to allow seedlings to mature and to rebuild the seed bank. Conversely, too long without a fire (about 30 years is the safe maximum in this case) may see the adults senescing and not being capable of producing enough seed to replace that lost in the soil through predation or loss of viability.

Accommodating such ecological needs is a very real and all too familiar problem, especially near housing. *Grevillea caleyi* exemplifies those species that can be eliminated from an area by the too-frequent use of fire, such as happens when regular burning is employed to reduce fuel as a precaution against wildfire. Public pressure in Sydney after the 1994 fires has called for more regular burning, and a freeing of legislative restrictions. How this potential conflict is resolved in *G. caleyi*'s habitat is crucial to the survival of the species.

Grevillea caleyi needs active management to survive over much, if not all, of its much reduced range. Tony Auld and colleagues are preparing a Species Recovery Plan that will address the fire issue and others surrounding its survival. There is an ongoing proposal to widen Mona Vale Road, which, if done, would clear large areas of prime habitat. Time for the regeneration of the burnt areas, and good faith on the part of all parties concerned, will tell for Caley's Grevillea. ■

Nick Wilson is a freelance biologist and photographer. He has poked around in Grevillea caleyi's habitat on both a professional and personal level.



Tests by the University of Sydney confirm what studies all around the world have found: insects are nutritious.

INSECT DINNER: THE BIG TABOO

BY TIM LOW

IN THE 1970S, THE TABOOS CAME tumbling down. Teenagers all over the Western world felt free to indulge in sex, alternative lifestyles and foods. Yet some powerful taboos did survive that era, and one of these was the taboo against eating insects. It is very odd that we in the West, open-minded and adventurous as we are, do not consume insects. We are indoctrinated to think that insects are disgusting and unfit for human consumption. Yet this is just the myth that maintains the taboo.

Many members of the class Insecta are tasty and nutritious. If you don't believe me, try a moth that has been lightly fried in a touch of oil*. (Or eat it raw.) If you can't bring yourself to do this, or if you think the moth tastes horrid, this only shows how strongly the taboo controls you.

As a liberated male I shrugged the taboo off long ago. Over the years I have indulged in many kinds of insects and other arthropods, and nearly all were good: caterpillars, grasshoppers, ants, flies, cockroaches, moths, as well as centipedes and spiders (members of the related classes Chilopoda and Arachnida).

I have helped others shed the taboo. I once persuaded a television journalist to eat a live March fly. On "A Current Affair" I goaded spider-fearing journalist Cathy Phillips to eat a baked golden orb-weaving spider (*Nephila* species). She agreed it had a pleasant taste, like pâté.

Australian Aborigines were not bound by the taboo and ate plenty of insects. Their fondness for witchetty grubs is well known (see ANH Autumn 1990).

Some Aboriginal groups also ate moths, ants, termites, flies, wasp larvae, lerps, hawkmoth caterpillars and praying mantids.

In northern Queensland, blood-sucking March flies (family Tabanidae) were eaten. I often snack upon these in the bush, for the abdomens have a pleasant sweet taste.

In the central deserts, caterpillars of

the hawkmoth *Hyles lineata livornicoides* were an important food after rain. I was not keen to try these brightly coloured caterpillars when I found some crawling over tar vines (*Boerhavia* species) near Windorah, but despite their bold colours they too are very tasty when roasted over coals.

Honeypot Ants (*Melophorus bagoti*) were (and still are) a delicacy in the mulga woodlands, and Green Tree Ant larvae (*Oecophylla smaragdina*) were eaten in the tropics. Recently, an orchard in northern Queensland has begun serving green ant juice and daiquiri, and green ant chilli sauce.

Overseas, giant water bugs (*Lethocerus* species) sell in the markets of Bangkok. In New Guinea and Africa, farmers eat the insect pests on their crops; and why not? The pests are often more nutritious than the crops.

Africa is the country in which insects

Longicorn beetles such as *Agrionome spinicollis* have wood-boring larvae that Aborigines gathered for food. Along with the larvae of cossid moths, these are called witchetty grubs.



*Do not eat moths or other insects bearing bright colours, especially orange or red; these are often toxic. Fortunately, most toxic insects are too distasteful to swallow.

are eaten the most. Mopane 'Worms', caterpillars of an emperor moth (family Saturniidae), are enormously popular in southern Africa, where they are dried and sold in supermarkets. The low turnout in a recent Zambian election was blamed by some diplomats upon its timing during Mopane Worm season—people were too busy catching caterpillars to vote.

The Malawi cookbook tells how to prepare shield bugs, cicadas, flying ants, bee larvae and grasshoppers. The authors state that the tiny flies (*Chaobora edulis*) that swarm over Lake Malawi during new moon are "extremely nutritious, being high in protein and calcium and containing six times as much iron as ox liver".

Tests by the University of Sydney confirm what studies all around the world have found: insects are nutritious. One witchetty grub sample yielded 0.92 milligrams per 100 grams of thiamine, much more than most Western foods. Bogong Moths (*Agrotis infusa*) are 27 per cent protein and 20 per cent fat. Overseas studies have found that termites contain twice the protein of steak, with a better mix of amino acids than almost any food.

Insects were eaten by Western societies in the past. The Greeks and Romans prized *cosus*, large grubs found in trees, and Moses and John the Baptist ate locusts. But somewhere along the way Western societies lost their taste for six-legged prey.

The few Westerners who advocated entomophagy (insect eating) have been branded eccentrics. In 1875 American entomologist C.V. Riley suggested the harvest of pest locusts, and in 1885 Englishman Vincent Holt wrote the book *Why not eat insects?*

Almost a century later entomologist Ronald Taylor and Barbara Carter published *Entertaining with insects: the original guide to insect cookery*. They gave recipes for cricket crisps, honeybee soufflé, beetle bars, candied insects, insect quiche and chapattis. They also had a section on earthworm cookery, featuring earthworm omelette.

I have not tried these dishes, although I have eaten a range of treats prepared by my friend Tom McRae of the Entomology Department at Queensland University. Tom makes excellent pâté from bee larvae. I can also recommend the witchetty grub soup served at Riberries restaurant in Sydney.

A couple of years ago the New York Entomological Society held a 'bug banquet' featuring mealworm dip and waxworm fritters, attracting world publicity. And the 1992 annual dinner of the Entomological Society of New South Wales commenced with a range of insect tidbits, including Bogong Moth 'fingers' with Motzarella cheese.

It is not surprising that most of the



Cicadas (family Cicadidae) are among the many kinds of insects eaten by people. Some Aboriginal groups ate the emerging nymphs, and in Malawi, the adults are fried in oil and salt.

brave souls promoting entomophagy have been entomologists. Imbued with professional respect for things that scuttle and buzz, they are not swayed by the crude prejudice, so vigorously promoted by insecticide makers, that insects are filthy and disgusting.

At present it does not really matter that Westerners do not eat insects. But that may need to change soon. The more I travel the world, the more convinced I am the world faces ruin from overpopulation and degradation. In Africa, Asia and Australia, sheep, cattle and goats are turning pastures to desert. Our seas are overfished. Unless we get very serious about controlling our numbers (and there is no sign of that), we will one day need to find new sources of protein.

Insects are probably the answer. They are nutritious and easy to rear. Colonies of mealworms can be kept in the kitchen. Children could rear silk-

worms for supper. In the garden, beetle larvae could be bred on kitchen compost. Insect culture could become a logical extension of permaculture.

But first we must put an end to that great taboo. ■

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Tim Low is an environmental consultant and author of four books about wild foods and medicines, all published by Angus & Robertson. He is especially fond of fly abdomens.

Queensland Tube-nosed Bats have set new standards with respect to flight, thermoregulation and speed of recovery from torpor.

SHORTLY AFTER DARKNESS FALLS in the coastal forests of north-eastern Australia a most unusual looking bat appears. It is the Queensland Tube-nosed Bat (*Nyctimene robinsoni*), a small (approximately 50 grams) brown bat with bulging eyes and tubular nostrils. Peppered all over its wings, face and ears are bright yellow spots. It is a pity they only fly at night, as a beautiful mottling of yellows, browns and greys is only evident when the wings are fully spread in strong light. It has the most colourful wings of all bats.

There are about 14 species of tube-nosed bats (*Nyctimene* spp.) in the world and they are found only from the Indonesian island of Sulawesi to New Guinea, the Bismarck Archipelago and north-eastern Australia. Three species are found in Queensland, one of which (*N. robinsoni*) is endemic. There has been very little research conducted on tube-nosed bats and knowledge of their biology depends

frequently on anecdotal observations like the following experience where we observed several behavioural aspects of the Queensland Tube-nosed Bat not previously recorded.

During the day Queensland Tube-nosed Bats hang by their toes from a small branch with their wings folded around their body. The bright yellow patches break up the shape of the bat and appear like dappled sunlight on a dead brown leaf. No two bats have the same pattern of spots, allowing individuals to be identified by their own spot code. The bats use the same branch each day for as long as the nearby food supply lasts. The roost site is usually 1.5–5 metres above ground in dense vegetation, which contains dead leaves that are similar in size to the hanging bat.

Figs are a principal food component

Queensland Tube-nosed Bats are extremely manoeuvrable in flight, even when carrying a fig more than half their own weight. This one is in the process of launching itself from its perch.

of the Queensland Tube-nosed Bat's diet. In the wet tropics the Cluster Fig (*Ficus nodosa*) and Variegated Fig (*F. variegata*) are favourite food trees. The fruit is produced in bunches on the trunks and limbs, and at night the tube-nosed bats can be seen hovering and landing on them. In southern parts of the bat's distribution figs are also a major food source. Moreton Bay Figs (*F. macrophylla*), Strangler Figs (*F. watkinsiana*) and Small-leaved Figs (*F. obliqua*) are large trees that usually emerge well above the canopy. As a result, when feeding, the bats mostly fly high in the canopy and are not often seen. This is probably the reason why they were thought to be rare in the southern part of their range. Historically there were few records south of Mackay but recently they have been recorded regularly in south-eastern Queensland and north-eastern New South Wales. The speed at which they fly through dense vegetation at night is amazingly fast, considering they navigate only by eyesight. Their fast flight may also contribute to the lack of recorded observations.

Figs produce a plentiful food supply and the asynchrony of their fruiting means there is a fig tree producing ripe fruit somewhere in the forest at most

THE BAT WITH THE STEREO NOSE

BY LES HALL & JACK PETTIGREW



times of the year. Tube-nosed bats roost near a fruiting fig and move to another roost site when the fig finishes fruiting. Although a large number of bats can be seen feeding on the one fig tree at night, Queensland Tube-nosed Bats roost singularly and have never been seen to form a roosting colony. While flying the bats produce a curious high-pitched whistle that probably serves as some sort of social signal.

In a patch of regrowth riverine forest near Mossman in northern Queensland, we caught eight Queensland Tube-nosed Bats in one mistnet between sunset and 8 pm. The net was set in an understorey clearing adjacent to a fruiting Cluster Fig. Several of the bats had a fig in the net beside them and it appeared that they must have been carrying them when caught. Our suspicion was confirmed when we caught another tube-nosed bat and ripe fig in a net set 50 metres away from the nearest fig tree. The bat weighed 54 grams and the fig 30 grams. The importance of these bats in dispersing fruit, particularly figs, throughout the forest was obvious. Tube-nose bats are the only 'under-canopy' fruit-eating bats in Australia. Flying-foxes (*Pteropus* spp.) will climb down trees to get fruit but mainly forage above the canopy. Other fruit



MICHAEL CERMAK

known to be eaten by Queensland Tube-nosed Bats in the wet tropics are the lillypilly *Syzigium cormiflorum*, the exotic Guava (*Psidium guajava*), and that of the satin ash *Eugenia erythrocalyx* and Brown Gardenia (*Randia sessilis*). The texture and size of their

Does the tubular structure of the Queensland Tube-nosed Bat's nose provide it with a stereo olfaction ability that enables it to locate food?

food varies from the large, rock-hard fruit of *Randia* to the small, soft lillypillies.

The importance and versatility of Queensland Tube-nosed Bats as the only small, understorey, seed-dispersing bat in Australian tropical forests becomes more apparent when comparisons are made with other tropical forests. In South-East Asian and Central American forests there are many species of small, understorey, fruit-eating bats that share the job of dispersing seeds.

While photographing Queensland Tube-nosed Bats in the confines of a netting enclosure at the Australian Tropical Research Foundation's Cape Tribulation field station, we observed just how manoeuvrable these bats were in flight. They were able to hover for several seconds and they could change the direction they were facing while still hovering. This they managed to do even while carrying a fig weighing more than half their own body weight. Their short broad wings allowed them to easily cruise around a 2 x 2.5-metre enclosure, although for some unknown reason they frequently tried to fly upwards against the ceiling. Hovering in bats is rare and is generally restricted to small light-weight bats that glean insects off leaves or take nectar from flowers.

Another aspect of their behaviour that became obvious in the enclosure was their ability to thermoregulate. Previously it was thought that all megachiropterans (large, fruit-eating bats) were homeothermic, that is, maintained a constant body temperature. But it was soon clear that these Queensland Tube-nosed Bats could quickly drop

JACK PETTIGREW



their body temperature and metabolic rate, and enter a state of torpor. When we first found them hanging motionless, unresponsive and cold in the enclosure, we thought they were dead. But following disturbance, the bats quickly elevated their heart rate, breathing and temperature, and became mobile. In several instances it took only 20 seconds to raise their body temperature the seven or eight degrees necessary for them to fly. The mechanism for this rapid heat production is known as tachycardia and is under nervous and hormonal control. Other species of bats that undergo torpor take considerably longer to raise their body temperature, relying on the slower heat-generating mechanisms of shivering or brown fat. The tube-nosed bats entered this state of torpor during the night as well as in the daytime. No doubt their ability to enter torpor would be an efficient energy-saving mechanism when weather conditions prevented foraging at night.

Queensland Tube-nosed Bats have set new standards with respect to flight, thermoregulation and speed of recovery from torpor. Now measurements of their cellular DNA content by Dr Russell Collins at the Royal Brisbane Hospital have revealed that the species has the smallest number of genes (genome size) of any mammal, about half the size of the human genome. This presumably means that there are fewer redundant genes in this bat's genetic make-up than there are in other mammalian species. Future comparative studies might even indicate which parts of the larger human genome are redundant.

Previously it had been assumed that the function of the bat's tubular nostrils was to keep them clear while eating their supposedly messy fruit meals. But after watching their feeding behaviour it soon became obvious that these bats were not messy eaters at all. When given a fig or another piece of fruit, they



JACK PETTIGREW

When feeding, tube-nosed bats make a tent with their wings and hide the food within it. For large food items, like this fig, they use their chest as a table so that they can hold the fig while slowly consuming it.

grabbed it firmly in their mouth. They then proceeded to clasp the perch with their thumbs and made a tent between their body and the perch with their wings. If the food item was large, such as a whole fig, they placed it on their chest and progressively bit pieces from it. At no time did they shove their face into it. Even if their nostrils were not tubular, they would probably not get blocked.

Bats became quite aggressive when they had food and resented any form of disturbance. They appeared to be hiding the food in the wing tent possibly from other animals or conspecifics that might covet the food. Chewing was slow and finally, after much pulping and sucking, a dry fibrous pellet was spat out. It took little time for the food to be digested, with faecal pellets being produced in only 15 minutes.

So, if the tubular shape of the nostrils has nothing to do with keeping them clear while eating, then what is their function? Further observations by us revealed that the two tubular structures can open and close and move independently of each other. And they do so in response to auditory, visual and olfactory cues. The bats seem to scan their surroundings using olfaction. We observed some changes in the flight direction of the bats towards hidden, ripe figs. If this direction finding was based on olfaction, then the tubular nostrils might provide independent measures of aroma concentration like stereo vision and stereo hearing from two eyes and two ears respectively. More research on the stereo nose of the Queensland Tube-nosed Bat should reveal how important olfaction is for this intriguing denizen of the rainforests. ■

QUEENSLAND TUBE-NOSED BAT

Nyctimene robinsoni

Classification

Order Chiroptera, family Pteropodidae.

Identification

Immediately recognised by its tubular nostrils, which protrude 5 mm above the muzzle. Wings and ears have scattered yellow patches. Body fur is brown with a slightly darker stripe down the spine. Weight 40 to 60 g. Forearm 60 to 70 mm.

Distribution

Far north-eastern NSW and coastal eastern Qld.

Habitat

Rainforest, gallery forest along watercourses, tropical woodlands adjacent rainforest. Roosts solitary in dense foliage where it resembles a dead leaf.

Status

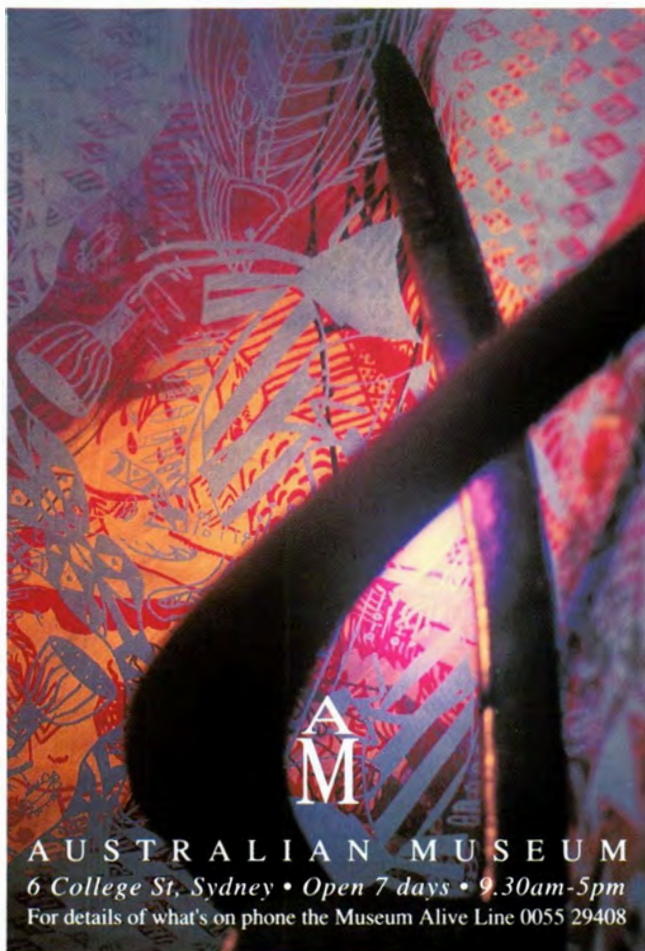
One of the most common bats in northern Qld, but infrequently seen in southern parts of its range.

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Dr Les Hall is a Senior Lecturer in the Department of Anatomical Sciences at the University of Queensland and has been working on bat biology for 25 years. Professor Jack Pettigrew is Director of the Vision, Touch and Hearing Centre in the Department of Physiology and Pharmacology at the University of Queensland. Jack has been studying the visual and auditory systems of a wide range of our fauna including fish, birds and mammals.



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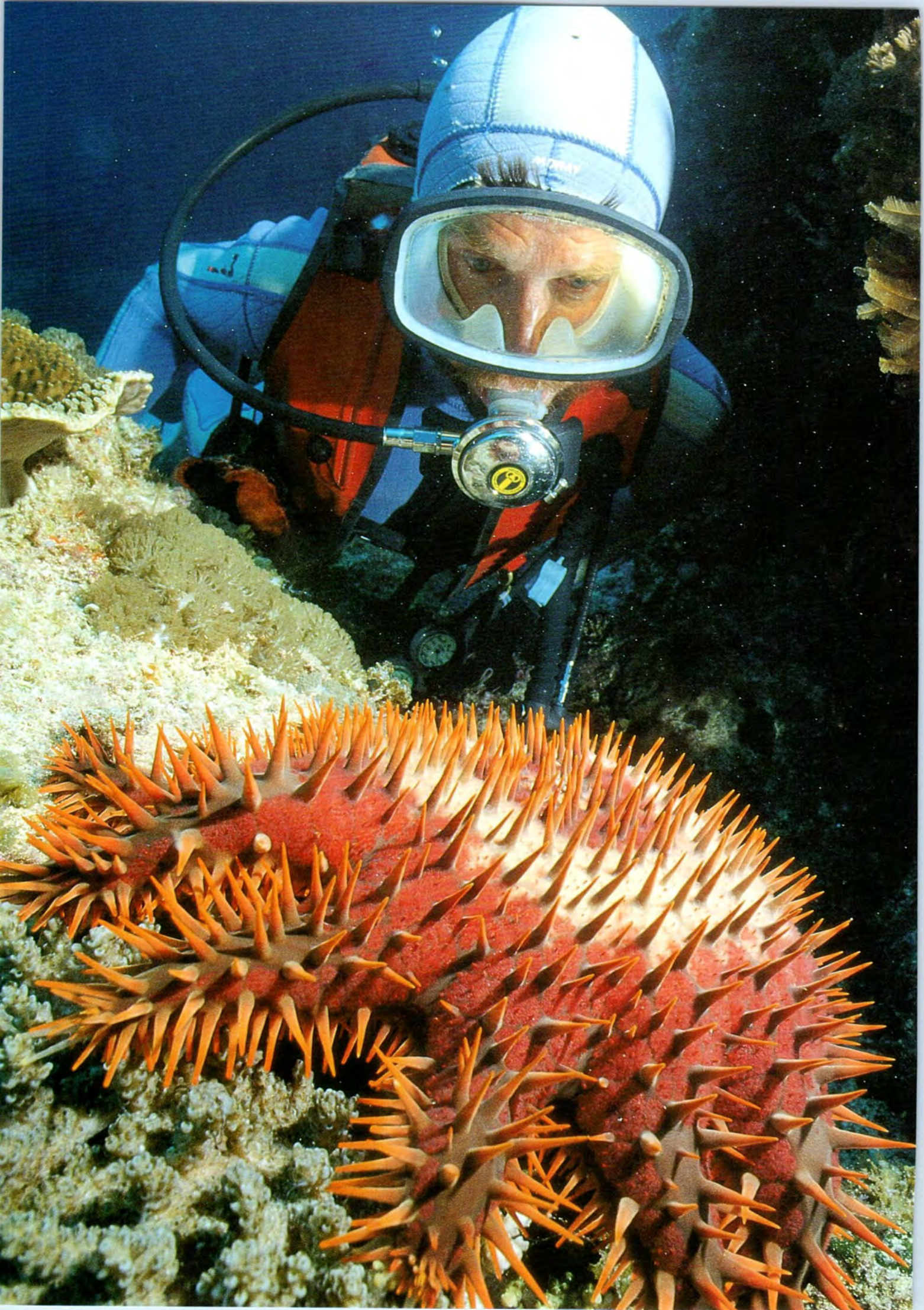
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In the past 12 months there has been a steady stream of reports that populations of juvenile starfish are increasing in the middle section of the Great Barrier Reef.

CROWN-OF-THORNS

BY KAREN MCGHEE



IT HAS BEEN MORE than a decade since the Crown-of-thorns Starfish (*Acanthaster planci*) last threatened to wipe out Green Island, north-east of Cairns, as a major tourist attraction. At one stage, in the early 1980s,

the coral reef around the island bristled with about 1.5 million of the prickly invaders. And then, almost as quickly as they arrived, the starfish seemingly disappeared, leaving behind hectares of bleached white and lifeless coral.

Could the spectacular coral gardens of the Great Barrier Reef be in for another destructive plague of Crown-of-thorns Starfish?

PHOTOS: KEVIN DEACON/OCEAN-EARTH IMAGES



The Green Island reef was just one of about 150 on the Great Barrier Reef (GBR) that were almost destroyed by the Crown-of-thorns plague, which reached its height in the mid 1980s.

Populations of juvenile starfish are increasing in the middle section of the GBR.

Back then millions of the animals, each about 30 centimetres in diameter, devoured their way through the spectacular corals off the Queensland coast. But the starfish, a species native to the Indo-Pacific region, and its notoriety, have since declined in Australian waters. Although there have been lin-

gering isolated infestations in the southern section of the GBR, most noticeably in the Swain Reefs north-east of Rockhampton, Crown-of-thorns numbers have generally fallen well below plague levels in recent years. Importantly, the numbers of starfish on reefs in the middle section of the GBR (between Cooktown and Mackay and including Green Island and the reefs north-east of Cairns) have been low for about ten years.

Since 1993, however, there has been a steady stream of reports that populations of juvenile starfish are increasing in the middle section of the GBR. The alarm bells are ringing once again.

Australian Institute of Marine Science annual surveys indicate that average Crown-of-thorns densities in coral reefs off Cooktown and Cairns are now about five times higher than they were two to three years ago. The Great Barrier Reef Marine Park Authority (GBRMPA), which gathers vital data on the population status of the coral predator through an effective reef-user reporting scheme



A close-up of the tube feet and poisonous spines of the Crown-of-thorns Starfish.

THERE HAVE BEEN TWO LARGE-SCALE Crown-of-thorns outbreaks in recent times: the plague that peaked by the mid 1980s after beginning around 1979, and a similar phenomenon that reached huge proportions by the late 1960s to early 1970s but was thought to have begun as early as 1962. It appears that the main path of destruction during each of these events began in the middle section of the GBR and GBRMPA scientists believe that larval starfish were carried mainly south by the East Australian Current, seeding a chain of population explosions.

The starfish spawn during the summer months, chemical messages released with the gametes synchronising the event between adjacent individuals. In the right conditions, each adult female is capable of producing up to 100 million offspring a year. Fuelled by this enormous reproductive potential, the past waves of infestation have leapfrogged down the GBR at a rate of about 70 kilometres per year to as far south as the Whitsunday Islands, north-east of Mackay.

As well as the location of recent sightings, their timing also has scientists worried. The patterns of the past outbreaks suggest they may conform to a 17-year cycle. If the cycle is recurring, then 1996 would be the anticipated target for the start of a third plague on the GBR, with populations building to a peak after the turn of the century. Unfortunately, if the prediction runs true, then it will only be with the benefit of hindsight that scientists will be able to confirm whether the starfish currently being found in the middle section of the GBR are the 'parents' of the next plague. The offspring they have produced during the last two summers will remain hidden from humans for as long as two to three years. Some scientists believe the starfish spend the early part of their lives as small algae-eating juveniles in deep water. They will start to eat coral at about six months and are one to two centimetres in diameter, but won't really become noticeable until they are about two years old and 30 centimetres in diameter.

The timing also fits generally with a 1983 prediction made in the scientific literature by a Queensland University team led by Associate Professor Robert Endean. Endean, who began working on the Crown-of-thorns Starfish in the early 1960s, and his colleagues forecast that another major outbreak would begin again on the GBR around 1995.

The other indication that a plague could be imminent is simply that there is, once again, enough coral around to sustain large numbers of starfish. GBRMPA estimates that about 500 of the 2,900 reefs on the GBR were affect-

ed to some degree by the last outbreak. Of these about 150, including Green Island, were classified as seriously affected, that is with more than 50 per cent of their corals killed over most of their perimeters. Fast-growing, opportunistic species such as the branching *Acropora* corals have rebuilt the total area of coral cover almost back to normal levels. However, the community structure of coral species on most reefs attacked during the last Crown-of-thorns onslaught are yet to return to pre-plague conditions.

Based on this, Endean and coworkers offer some dire predictions about the long-term impact of a third and future plagues. There are basically two kinds of hard corals, the fast-growing, relatively short-lived, branching species and the slow-growing, 'massive' species such as brain corals, some of which can live for thousands of years. The starfish prefer to eat the branching species and, during the 1970s outbreak, left most of the massive corals alone. During the last outbreak, however, the starfish started to include the massives in their feeding assaults on many reefs. These massive corals grow at a rate of about one centimetre per year, usually reaching sexual maturity at about 12 years of age. Because of this, Endean feels that

CROWN-OF-THORNS STARFISH

Acanthaster planci

Identification

One of the world's largest starfish, normally 25–35 cm across, up to 70 cm. Colour ranges from purplish blue body with red-tipped spines to green body with yellow-tipped spines. Adult arm number 6–23; covered by very sharp spines up to 5 cm long that often produce severe toxic reactions in humans; when attacked can shed arms, which will regenerate over several months.

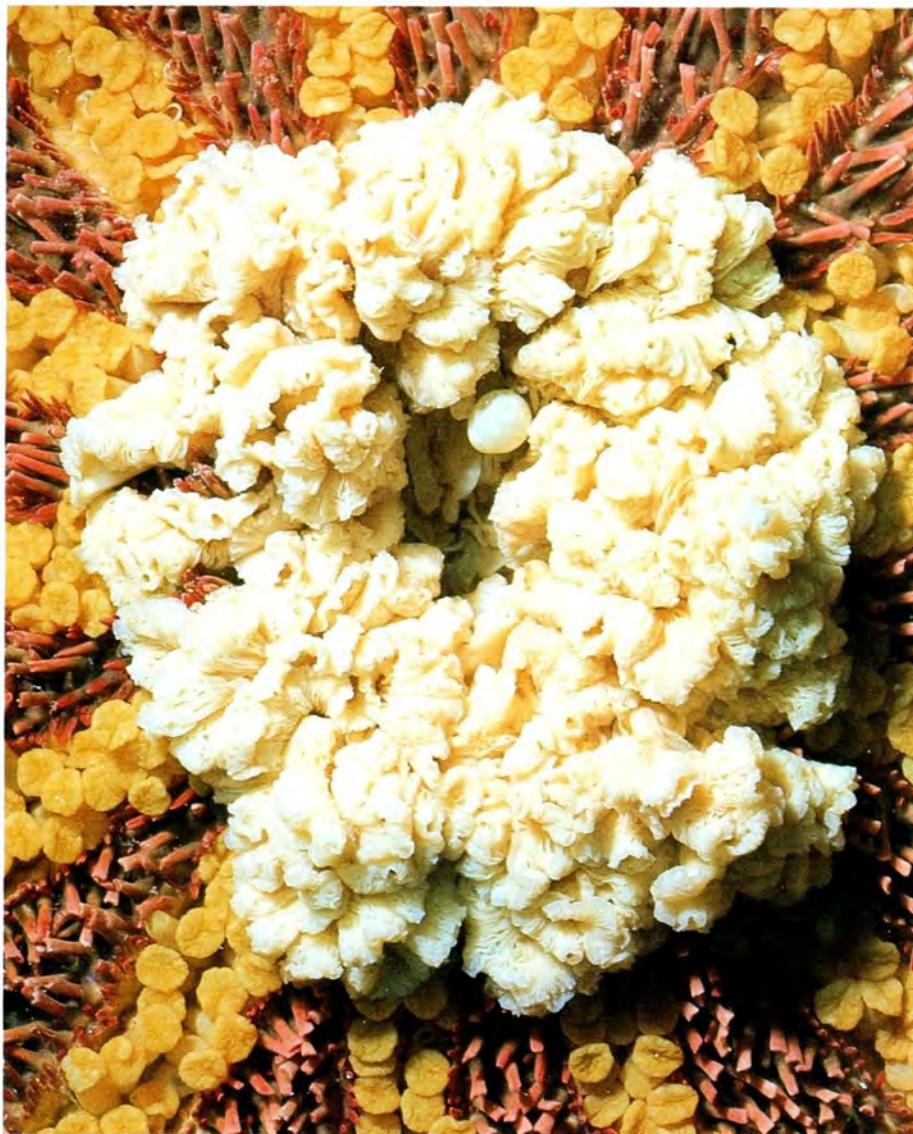
Distribution

Endemic to Indo-Pacific region where it is found on reefs of the Red Sea, Mauritius, Maldives, Indonesia, Micronesia, Ryukyu, Hawaii, Samoa, Tahiti, Tonga, Gulf of Panama and Great Barrier Reef.

Life Cycle

External fertilisation during summer months; mature females produce up to 100 million eggs per year; fertilised eggs develop into free-swimming planktonic larvae that, after 10–28 days, settle out onto coral rubble and change into tiny crawling five-armed starfish that eat encrusting coralline algae; at 4–6 months and 10 mm in size they begin to feed on corals and grow more rapidly, reaching adult size after two to three years.

known as 'Cotswatch', has noticed similar trends. Reef-users, ranging from professional tourist operators to recreational divers, provide a useful and steady flow of information about the distribution and abundance of Crown-of-thorns by completing survey forms after each reef visit. According to Dr Brian Lassig, coordinator of GBRMPA's Crown-of-thorns research program, the average number of starfish reported per reef (usually per dive) in the Cairns area has increased from 0.5 to 3.5 during the past four years. A similar increase has been recorded during the same period for the reefs north-east of Cooktown. In addition, scientists working on the popular tourist destination of Michaelmas Cay and Lizard Island report that densities on localised areas of these reefs are very close to 'outbreaking' population status. While the increases cannot be regarded as unequivocal evidence that another major Crown-of-thorns plague on the GBR is imminent, they are significant enough to cause serious concern among marine scientists.



BEN CROPP

When feeding, a Crown-of-thorns Starfish everts part of its stomach through its mouth. The white tissue in this picture is the starfish's everted cardiac stomach and running out from the centre are alternate rows of pink spines and yellow tube feet.

the starfish plague cycle may be too short to allow massive species to become re-established where they have been killed off by past Crown-of-thorns infestations. This, he predicts, could mean localised extinctions of massive species of coral on many reefs.

WHILE SCIENTISTS SEEM TO CONCUR about the possible timing of the next plague, the cause of the outbreaks remains unresolved. For many years from the late 1960s, scientific opinion on this question was deeply divided. There were those who believed the dramatic surges in Crown-of-thorns populations were a natural occurrence, just part of the many normal evolutionary forces that contribute to the diversity of life on the reef. The alternate point of view, with Endean as one of its chief protagonists, was that the plagues were totally unnatural and due solely to ecological imbalances created by humans. Endean argued then, as he does now, that the long-term viability of the GBR

faces a serious threat. The dispute became a political and media event, described by one commentator at the time as "one of the most protracted and unyielding scientific controversies of this century". However, as the starfish numbers declined after the second plague, so too did public interest in the argument.

It is possible that controversy will flare once more when, and if, the Crown-of-thorns returns in plague proportions and again starts threatening the tourist dollar. Certainly scientific opinion on the cause of the plagues remains divided. Lassig, as the coordinator of the world's largest research program on the Crown-of-thorns, says that most scientists working on the starfish believe the truth about the cause of the plagues lies somewhere midway between the two extremes of the argument. He believes the consensus is that plagues are probably a natural phenomenon, their frequency and proportions possibly accelerated and

exaggerated by human activities.

However Endean vehemently disagrees and maintains there is no clear evidence of starfish plagues occurring on the GBR before the 1960s. The results of geological research have been claimed to indicate that large numbers of Crown-of-thorns occurred up to 7,000 years ago on the GBR. But it remains unclear whether any past aggregations occurred in the same proportions and frequency as the recent plagues. Endean believes that Crown-of-thorns populations build up unchecked only on reefs where humans have removed too many of their natural predators. These predators of both juvenile and adult starfish include large reef fish, which are popular spearfishing targets, and the Giant Triton (*Charonia tritonis*), a huge carnivorous sea snail highly prized by shell collectors. Endean argues that the reefs worst affected during the past two plagues were those most heavily exploited by humans, and



The dispute became a political and media event.

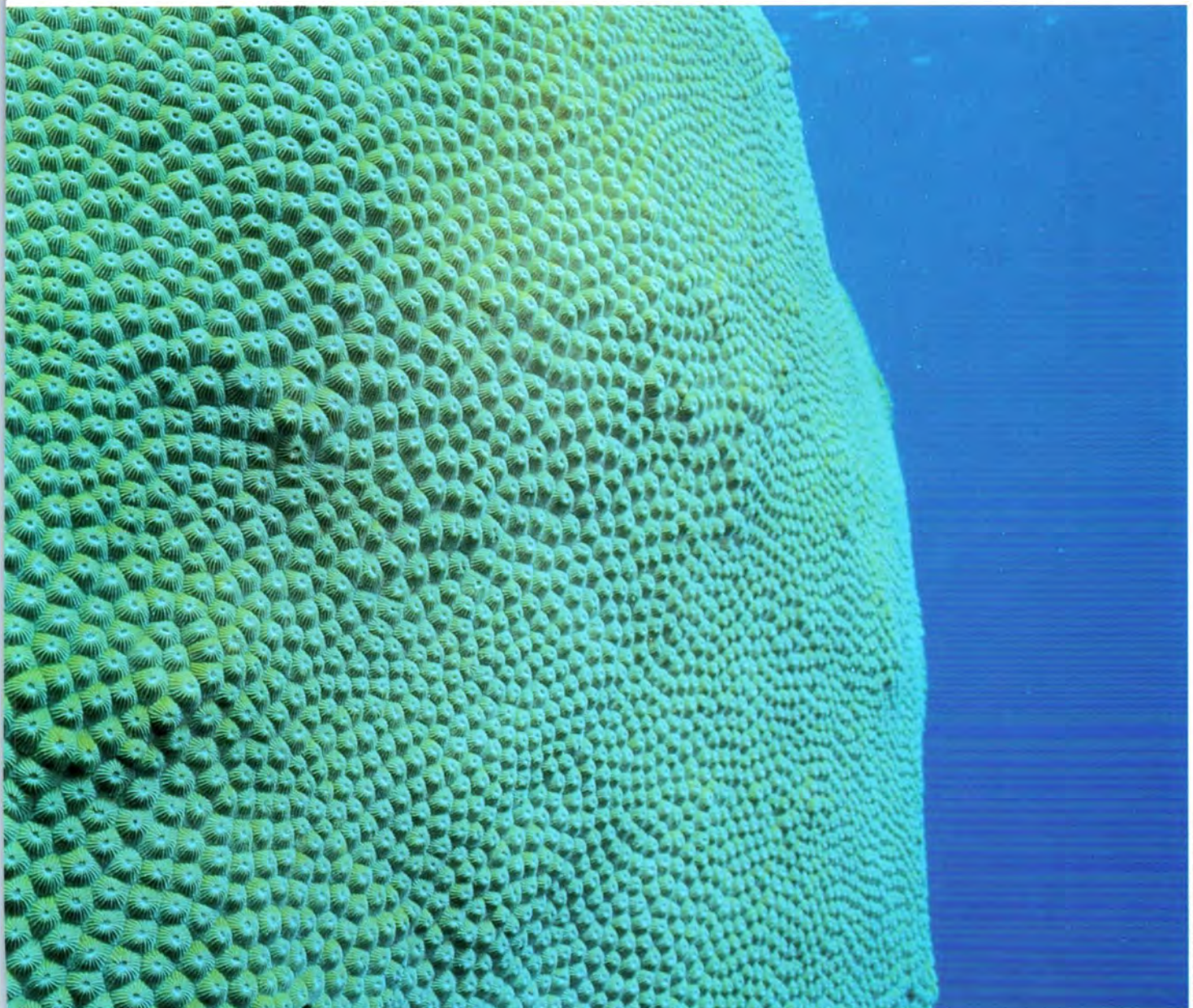
However, as the starfish numbers declined after the second plague, so too did public interest in the argument.

that the reefs that resisted and survived Crown-of-thorns attacks were those that maintained natural levels of starfish predators.

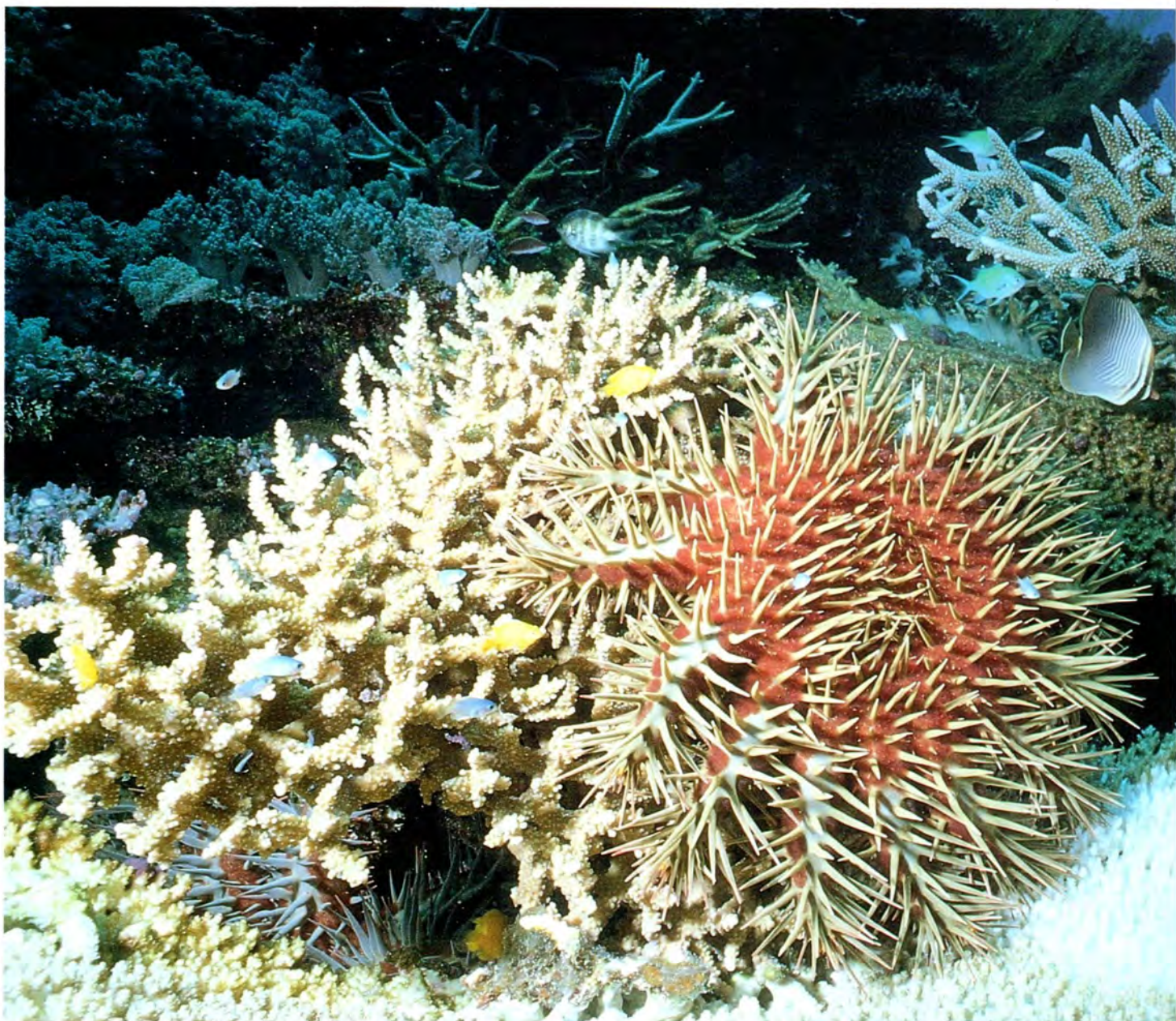
Lassig points out, however, that there are cases of Crown-of-thorns outbreaks on virtually pristine Pacific reefs that have not been subjected to intense fishing pressure. He supports the views of reef scientists who believe there may be several human activities contributing to the plagues and that over-exploitation of the Crown-of-thorns predators could be one of them. GBRMPA research into

the cause of the outbreaks points increasingly to the impact of catchment farming activities and tourist and urban developments on coastal water quality. According to Lassig, nutrients from the run-off of these activities may give Crown-of-thorns Starfish larvae a better than normal chance of survival. Research suggests also that natural events such as cyclones could raise the nutrient levels of reef waters by increasing stormwater run-off from the land and stirring up nutrient-rich ocean sediments. These conditions may in turn

With a life span of possibly hundreds of years and a growth rate of about one centimetre annually, massive corals, like this *Diploastrea heliophora*, may be unable to survive frequent attacks from Crown-of-thorns Starfish.



KEVIN DEACON/OCEAN-EARTH IMAGES



A Crown-of-thorns Starfish eats its way across *Acropora* coral, leaving a trail of dead coral, clearly visible by its stark white appearance.



A feeding front of Crown-of-thorns Starfish on the slopes of Little Broadhurst Reef.



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

A Giant Triton feeds on a Crown-of-thorns Starfish. Giant Tritons are important predators of Crown-of-thorns and their removal from the reef by collectors may have serious repercussions.

prove favourable for the survival of larger than normal numbers of starfish larvae. However, Endean says that the nutrient-enrichment theory has been criticised and never validated.

While the threat of another outbreak is certainly of concern to both scientists and the tourist industry, many scientists believe there is very little that can or should be done to prevent it. GBRMPA is reluctant to interfere with what may have a natural basis and is not really capable of doing anything on a large scale anyway.

The Authority can offer tourist operators technical advice and assistance to save localised areas at tourist destinations. But science can offer nothing at this stage to alter the impact of outbreaking starfish populations on a whole reef. A contingency plan developed by GBRMPA scientists to be implemented in the event of another outbreak is geared mainly to ensuring the execution of adequate monitoring

and research, which did not occur during past infestations. Lassig and his colleagues believe the only solution to controlling the outbreaks will be a long-term one. If the nutrient-enrichment theory proves correct, then better controls on coastal developments and activities will be one important response.

Amid overtones of the old controversy Endean continues to disagree with GBRMPA. The Authority, he says, should be directing more of its Crown-of-thorns research dollars into testing the predator-reduction hypothesis. Endean believes that collecting programs should be implemented on infested reefs. In the long term, he advocates that tighter policing of reefs to restrict illegal spearfishing and collections of the Giant Triton shell would go a long way to restoring the natural protection reefs have against the starfish.

Meanwhile the lucrative tourist industry based on the spectacle of the reef is getting increasingly nervous about a possible new plague. It is not, however, so much the starfish itself that has the operators twitchy, but the publicity the animal attracts. Operators say that their region suffers broadly from misrepresentation in the southern Australian media, and they publicly downplay the impact of the Crown-of-thorns on the reef. Many operators believe that, in the event of another plague, they will be able to minimise any impacts on the industry by moving from affected reefs to locations free of the starfish. They acknowledge that scientists can tell the difference between a pristine reef and one that has regrown after a Crown-of-thorns attack, but believe that most

tourists cannot.

Endean maintains, however, that the Crown-of-thorns has the potential to do severe damage to the reef, that tourists will notice, and that the industry has more to worry about than sensationalistic reporting. In fact, after witnessing the destruction of the last two outbreaks he has been sitting back waiting for the next to come around with a great deal of apprehension.

Whenever the next plague occurs, one thing is certain. Scientists are better prepared than ever before to monitor the phenomenon and the spread of the starfish. Perhaps, next time around, they may find a definitive answer to the question of why this creature's population undergoes such dramatic cycles of boom and bust. ■

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ILLUSTRATION BY ANNE BOWMAN

From Illamurta Springs to Mt Windajong, Watarrka National Park to the Bilba Hills and Mt Liebig, camp sites were made and 4,650 traps set.

SEARCH FOR THE CENTRAL ROCK-RAT

BY DAVE WURST

With no sightings for the last 35 years, the Central Rock-rat is a rare rodent indeed. But is this the result of competition from introduced species, or was the Central rock-rat on the path to extinction long before the arrival of Europeans in Australia?



The Central Rock-rat was restricted to the desert regions of central Australia. This area of the MacDonnell Ranges near Mount Liebig was where the last specimen was collected in 1960.

LIKE MANY GOOD STORIES THE TALE of the Central Rock-rat (*Zyzomys pedunculatus*) begins in Australia's pioneering past, and in this case, with the Horn Scientific Expedition to central Australia. This expedition was the first truly scientific collecting trip to central Australia, and last year (1994) marked its 100th anniversary. It was during this 1894 expedition that Professor Baldwin Spencer is credited with obtaining the first specimen of the Central Rock-rat. The description of the species, then named *Conilurus pedunculatus*, was published by E.R. Waite in 1896, in the report on the expedition.

As its common name implies, the Central Rock-rat occupied a wide range of rocky habitats throughout central Australia and, although many researchers and naturalists have searched for the Central Rock-rat throughout the 20th century, few have had success. Typically however, when the last specimen was collected on 29 January 1960, science had very little to do with it. While camped near Mt Liebig, about 300 kilometres to the west of Alice Springs, a stockman named George Gape killed a rat that was trying

to avail itself of the contents of the camp tuckerbox! Having a friend in Alice Springs interested in any small native animals that he might happen to find, he packed up the dead animal and took it with him when he returned to Alice Springs. As a consequence the specimen is a rather battered one, having suffered not only from the trauma of its death but also from the slow and hot journey back to town.

There are only 33 Central Rock-rat specimens held in museum collections around the world and, unfortunately, the information provided with them is very limited. This makes the job of determining the lifestyle and ecology of the Central Rock-rat almost impossible, and we must look at other closely related species for a clue.

The Central Rock-rat is one of five members of the genus *Zyzomys* and the only one restricted to the desert environment of central Australia. Two of the other four species—the Common Rock-rat (*Z. argurus*) and the Large Rock-rat (*Z. woodwardi*)—are from the seasonally wet and dry tropics of northern Australia, and range from the Dampier Archipelago in Western Australia to Ayr in northern Queensland. The two other



members of the genus (*Z. maini* and *Z. palatalis*), described as late as 1989, have more restricted distributions within the above tropical range.

THE CENTRAL ROCK-RAT IS THE SIZE OF a small to medium rat, about 30 centimetres from the tip of its nose to the tip of its tail. It is distinguished from other arid-region rodents by the tail fur, which is dense enough to conceal the tail scales. Moreover the tail is carrot-shaped and attaches to the body by a much narrower section. This feature provides the specific name *pedunculatus*, referring to the pedicle or stalk-like connective section of the tail. A 'Roman nose' appearance is also characteristic of the Central Rock-rat.

The ease at which skin will strip from the tail is another distinctive feature of the Central Rock-rat and the other members of the genus. This feature was evident even to Baldwin Spencer who first commented on the fragility of the tail in 1894. Of the seven Central Rock-rat specimens collected for the Horn Scientific Expedition, only two animals had a fully intact tail! Once the skin and fur is stripped, the exposed fleshy portion of the tail withers and drops off,



and does not regrow. It has been speculated that, because the tail skin is lost so readily, it may be a means of predator evasion. In other words, if a predator

One of three specimens of the Central Rock-rat collected by the Horn Scientific Expedition in 1894 that are held in the mammal collection at the Australian Museum.



Because so little is known of the Central Rock-rat's ecology, much of the information on which the expedition was based came from knowledge of its sibling species, such as this Common Rock-rat.

grabs a rock-rat by the tail, instead of ending up with a nice fat rat for dinner, all it would get is a piece of furry skin. It has also been noted that the tail of other rock-rats can become swollen as a result of fat deposition. This suggests that the tail may act as an energy reserve, although this makes little sense if the tail is so easily lost. Currently there is no explanation to clarify this apparent riddle. Quite a few lizard species (many skinks and geckos) are known to drop their tails, and some are known to lose their skin (see ANH Autumn 1994), in response to

predators, but these animals regrow their lost tails or skin; this is a very different process to that employed by rock-rats.

An interesting behavioural characteristic noted for the tropical rock-rat *Zyomys maini* may also be significant with regard to the Central Rock-rat. In western Arnhem land, *Z. maini* (thought at the time to be *Z. woodwardi*) was noted for its habit of collecting seeds, ranging from around two centimetres down to 0.4 centimetres in diameter, and relocating them to safe places such as rock crevices or nar-

row protected ledges to eat. Although no extensive accumulations of seed shells have been found in central Australia, collections of Sweet Quandong (*Santalum acuminatum*) seeds have been found in many rocky crevices and small caves. Based on the habits of *Z. maini*, and the rocky situation in which the seed aggregations have been found, these collections have been largely attributed to the Central Rock-rat. Unfortunately, however, all of these seed collections appear to be quite old.

WITH THIS HISTORICAL BACKGROUND, and a review of the ecology of its sibling species, the quest to rediscover the Central Rock-rat was launched. The project was conducted by the Conservation Commission of the Northern Territory with funding from the Australian Nature Conservation Agency under the Endangered Species Program.

Survey locations were determined after considering the existing specimen location data, and the habitat preferences of the other rock-rat species. This resulted in a series of sites that not only covered a wide range of rocky habitats, but were scattered across an area of 52,000 square kilometres to the south and west of Alice Springs!

A schedule for the required field work was also prepared and the essential equipment needed for ten-day bush trips organised. Collapsible, live capture



This scree slope and cliff in Talipata Valley, central Australia, was one of the 27 survey sites spread over an area of 52,000 square kilometres.

Trap placement was not without cost, with one broken finger in a rock slide and a very close encounter with a rather surprised Western Brown Snake on a narrow ledge.

traps were assembled by the box-load, sundry torches, measuring apparatus and all kinds of scientific paraphernalia were gathered and loaded into a four-wheel-drive vehicle.

On only one occasion was a field trip cancelled (due to a fire inside the car), and this, luckily, happened on the first day out of town. With the use of a length of fencing wire and a few threatening gestures, we were able to drive the vehicle the 200 kilometres back to Alice Springs. Trivialities of flat tyres and being 'hung-up' on rocks aside, the only other problem to arise was the miles-from-anywhere flat battery syndrome. Although easily rectified, the ranger who had a six-hour round trip to jump-start the vehicle thought it a great joke, as did everyone else he told!

Over a period of about nine months 4,650 traps were set. These were spread

over 27 survey sites. Due to the often rough nature of these sites, ranging from broken cliff lines to scree slopes, a great deal of effort and enthusiasm was often required to set the traps. On more than one occasion this zealous nature of trap placement led to lengthy searches for hidden traps the following morning. This strategy often resulted in good trap success, however it was not without

cost, at one broken finger in a rock slide and a very close encounter with a rather surprised Western Brown Snake on a narrow ledge.

From Illamurta Springs to Mt Windajong, Watarrka National Park to the Bilba Hills and Mt Liebig, camp sites were made and traps set. Temperatures from -5° to 40° C were endured but to no avail; the Central Rock-rat was not to be found. Although unsuccessful in terms of its major objective, the trapping program was not without some success. Four mammal and two reptile species were recorded to provide a total of 204 captures. Although this appears to be a low species diversity, it is typical of the rocky habitats of central Australia. It must also be noted that these figures refer only to the results from one type of live-capture trap. The most common animal caught was the Fat-tailed Antechinus (*Pseudantechinus macdonnellensis*), followed by the Sandy Inland Mouse (*Pseudomys hermannsburgensis*). The skink *Egernia margaretae* was also recorded from four different locations, one of which represents a notable extension of range. The other species caught were the House Mouse (*Mus musculus*), the Spinifex Hopping-mouse (*Notomys alexis*) and the Ridge-tailed Monitor (*Varanus acanthurus*). An interesting fact brought to light during the survey was the discovery that Sweet Quandong seeds are gnawed by Spinifex Hopping-mice, a phenomenon previously attributed to the Central Rock-rat or the Lesser Stick-nest Rat

CENTRAL ROCK-RAT

Zyzomys pedunculatus

Classification

Order Rodentia; family Muridae.

Identification

Yellow-brown above, cream to white below. Fur coarse and continues along the full length of the tail. Tail thickened and carrot shaped. Head-body length 108–140 mm; tail length 110–140 mm.

Distribution

Confined to rocky outcrops in central Australia.

Status

Endangered, possibly extinct.

(*Leporillus apicalis*)!

By targeting rocky habitats the trapping program also served to act as a survey for other rare native animals. Species like the Long-tailed Dunnart (*Sminthopsis longicaudata*) or the Western Quoll (*Dasyurus geoffroii*) might also have been detected. Further records and locations of the Common Brushtail Possum (*Trichosurus vulpecula*), rare in central Australia, were also a potential result for the survey. Unfortunately, no evidence was found to indicate the presence of any of these three species, confirming their rare or extinct status within the Northern Territory.

One exotic species, the House Mouse, was regularly caught and made up 25 per cent of the total trap results. Regrettably signs of at least one exotic species—whether cats, foxes, rabbits or stock (cattle, horses, donkeys)—were found at all survey sites; many sites displayed evidence of several introduced species. The direct effect these species may have had on the Central Rock-rat is impossible to determine. However their presence in many cases suggests that competition for food may have contributed to the rock-rat's decline.

The most disappointing part of the survey has now to be confronted. Why wasn't the Central Rock-rat found? The answer to this may be quite simple: the wrong places were surveyed! But this is unlikely as part of the aim of pre-survey research was to minimise this possibility. On the other hand, the answer may be that the Central Rock-rat is extremely rare or extinct. Generally, however, a 50-year period without substantiated proof of existence is required before an animal is officially considered extinct. The Central Rock-rat now has only 15 years to go before its official time is up.

This may sound grim, but recent rediscoveries of 'extinct' species provides hope yet for the Central Rock-rat. The Long-tailed Dunnart is one such animal. Although known from a few localities in Western Australia, it was thought to be extinct in the Northern Territory, not having been recorded there since 1894. Its rediscovery in 1993 west of Alice Springs marked a period of 99 years between records! Another recent case of rediscovery is that of the Adelaide Pygmy Bluetongue (*Tiliqua adelaidensis*), which had not been seen since 1959 and turned up in 1993, just six years before its official time was up (see ANH Autumn 1994).

Although we remain hopeful for the Central Rock-rat's rediscovery, the proposition of its possible extinction cannot be overlooked. Central Australia is already notorious for the loss of small mammal species, and much thought has been given to this matter. Increased predation pressure from cats and foxes would have had some effect, however the rugged nature of the Central Rock-rat's preferred habitat is generally thought to protect small animals from these predators. The more indirect effect of competition for, and degradation of, the often-limited supply of suitable food from introduced herbivores would have presented a far greater threat.

Based on other rock-rats, the type of diet preferred by the Central Rock-rat is thought to have consisted largely of seeds from trees, shrubs and grasses (especially the larger hard-shelled varieties), and herbs and other soft plant material. Other native species are not thought to have competed for these resources; quite the opposite in fact. Emus and other birds coming in to drink at the waterholes or soakages that



are often found in association with this type of rocky habitat pass undigested seeds, which act as a potential source of rock-rat food. It may be that a decrease in the number of Emus in some areas has contributed to the demise of the Central Rock-rat. These habitats often represent locally rich areas of plant diversity, and consequently act as refuge areas for larger, more mobile species in times of drought or fire. Animals such as rabbits, horses, camels and cattle would seek out these oases, causing an immediate reduction in plant material available and potentially longer-term problems due to degradation of the habitat. It is unlikely that the Central Rock-rat could have competed successfully in this type of situation, especially if, like other rock-rats, its reproductive strategy was one of small litters with a high survival rate. Under this type of strategy the quality of resources to ensure survival of the young to breeding age is of vital importance.

Alternatively the Central Rock-rat's fate may have been decided long before



The more common Spinifex Hopping-mouse could be responsible for gnawed quandong seeds that were previously attributed to the Central Rock-rat.



HARRY EHLMANN

the species was discovered by the Horn Expedition. The very few specimens in existence suggest that the animal may have been rare before the arrival of Europeans in Australia. It may have represented a species from a different climatic regime persisting in a limited and ever-decreasing number of island refuges. Whatever the case, it appears for the moment that the Central Rock-rat has gone, and we can only speculate on the reasons why.

IT COULD BE ASKED WHY WE BOTHERED looking for rock-rats in the desert at all. Indeed, why look for any possibly extinct species? The value in such an exercise is much more complicated than simply finding the species in question. It is not so much about learning which species are endangered or extinct, but rather why the change in status has occurred. This survey, directed at finding the Central Rock-rat, may not have been successful in its primary objective, but much useful information was still collected. Data on the abundance or lack of species, and the extent

of distribution and potential sphere of influence of exotic species were recorded. Measurement of the degree of change in the regions surveyed will be possible as a result of the baseline data collected. Basically, a general review of the status of rocky habitats in central Australia was conducted.

In this way surveys help to keep us in touch with the status of the environment, despite the fact they don't always reveal everything there is to know about an area. (The two previously mentioned rediscovered species were both found by accident in areas surveyed thoroughly in the past.) In general, though, systematic research of this kind alerts us to shifts in the balance of nature, which may directly affect the well-being of individuals or of whole communities. If the reasons for change (be it in the abundance of a particular species, or in the biodiversity of a system) can be identified, we may be able to better manage our actions, and their consequences, so as to maintain biodiversity and a healthy environment. ■

A few other mammals and reptiles were caught in the traps laid for the Central Rock-rat including small Ridge-tailed Monitors.

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Scientists recently reported an analgesic compound in frog skin that is 200 times more powerful than morphine.

FROGS AND DRUGS

BY MICHAEL J. TYLER





THE ROMAN PLINIUS SECUNDUS (Pliny to his friends) and the Englishman, Francis Bacon, have both been described as “martyrs to experimental science”. For Bacon died of a chill that he caught while stuffing a chicken with snow, in order to test the preservative properties of refrigeration, and Pliny was asphyxiated by volcanic gases while investigating the eruption of Mount Versuvius in AD 79.

For hundreds of years, folk medicine has known of the medicinal value of frogs. Certain groups of Gipsies, for example, relieved joint pain with the fresh spawn of grass frogs (*Rana* sp.).

AUSTRALIAN PICTURE LIBRARY/ZEEA

Bacon and Pliny were equally fascinated by folk medicine, and the latter solemnly and unquestioningly recorded every treatment he heard about. Some were revolting and others absurd. For example, digging up the soil where a dog had just urinated and applying this to a joint seems an unlikely treatment for a dislocation. Similarly, the prospect of curing jaundice by staring at a canary, or ensuring that a baby will have black eyes by inducing a pregnant woman to eat a rat are, at best, unconventional. Not surprisingly, folk medicine fell into disrepute.

But now there is a resurgence of interest in the so-called 'alternative medicines', and frogs and toads are of special interest because they have a wide array of compounds of clinical potential in their skin. In fact, their skin is more complex than that of any other type of living creature. Scattered throughout the outer layer of the upper surface are circular glands that produce a variety of chemical compounds. For example, there are mucous glands that keep the surface slightly moist for gas exchange and for cooling by evaporation. There are also lipid (fat) secreting glands that provide frogs with a water-proofing agent. Nerves in the deeper layer of the skin trigger the release of all these skin chemicals.

The glands that are of current interest are termed granular glands and these are filled with circular vesicles a few

The skin of the Green Tree Frog (shown here in its blue form) produces a compound which can reduce blood pressure and restore gut function after surgery.



The granular glands of Cane Toads are grouped on their shoulders to form super-glands. These superglands exude a poisonous creamy substance used by the frog for defence but which may contain a number of compounds valuable to humans.

microns (millionths of a metre) across. It is these vesicles that contain the chemicals. Sometimes the granular glands are aggregated together into giant superglands like those on the shoulders of the Cane Toad (*Bufo marinus*), or upon the entire head of the Magnificent Tree Frog (*Litoria splendida*). There may be 20 or 30 chemical compounds in a single species and every species seems to have at least some chemicals not possessed by others.

The granular gland secretions of some species can be highly toxic, such

as those belonging to the South and Central American poison-dart frogs (family Dendrobatidae). These are so named because Colombian Indians tipped their darts with frogs' skin secretions and, using a long blowpipe, were able to capture birds and small mammals. The frogs are often brightly coloured, presumably a warning to creatures that might eat them. Three major groups of toxins have been discovered in their skin: batrachotoxins, pumiliotoxins and histrionicotoxins. The toxins are as complex as their names and include compounds that are far more virulent than the most venomous snake; in fact they have been described as among the most toxic substances known to mankind.

Not all frog and toad secretions are toxic. In 1757 Oliver Goldsmith wrote of an amorous woman of Rome married to an invalid husband who suffered from a weak heart and fluid retention. Wishing to hasten her husband's death she made a potion from a toad and slipped it into her husband's drink. But she made a fundamental error in the identity of the toad species. The one she selected contained a heart stimulant and a diuretic, which increased the flow of urine. The result was that she cured the husband she detested and restored him to perfect health.

In general, however, toads are poisonous, and not just the skin glands. A university student in Sydney recently discovered this when, for a bet, he ate the ovaries of a Cane Toad. He received \$20 and a cardiac arrest.

The granular gland secretions of poison-dart frogs include some of the most toxic substances known. These male Strawberry Poison-dart Frogs (*Dendrobates pumilio*) from Costa Rica are wrestling over territory.





The supergland on the head of the Magnificent Tree Frog exudes a cocktail of chemicals, including some with antibiotic properties.

Occasionally just a hunch can lead to a great discovery. Thus in 1986, Professor Michael Zasloff of the National Institute of Health in the USA became curious at the fact that the common laboratory African Clawed Frog (*Xenopus laevis*) never suffered from infections following experimental surgery. He correctly forecast the existence of antibiotics in the skin, and an American pharmaceutical company is now developing them for human use.

A totally different compound was found in the skin of the Green Tree Frog (*Litoria caerulea*) of northern Australia. Named caerulein in honour of the frog, it has been marketed in Germany under the brand name of Ceruletide. Tested initially as a drug to reduce high blood pressure, it was found to be a powerful stimulant of the gut and has found a role in restoring gut movements following major abdominal surgery. It has also been put to good use in the human brain, with symptoms of chronic schizophrenia being blocked for a month following a single injection.

Pain-killing compounds resembling opiates have been found in the skin of *Phyllomedusa* species of South America, and a group of scientists in Baltimore recently reported an analgesic compound in frog skin that is 200 times more powerful than morphine.

I BECAME INVOLVED IN THE STUDY OF FROG skin secretions in the 1960s but it was only in 1977 that it became possible to identify them. I talked to Professor John Bowie of the Department of Chemistry at the University of Adelaide, and we formed a research team to isolate the various ingredients of the skin cocktails.

The trigger for our work was the discovery of the Magnificent Tree Frog (see ANH Autumn 1994). I was simply fascinated by the huge gland on its head, and wanted to know what it contained. When I first handled one of these frogs, it exuded a creamy secretion that smelt like cashew nuts.

An initial problem was to find a means of inducing the Magnificent Tree Frog to release its secretions, because in captivity this species, like its close relative the Green Tree Frog, settles down very quickly, is happy to be handled, and

simply will not release secretions for an investigator. I was not prepared to kill such fantastic creatures and remove and mash their skins just to look at their skin secretions. There had to be an alternative. One day, while having acupuncture to relieve headaches, I was idly watching one pair of needles inserted into the skin between the base of my thumb and forefinger. The needles flicked once each second as muscles beneath the skin received electric shocks from a battery-powered unit nearby. Because the stimulus was so mild and localised, but effective, I wondered whether the muscles in the frog skin could be made to contract in the same way, causing the glands to liberate their secretions. That weekend I returned to the acupuncturist's rooms with a cathode ray oscilloscope and measured the electrical characteristics of his instrument. A manufacturer of acupuncture stimulators in Melbourne agreed to modify one of his units for me. When it arrived in Adelaide I took a frog and gently rubbed its back with a pair of silver electrodes (instead of sticking needles into its skin). For ten seconds nothing happened and I worried that I had made a great mistake,



but then the secretions poured out and could be washed off into a container with a jet of distilled water. The frogs gave no indication of enjoying the sensation, but I am comforted by the response of Maurice Chevalier who, after a lifetime of entertaining the world, was asked whether he enjoyed old age. "No", he replied, "but the alternative is worse".

From a single milking we could obtain up to 100 milligrams of crude extract. Microbiologists tested the extracts upon cultures of bacteria, fungi and viruses, and demonstrated their ability to inhibit the growth of the virulent bacterium *Staphylococcus aureus* ('Golden Staph') and the virus *Herpes simplex*. The next step was to find out what effects the secretions had upon living mammalian cells. If they were toxic we could abandon any plans to explore them further because, obviously, they could not be used as future drugs. The results were favourable—the compounds did not harm the cells. But the crude secretions were a cocktail of as many as 30 chemicals and we did not know which of them had the antibiotic properties. So my chemist colleagues isolated and worked out the structural formula for each chemical and we took these to a biotechnology company, which manufactured some of them at a cost of \$2,000–\$3,000 for just ten milligrams per chemical. These were tested on a variety of bacteria, fungi and viruses, but the results were not always the same. It seems that a cocktail works better than one chemical alone. Clearly this research is expensive and currently we lack the support of a major drug company to test the remaining chemicals in the secretion. Without help I doubt if our findings will ever be exploited and brought to the pharmacy shelf.

Despite great interest in frog skin secretions, few species have been examined other than extremely superficially. With 4,000 species of frogs now known it makes sense to follow up the folklore, as a short cut in the selection process.

And it is not only antibiotics that await investigation. Gypsies in Germany and Czechoslovakia relieved the pain and swelling of rheumatic joints by applying a poultice of fresh spawn of grass frogs (*Rana* species). Presumably there is an anti-inflammatory compound in the jelly.

In many countries, including Australia, people are alarmed at the decline and disappearance of frog populations (see ANH Autumn 1991). The discovery that frogs are mobile pharmacies may just provide the stimulus to assist their survival. ■



African Clawed Frogs, like this albino laboratory specimen, have been found to have valuable antibiotics in their skin.

The skin of certain South American *Phyllomedusa* frogs produce pain-killing compounds.

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Michael J. Tyler is Associate Professor in the Department of Zoology at the University of Adelaide and former Chairman of the South Australian Museum Board. His research interests are confined to the study of frogs.

*There are an estimated
2,000 kilometre-sized asteroids regularly
buzzing Earth as they orbit the Sun.*

THE COSMIC SHOOTING GALLERY

BY GEOFF McNAMARA

THE ASTEROID APPROACHED EARTH from the direction of the Sun, and that's probably why nobody knew it was coming. Travelling at 75,000 kilometres per hour, the house-sized boulder had the potential impact energy to destroy a large city. It missed the Moon by 200,000 kilometres—a tiny distance in astronomical terms—and then blindly flew on toward the Earth.

The 'Near-Earth Asteroid' (NEA) approached our blue planet early on the morning of 20 May 1993 as Australia slept. NEAs, also known as 'Near-Earth Objects' (NEOs), are simply big rocks anywhere from a few tens of metres to kilometres across that approach Earth at a typical speed of 70,000 kilometres per hour. Two decades ago they were considered uncommon and so relatively harmless. Now astronomers are finding dozens of NEAs each year and are worried that an NEA could call in on Earth...in a big way.

AUSTRALIAN PICTURE LIBRARY

Viewed from the Moon, the Earth looks like a safe place to be, but collision with just one large asteroid could change all that, as it did for the dinosaurs 65 million years ago.





This time the Earth was safe. The NEA, christened '1993 KA₂', missed Earth's surface by a scant 140,000 kilometres. Eight hours later it was spotted by an astronomer searching for NEAs from Kitt Peak Observatory in the United States. Only after plotting the asteroid's path through space did astronomers realise just how close 1993 KA₂ had come. The fact that it missed Earth was simply a matter of chance: it's hard to believe, but the Earth is in the middle of a cosmic shooting gallery.

The idea of objects crashing into planets isn't new to astronomers: one quick look at the Moon's heavily cratered surface tells you that collisions between asteroids and planets have happened in the past. What astronomers are beginning to find out, however, is just how probable a future impact on Earth is. Based on the number of recent discoveries, there are an estimated 2,000 kilometre-sized NEAs regularly buzzing Earth as they orbit the Sun. Added to these are comets—large lumps of ice

ASTRONOMERS HAVE BEEN AWARE OF asteroids for almost 200 years. Their discovery coincided with the prediction of an unknown planet between Mars and the giant planet Jupiter. The orbits of the planets are spaced outward from the Sun at regular intervals, so when a gap showed up between Mars and Jupiter, astronomers decided to search for the 'guest planet'. In 1801 the 1,000-kilometre-wide asteroid Ceres was found in the predicted orbit. The gap seemed to have been filled. But then more objects were discovered orbiting the Sun at about the same distance as Ceres: first hundreds and then thousands. By 1992 over 5,000 asteroids had been found in a region now known as the 'asteroid belt', which completely circles the Sun. And it's expected that 10,000 asteroids will have accurately determined orbits by the turn of the century.

Asteroids are the debris of a planet that failed to form: the constant gravitational tugging by the giant planet

Either way, the collision resulted in the immediate destruction of life for hundreds of kilometres in every direction. But despite the severity of the explosion, the worst was yet to come.

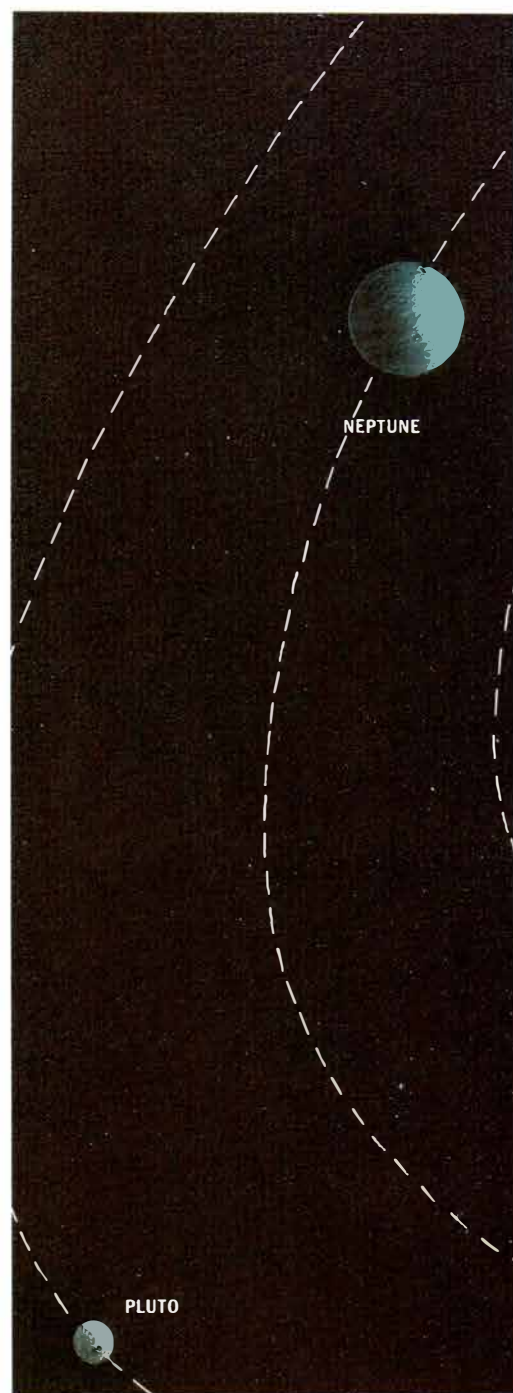
and rock. Any one of these objects could smash into Earth causing inestimable loss of life. For example, if a 20-metre-wide asteroid struck the Earth, it would explode with a force 20 times more powerful than the bomb that destroyed Hiroshima. If such an impact occurred over a city, millions of people would lose their lives. The collision of a ten-kilometre-wide object could lead to the obliteration of most life on Earth.

"Each human on this planet runs a risk of about 1 in 20,000 of dying from a cosmic collision", said Ken Russell, Resident Astronomer at the United Kingdom Schmidt Telescope at the Anglo-Australian Observatory in northern New South Wales. Russell and his colleagues have been using the 'UK Schmidt' to search for NEAs so that potentially dangerous objects can be found well in advance; given enough notice a major natural disaster could then possibly be averted. But so far NEA search efforts in Australia and overseas have been poorly supported. Russell and astronomers like him want to establish a dedicated search for NEAs, and point out that the costs are relatively low and easily justified: "The amount of money involved in setting up a survey is just trivial compared with the consequences of the Earth being hit by one of these things".

Jupiter prevents these tiny worlds from coalescing into one normal-sized planet. Not all asteroids stay within the asteroid belt, however. Chance collisions between asteroids and the gravitational effects of Jupiter can send asteroids hurtling toward the inner solar system. Once there they settle down into stable orbits...some of them dangerously close to the Earth's orbit. These are the NEAs that astronomers want to keep an eye on.

Up until the 1970s little attention was paid to the possibility of an asteroid colliding with the Earth. Despite mounting evidence, such as the continuing discovery of relatively young craters on Earth and the other planets, few scientists took the idea seriously. The vast majority of craters were formed billions of years ago as the planets swept up the rubble left over from the formation of the solar system. Most astronomers believed that the chances of Earth being hit by anything in the current epoch to be, well, astronomical. Then, in 1980, a group of scientists led by father and son team Luis and Walter Alvarez published a now historic paper that turned the minds of scientists to the distant past and their eyes to deep space.

The Alvarez team found an unexpected amount of the element iridium in



deep-sea limestones exposed in Italy, Denmark and New Zealand. Iridium is rare in Earth's crustal rocks, and so the anomaly was difficult to explain. But just as important as the amount of iridium was its location in the geological record—the iridium was deposited 65 million years ago, precisely matching the division between the Cretaceous and Tertiary periods, the so-called 'K-T boundary'. The K-T boundary is perhaps more famous as the time when most of Earth's species, including the dinosaurs, became extinct. These two clues suggested that the death of the dinosaurs and the iridium deposit were somehow linked.

An earlier explanation for the iridium

*By convention, the Cretaceous-Tertiary boundary is abbreviated to K-T because C is reserved for the earlier Carboniferous period.

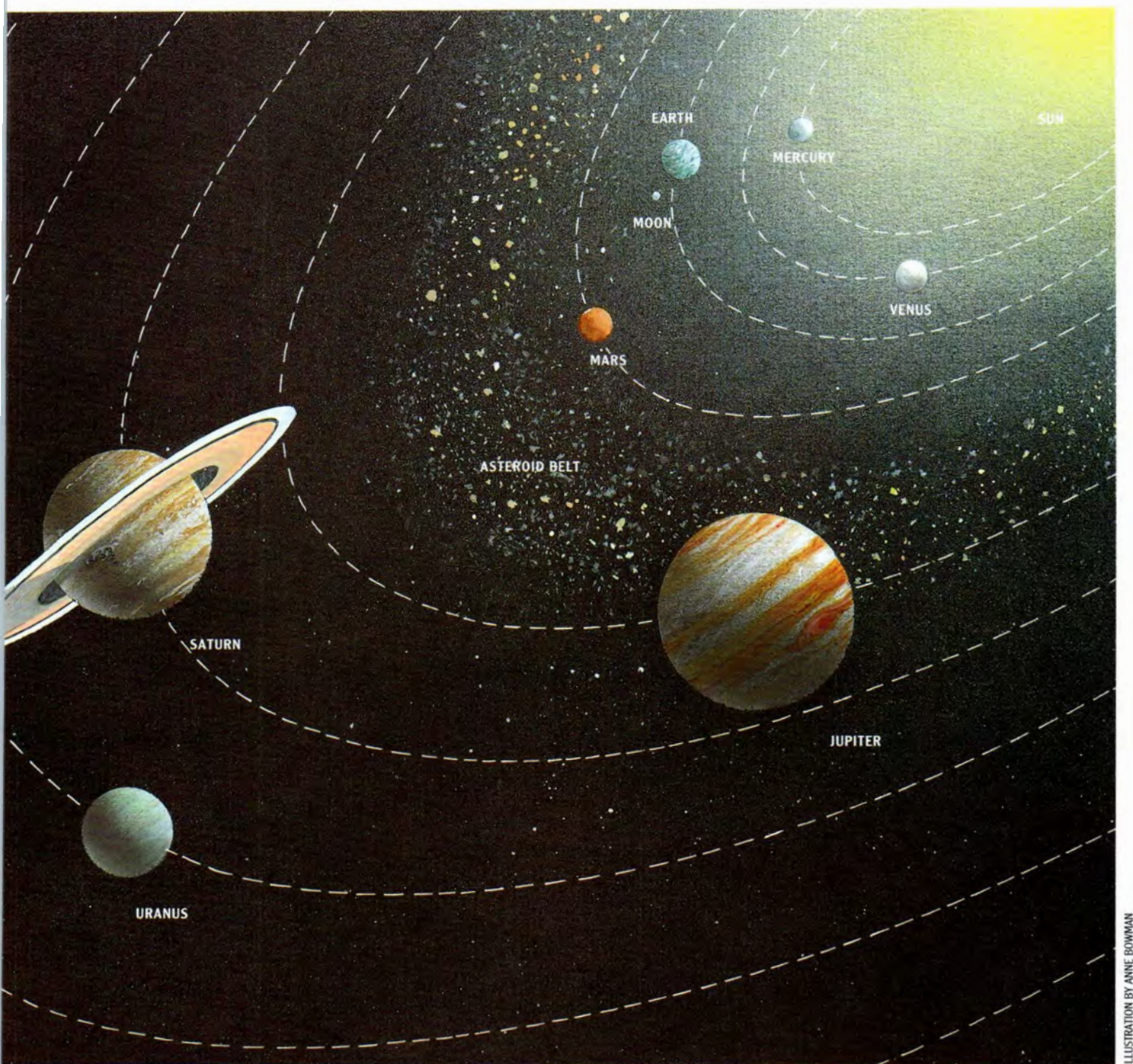


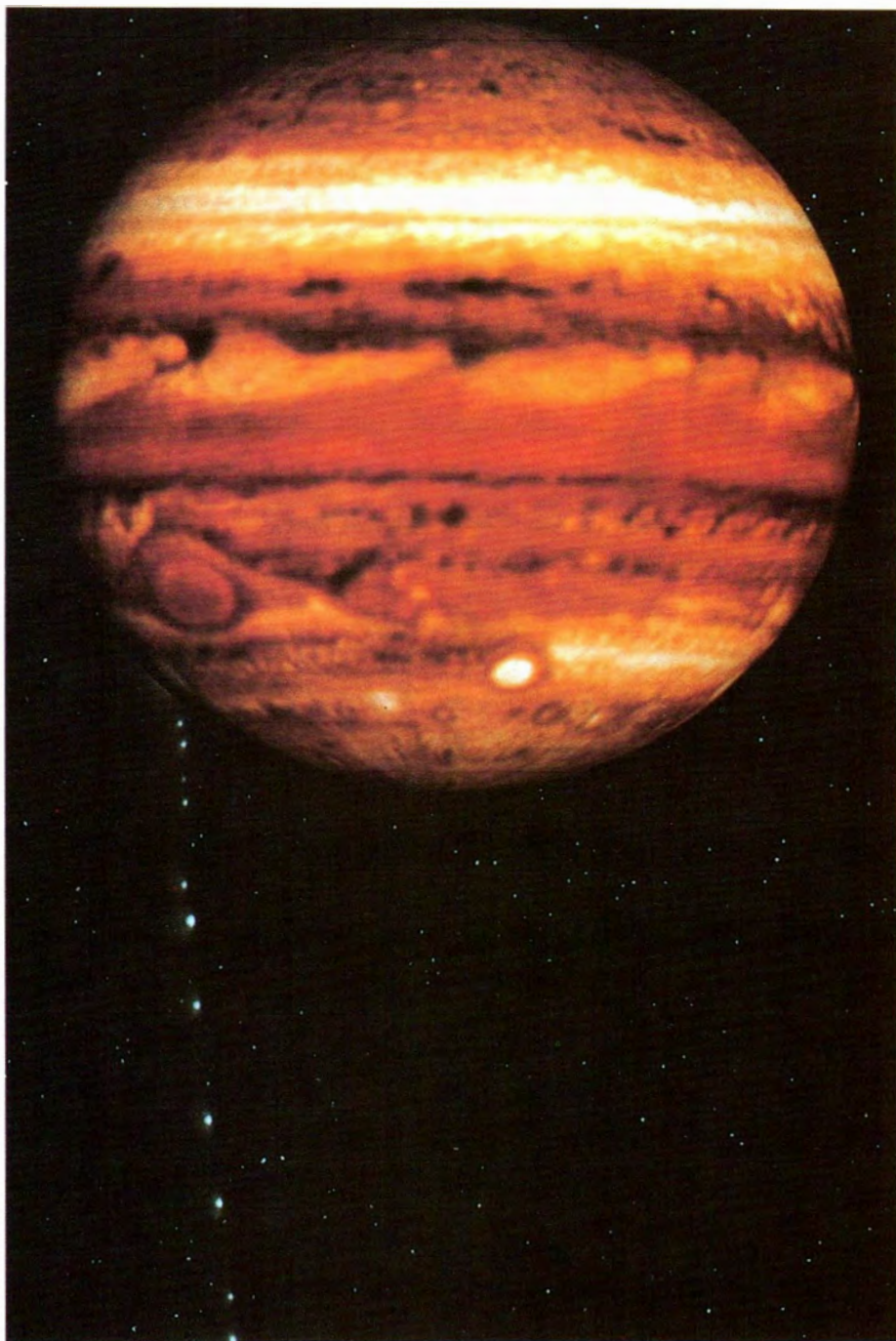
ILLUSTRATION BY ANNE BOWMAN

was that it was brought to Earth by meteorites—small rocks that litter the solar system and occasionally land on Earth. Meteorites are rich in iridium compared with the Earth's crust. However, the average meteorite isn't likely to do more than make a loud bang as it lands; globally, life would continue unchanged. What the scientists needed to know was a way of depositing iridium over the entire planet and killing off a large fraction of the biosphere. The story the Alvarez team told sent shivers through the scientific community.

Sixty-five million years ago the Earth was struck by a ten-kilometre-wide asteroid. The asteroid was travelling some 40 kilometres per second when it entered the Earth's atmosphere, punch-

ing a 'hole' through it and throwing some of it back into space. The asteroid then slammed into the Earth with the explosive yield of 100 million million tonnes of TNT. The asteroid was instantly destroyed, being compressed and vapourised by the collision. Billions of tonnes of rock and water were thrown into the sky, leaving behind a crater 200 kilometres across. If the impact occurred in one of Earth's oceans it would also have produced huge tsunamis (large waves), kilometres high, that would have swamped the surrounding landmasses. Either way, the collision resulted in the immediate destruction of life for hundreds of kilometres in every direction. But despite the severity of the explosion, the worst was yet to come.

Just as the planets orbit the Sun, so does a belt of asteroids that lies between Mars and Jupiter. Currently, there are over 5,000 known asteroids in this belt. (Illustration not to scale.)



An artist's impression of the Shoemaker-Levy 9 comet fragments as they began their collision with Jupiter in July 1994. The comet was broken up during a previous close pass to Jupiter and the resulting fragments are spread out along a common path, giving the appearance of a 'string of pearls'.

The many million tonnes of dust thrown up by the explosion reached the upper atmosphere and began to spread around the world. Widespread fires added soot to the dust. Within a year the entire planet was covered with an airborne layer of fine dust that blocked out the Sun. The surface of the Earth was plunged into total and impenetrable darkness. Deprived of the sunlight needed for photosynthesis, the plants died. The animals, roaming a frozen and desolate landscape, began to starve.

The darkness persisted for years; the food chains collapsed. As a direct result of that chance collision, three quarters of the planet's species died.

The theory met with stiff opposition. For one thing, where was the crater produced by the proposed impact? The chances of finding even a 200-kilometre-wide crater 65 million years after the event were slim. Unlike some other planets, the Earth's surface is dynamic. Between the effects of weathering, sedimentation and crustal movements a crater could easily have been erased millions of years ago. Nonetheless, clues began to emerge.

Scientists discovered unusual deposits of coarse rock fragments at the K-T boundary whose appearance suggested rapid transfer from one place to another by massive tsunamis. The most

obvious examples showed up at sites clustered around the Caribbean basin. But surely a 200-kilometre crater in or around the Caribbean would have been noticed by now?

In 1978 a completely unrelated survey commissioned by the Mexican oil company Petroleos Mexicanos revealed a circular geological feature roughly 180 kilometres across buried under the coast of the Yucatan Peninsula, which defines the south-eastern edge of the Gulf of Mexico. The feature has been shown to be an impact crater and some scientists propose its diameter is closer to 300 kilometres. Tests of core samples revealed the crater's age: 65 million years, exactly the time that the dinosaurs vanished.

As a result of the confirmation of the age of the Yucatan crater, the impact

The darkness persisted for years; the food chains collapsed. As a direct result of that chance collision, three quarters of the planet's species died.

hypothesis for the K-T extinction has been widely accepted. As Walter Alvarez puts it, "It looks to me like this is the smoking gun. This should let us stop arguing about whether there was an impact and start working on the details of the impact". Some scientists even suggest that this hasn't been the only time the Earth's species have been culled by an asteroidal impact. Evidence supporting the controversial theory that periodic extinctions are the result of periodic impacts is slight, from both astronomers' and palaeontologists' standpoints. But evidence suggesting that more than one major collision has occurred in the recent past is mounting rapidly, both on Earth and other planets. Now that scientists know what buried craters look like, they're discovering more of them. And the more craters they find, the more the question needs answering: could it happen again?

EARTH IS STRUCK BY THOUSANDS OF BITS of rock every day, ranging in size from microscopic dust particles that collide with the atmosphere and then gently float to the surface to football-sized objects that have been known to land on, or rather hurtle through, houses and even parked cars. Interesting as these meteorites are, they don't consti-



ITAR-TASS/SONOTO

In 1908 a 30-metre-wide asteroid exploded above the Tunguska River in Siberia. The resulting shockwave flattened 2,000 square kilometres of forest. Had the asteroid arrived a few hours later, the Earth's rotation would have put it over Europe.

tute a major hazard.

The most recent example of a major cosmic collision on Earth occurred on 30 June 1908. On that northern summer morning, a 30-metre-wide asteroid exploded eight kilometres above the Tunguska River in Siberia. It exploded with a force a thousand times more powerful than the Hiroshima bomb. The resulting shockwave flattened 2,000 square kilometres of forest: 60-centimetre-thick trees were snapped like toothpicks and felled in a radial pattern pointing away from the centre of the blast. Heat from the explosion was felt by witnesses 60 kilometres away. Despite the local devastation caused by the event, its effects didn't extend globally.

The greatest threat comes from objects capable of producing global damage. An NEA one kilometre across colliding with the Earth could lead to the death of over a quarter of the Earth's population. The main cause would be climatic change, leading to disruption of the world's food production and eventually widespread starvation. The disaster could also lead to the collapse of the world's social, economic and political structures. So, while the immediate effects of the impact of a kilometre-sized object over a populated area would be the instantaneous death of millions of people, the explosion would lead indirectly to the deaths of billions of human beings.

The most detailed study of the chances of Earth being struck by an NEA or comet was carried out by Clark

SOURCES OF COSMIC COLLISION

The distinction between asteroids, meteoroids and comets used to be clear. Now, astronomers realise that they are part of a continuum of objects that make up the solar system we live in. Some asteroids have turned out to be comets; both asteroids and comets produce meteoroids, and the distinction between meteoroids and asteroids is often a matter of taste. However, here is a brief guide to the solar system's inhabitants.

Asteroids

Relatively small, rocky objects that orbit the Sun with the nine major planets. Most asteroids orbit the Sun between the orbits of Mars and Jupiter, and are the remains of a planet that failed to form. However, many asteroids orbit the Sun outside this 'asteroid belt'. These may be 'main belt asteroids' that have been thrown out, comets that have been pulled into new orbits by Jupiter, or simply the debris left over from when the solar system formed some 4.5 billion years ago. Asteroids in orbits that pass close to Earth's orbit are called Near-Earth Asteroids (NEAs).

Asteroids range hugely in size from just over 1,000 kilometres to only tens of metres across. Below this size, it's a matter of personal preference whether you call the object an asteroid or a meteoroid!

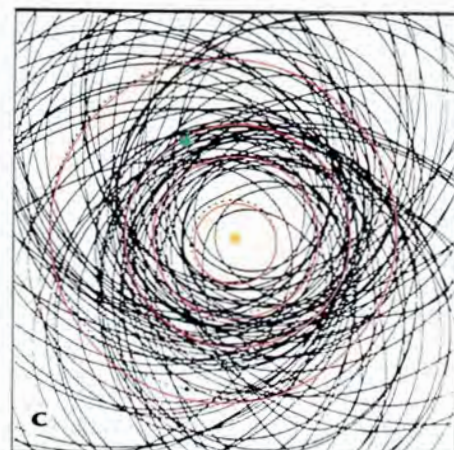
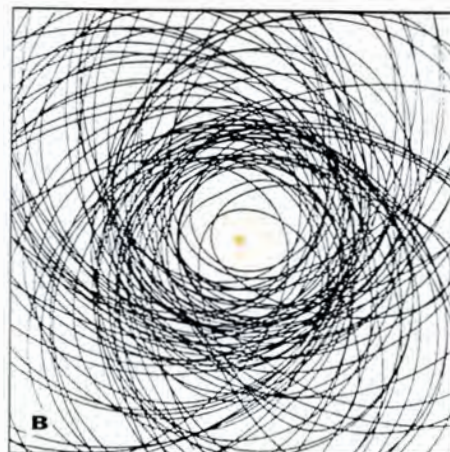
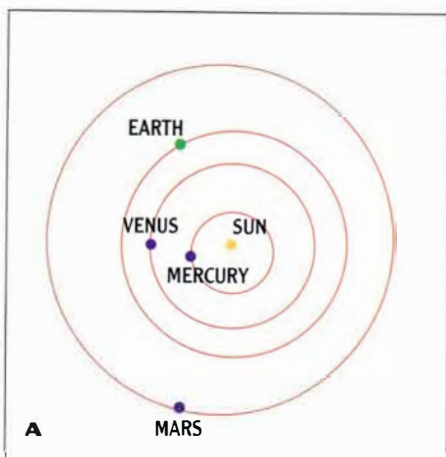
Meteoroids

In a sense, small asteroids! Most meteoroids are the remains of the formation of the solar system; many are fragments of asteroids and comets. The majority of meteoroids are dust-sized and so completely harmless to Earth. When they collide with Earth, most meteoroids burn up in the atmosphere, producing a streak of light called a meteor, or 'shooting star'. Some meteoroids survive the journey through Earth's atmosphere and land on Earth's surface, and are then called meteorites. Some meteoroids make it to the surface simply because they're so small that they literally float to the ground. There are thousands of these interplanetary particles in the room you're in now, stuck to your clothes, in your hair, everywhere. Other meteoroids avoid destruction because they're big enough to survive their fiery descent.

Comets

Kilometre-sized balls of ice and rock, prompting the term 'dirty snowballs'. Most comets originate in the outer solar system. For reasons not yet fully agreed upon, comets occasionally 'fall' in towards the Sun and the inner solar system. As a comet approaches the Sun, its surface heats up and vapourises. These gases surrounding the comet are pushed away by the intense solar radiation, producing a tail up to millions of kilometres long. After passing very close to the Sun, the comet then swings around the Sun and returns to the outer solar system.

Some comets pass close to Jupiter as they approach or recede from the inner solar system. Jupiter's gravity can shift the comet into a new orbit. Some objects previously classified as asteroids because of their appearance and location in the solar system are now believed to be comets that have been shifted into asteroid-like orbits by close encounters with Jupiter and the other planets.



Although it may not seem like it, the Earth is surrounded by a frighteningly large number of asteroids and comets, as shown by this composite illustration (C) of the inner planets (A) and orbits of the 100 largest known Near-Earth Asteroids (B).

Chapman of the Planetary Science Institute in Tuscon, Arizona, and David Morrison from the NASA Ames Research Centre in California. The risk of Earth being hit by an NEA turned out to be slight. As Chapman and Morrison put it, "Impacts are an extreme example of a low-probability/high-consequence hazard".

Earth is struck by more small objects than large ones simply because there are more small objects drifting through space. Chapman and Morrison calculate that impacts like the Tunguska event occur every few centuries. While such impacts could potentially wipe out millions of people, only a tiny fraction of the Earth's surface is heavily populated and so most Tunguska events occur over uninhabited areas. Larger objects strike the Earth less frequently: a 500-metre asteroid, about the smallest

object capable of global devastation, strikes Earth every 35,000 years, while events like the K-T impact occur roughly every 100 million years.

For the first time in the Earth's history such a catastrophe can be avoided. About the only good thing to come out of the development of nuclear bombs is that they could be used to deflect a threatening object before it hits our planet. If an NEA or comet is found to be on a collision course with the Earth, a nuclear warhead exploded on or near the threatening object while it is still far from Earth would nudge it into a slightly different orbit so that it by-passed Earth. Successful mitigation depends on early detection, however, and this is where Ken Russell and his colleagues come in.

Since 1990 the astronomers have conducted the Anglo-Australian Near-Earth

Asteroid Survey (AANEAS) using photographs taken with the UK Schmidt telescope. The UK Schmidt has a wide field of view and so is used to photograph large areas of the sky for use in surveys unrelated to AANEAS. Because most celestial objects are faint, the telescope tracks the stars while the film soaks up their feeble light. Typical astronomical exposures with the UK Schmidt can last from several tens of minutes to over an hour. As asteroids and comets orbit the Sun they move against the background stars and so leave tiny trails on the photographs. If a trail is found, the object can be observed in more detail the following night to determine its orbit. The orbital information tells the astronomers whether or not the object is an NEA and, if so, whether it poses a threat to Earth.



This picture of asteroid Ida was taken by the Galileo spacecraft in August 1993. Ida is the second asteroid ever encountered by a spacecraft and is about 52 kilometres in length.

Since the AANEAS started in 1990 the astronomers have been discovering about one NEA each month. They intend to expand the program by making use of the telescope during moonlit nights. The UK Schmidt is normally used to take long-exposure photographs of the night sky so that the fainter celestial objects can be recorded on the film. Most astronomers hate the Moon because it lights up the sky, drowning out the light from these fainter objects. In the past this has meant that the UK Schmidt has been unused for several nights each month. But NEAs are brighter than most celestial objects, so the AANEAS team will put the telescope to good use by taking short ten-minute photographs—long enough to record an NEA without the moonlit-sky overexposing the film. A second photograph of the same part of the sky is taken later the same night. The photographs are then compared. Because the stars remain fixed relative to each other, they'll be in the same positions on the two photographs. So anything that has moved between the time of the first and second photographs is not a star and is therefore looked at more closely.

Astronomers want to catalogue all the NEAs so that any threat to life on Earth can be assessed and, if necessary, averted. Because of a lack of funding, however, search methods have been hit and miss—both metaphorically and perhaps literally. Current searches are understaffed and poorly equipped. Even the AANEAS team has to resort to borrowed time on the UK Schmidt while it's not being used by other astronomers. The AANEAS team is grateful to the Anglo-Australian Observatory for letting them use the telescope, but it's not enough. They just cannot search enough of the sky for long enough to find all the dangerous NEAs. So far, of the estimated 2,000 NEAs over one kilometre across, only about 200 have been found by the dozen or so people involved in the search worldwide.

In 1990 NASA was asked by the US Congress to examine ways of accelerating the rate of NEA discovery. NASA recommended a dedicated survey of NEAs that would take 20 years, and cost \$US200 million shared internationally...truly a small amount for the insurance of life on Earth.

Gosses Bluff in central Australia resulted from a comet impact about 130 million years ago. The ring of hills visible today is all that remains of the original crater's core. All trace of the outer rim has been eroded over time. Satellite images of the area suggest that the original crater was approximately 20 kilometres across.



JET PROPULSION LABORATORY/CALIFORNIA INSTITUTE OF TECHNOLOGY, USA

But if the idea of the Earth being hit by an NEA or comet still leaves you feeling skeptical, consider this: in July 1994, the planet Jupiter was struck by a comet that had broken into 21 fragments. The largest fragments were in excess of one kilometre across. If just one had struck the Earth it would have caused a global catastrophe. Planetary impacts are real. A collision between the Earth and an asteroid is more than just possible, it's inevitable. ■

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Geoff McNamara has been involved in public education in astronomy for about ten years. He is a writer for Sky & Space magazine, and writes and produces a weekly radio segment called "The Sky This Week". He would like to acknowledge the work of the Anglo-Australian Near-Earth Asteroid Survey team, which is made up of Duncan Steel, Rob McNaught, Gordon Garrard, David Asher and Ken Russell.



FROGS



Litoria gracilentata from north-eastern Australia.

BY PAVEL GERMAN

People either love frogs or hate them. There is something about these wonderful animals that polarises opinion. Their large eyes and permanent grin make it easy to credit them with human-like character.

In order to better express my vision of frogs I try to photograph them at eye level. The 3-D feel, created by the use of multiple flashes, helps to focus attention on the subject. I also carefully compose the photographs to achieve more graphic and often dynamic images.



Litoria subglandulosa from northern New South Wales.

P H O T O A R T

Nyctimystes cheesmanae from Papua New Guinea.

ANH AUTUMN 1995



P H O T O A R T

Platymantis guppyi from the Solomon Islands.





Litoria phyllochroa from eastern New South Wales.



Pseudobufo subasper from the Malay Peninsula.

FROGS

Mixophyes balbus from south-eastern Australia.



Phrynomantis sp. from Papua New Guinea.

FROGS



Litoria sp. from Papua New Guinea.

The search intensified, for if there was one 'dead' gall, green galls containing live insects were likely to be found close by.

GUMS AND GALLS

BY PETER CRANSTON
& PENNY GULLAN

WE STAND IN THE LATE morning heat of the East Kimberley region among the sparse trees of the savanna landscape. One of us stares with eyes shaded from the sun into a eucalypt, the other uses binoculars to scan a distant sandstone hill rising from the clayey floodplain. Kites whistle overhead, Magpie Geese call from a billabong, and Brolgas trumpet nearby. Having earlier witnessed a noisy sunrise over Parry's Lagoon, these calls are now just distractions. In increasing heat, progress is slow as our two erratic paths link eucalypts, each of which is scanned from the ground. Boab and baubinia trees are passed with barely a second glance. The rounded red prominence, Goose Hill, nears.

What we are looking for is the result of a uniquely Australian interaction between particular insects and trees. The trees are eucalypts; the insects are an endemic Australian radiation of scale insects. Australia has many species of scale insects, all of which belong to the superfamily Coccoidea and which suck the sap of plants. Some, like mealybugs (family Pseudococcidae), cause economic damage to crops and garden plants. What principally concerns us here are some very specialised members of the family Eriococcidae, belonging to the genus *Apiomorpha*.



The adult female of *Apiomorpha cucurbita* removed from its gall. The body tapers to the tail. Attached to and surrounding her body are first instar offspring.

Each of these species of scale insects attacks a small range of eucalypt species, sometimes only one. The tree then reacts by forming, at the site of attack, a characteristic swelling or gall that encloses the insect. There are only a few genera of Australian scale insects (almost all in the family Eriococcidae) that induce their host plants to form galls. Within each gall, a single scale insect feeds on the tissues of the host plant, and releases sweet excreta from a small opening at the tip of the gall. In *Apiomorpha*, the female of each different species induces the eucalypt to form a distinctively shaped gall, but the 'male galls', which are smaller, are less characteristic. The shape of the 'female gall' seems to be consistent within each insect species, no matter which type of eucalypt is the host, and it can often be used to identify the insect, although confirmation must be made by microscopic examination of its cuticle.

Although scale insects that induce gall formation cause the host eucalypt to divert energy into growth of insects and galls rather than its own plant tissue, there is no evidence of tree death being caused by the galls. At worst, some trees may shed heavily infected limbs.

The 'bloodwood apple gall' or 'bush coconut' of central and northern Australia is probably the best known of these eucalypt growths. These galls are induced by female *Cystococcus* scale insects—another genus of eriococcid. The coconut-like inner flesh of the gall and the sweet fluid-filled *Cystococcus* females within are well known as bush tucker. The galls of *Apiomorpha* species show a much wider range of shapes, but are generally smaller than the bloodwood apples. In the late 1970s, one of us (Penny), while a postgraduate researcher at Monash University, studied *Apiomorpha* galls and their causative insects in the southern part of Australia. Some 38 species were recognised based on the morphology of the insect and gall, but now Lyn Cook, studying the evolution of *Apiomorpha* at the Australian National University in Canberra, has shown that some of the populations vary in their chromosome number and so represent additional species that are difficult to distinguish on the basis of gall shape or features of the female scale insect within. One of the goals of our extensive entomological trip through north-western Australia was to examine a range of different eucalypt species with gall infestations and to collect these gall-making insects for chromosomal study.

At Goose Hill, however, there was more to the search. Northern Australian *Apiomorpha* species are poorly known. We were after a particular enigmatic northern species that was named just over a century ago by entomologist Claude Fuller as *Apiomorpha cucurbita*,



PHOTOS BY P.J. GULLAN

Over one hundred years since their first discovery, the galls of *Apiomorpha cucurbita* were rediscovered at Goose Hill, Western Australia.

because of its peculiar-shaped gall that resembled a cucurbit or gourd. The dried-out and distorted gall from Fuller's original collection in the South Australian Museum had no insect inside, just the woody gall. Nothing had been found since and the animal that caused the gourd-like gall was unknown. The specimen bore a label stating simply "Goose Hill, East Kimberley". On our 1:100,000 maps of the East Kimberley, a "Goose Hill" was shown as rising all of 59 metres above the open wetlands of the Ord River floodplain, beside an old track linking Wyndham and Kununurra. So here we were, searching the scattered eucalypts for the gourd-shaped gall.

We walked over to an attractive stand of Broad-leaved Carbeen (*Eucalyptus confertiflora*) but were rewarded with no more than stiff necks. Nearer the foot of the hill there were some grey-barked eucalypts. These turned out to be Flooded Box (*E. microtheca*), a tree known confusingly as Coolibah in the north. Its fruits, at only two to three millimetres long, are among the smallest of the eucalypts, so we were not going to have any problems distinguishing gum nuts from the larger galls when searching from the foot of a tree.

Sure enough, one branchlet bore two conspicuous growths—galls indeed, but they were shaped more like cloves than any gourd. These galls were formed by *Apiomorpha sloanei*, a northern species that we had found earlier on the trip. Although this was an interesting enough find, it wasn't until many trees later that a more likely candidate caught our attention, high in a mature Flooded Box. A scramble up the scaly trunk brought within reach an elliptical, three centimetre-long gall, but the galled

plant tissue was brown and woody, indicating there was no longer any insect living inside. The search intensified, for if there was one 'dead' gall, green galls containing live insects were likely to be found close by.

It was a worry that there was evidence of recent burning, because it takes a long time for *Apiomorpha* species to return after fire, if indeed recolonisation takes place at all. However, we were lucky to find some unburnt trees in a protected site near the foot of the hill with several more galls. These specimens matched the shape of Fuller's dried-out 'cucurbit' well enough to convince us not only that we had rediscovered the enigmatic gourd-like gall, but also that we had probably already collected it, unwittingly, the previous week, some 400 kilometres further west on the Mitchell Plateau, where it was growing on Darwin Box (*E. tectifera*).

By now our water had run out and we had covered several kilometres of scarcely shaded ground. Clutching the precious handful of gall-infested eucalypt branches, we turned our backs on Goose Hill. Our guide book showed a local swimming hole named "Alligator Pool"—alligator or crocodile, fresh or salt; it didn't matter much in our need to cool off.

Back in Canberra, the galls were carefully cut open to extract the female insects for chromosomal work and morphological examination. The cuticles of specimens from Goose Hill in the east and Mitchell Plateau in the west did turn out to be practically identical and clearly belonged to the same species. Although resembling the southern Australian species *Apiomorpha ovi-coloides*, our West and East Kimberley

specimens differed from their southern counterpart in certain small features, including the shape and number of spines at the end of their abdomens. We eagerly awaited Lyn's chromosomal counts of the Kimberley specimens, as she had already shown that *A. ovi-coloides* had a diploid chromosome number (the combined chromosomal inheritance from the parents) of 74. Sure enough, our Kimberley scale insects had a different count of 76 chromosomes. All-in-all, we can safely assume that this is indeed the long-lost *A. cucurbita* described by Fuller. The question that remains concerns the significance of these subtle differences in morphology and chromosome number. Should *A. cucurbita* be considered a species distinct from *A. ovi-coloides*? Perhaps, but a final decision on the species status of our northern gourd-like galls must wait until Lyn synthesises her morphological, chromosomal and other genetic data to reveal the pattern of speciation in *Apiomorpha* as a whole. ■

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Dr Peter Cranston is a Principal Research Scientist in the CSIRO Division of Entomology, Canberra. Dr Penny Gullan is a Senior Lecturer in the Division of Botany and Zoology at the Australian National University. They are the authors of The insects—an outline of entomology (Chapman and Hall). Their Kimberley trip was part-funded by the Australian Biological Resources Survey.

As I write, Dr Helene Martin is chemically 'digesting' part of the brain in an attempt to recover these precious Miocene memories.

DEVILS, DUGITES AND 'DIRT BRAINS'

BY MICHAEL ARCHER

TURNING MY BACK ON THE BRILLIANT Western Australian sunshine, I wormed my way down the sloping limestone floor that led through the cave's keyhole entrance. The lure was the possibility that fossil skulls of the recently extinct mainland Tasmanian Devil might be jutting out of the dark walls beyond the light of day. I had no idea how big this cave was because the light from my sputtering carbide lamp refused to bend around

corners. All I could do was to lead with my feet, leaving one hand free to hold on in case the entrance floor unexpectedly vanished. Moments later, my feet popped out into open space. As I edged further in, swinging my legs around to find a toe-hold on a wall, a small bat rushed up the tunnel past my head. Feeling again for an end to the space, my foot unexpectedly touched the muddy floor of the small chamber. Then something, much bigger than a bat, hit my leg. I froze. Sweat erupted as I felt a snake's large body move up the outside of my overalls, headed for regions of me that desperately wanted to be somewhere else. I strained to see the reptile using me as an escape route,

hoping it was just a python. But when the greenish-brown head of a large venomous Dugite (*Pseudonaja affinis*) appeared on my chest, all thoughts save panic vanished. In the end, the snake didn't even stop for a second look; it was up and out, just like me microseconds after the tip of its cold tail slid off my chin. That particular cave, I decided, could keep its devils, Tasmanian and otherwise.

Nearly 30 years later I was in a similar situation, perched on the slippery entrance of a cave filled with fossil skulls, little bats and the bones of trapped snakes. But this time the slippery slope was itself fossilised after being the door to immortality for beasts that lived 15 million years before the Dugite cave had even formed. This was 'AL90', a fossil cave on Riversleigh Station discovered in 1990 by Alan Krikmann. The site had been named and mapped but not sampled; 1990 was already overloaded with too many tantalising new discoveries.

The next two years of searing sun and monsoonal rains continued to score signatures across the weather-beaten face of AL90. Then in 1993 we began investigating nearby Encore Site, a locality that was beginning to look like Riversleigh's first late Miocene deposit. But because the site was too small to

Riversleigh expedition members pry up slabs of AL90, the ancient floor of a fossilised cave that contains exquisitely preserved skulls and skeletons of strange Miocene beasts.



MICHAEL ARCHER

keep all of the Expedition's personnel busy. Anna Gillespie, Senior Preparator of the Riversleigh Project, and three volunteers, Robin Banks, Judith Gillespie and Ange Vincent, offered to 'trial' AL90. So, sledge hammers in hand, they set to work; mere moments later their hammering suddenly stopped. "You'd better have a look at this!" Anna shouted across the spinifex. As we gathered around, she turned over a large block to reveal a stunningly perfect lower jaw of some kind of wombat-like diprotodontid with strange teeth jutting provocatively from the stone. Far more intriguing, however, was a series of mineral-white bones next to the jaw that were obviously articulated elements of a

contained their brains is a mystery that Dr Suzanne Hand, Riversleigh's bat expert, will try to solve.

Returning in 1994 with a tractor provided by the Queensland Department of Environment and Heritage, large blocks were hoisted over the lip of the ancient, still-treacherous entrance slope (which cost me a turned ankle), bringing to light a potpourri of prehistoric creatures trapped and stored in stone. Sections were drawn, hypotheses formed and tested, and samples taken. Visiting French Professor Bernard Sigé marvelled at the bats, some of which are closely related to Miocene species from France. PhD student Russell Drysdale took samples of travertine for palaeomagnetic analysis, which might help to more precisely date the rocks. And perfect, uncrushed skulls of small, beautiful diprotodontids turned up one after another. PhD student Karen Black, who just the previous year had chosen diprotodontids as the subject for her research, became afflicted with an unstoppable grin as the skulls piled around her.

One of these skulls led to an even greater surprise. A crack enabled the rear half to be gently pulled away revealing what looked like a shrivelled brown prune embedded in a shell of calcite—a 'dirt brain'! Evidently the skull became totally entombed in limestone. The 'dirt brain' shrivelled as it dehydrated leaving a space that later was filled by calcite crystals. The moment we realised what this thing was, it was thrust into a plastic bag and thoroughly sealed from the atmosphere. Why? Because, just possibly, this 'dirt brain' will retain a kind of fossil memory of the original forest vegetation around the cave—if it retains fossilised pollen grains. Dr Helene Martin, a palynologist at the University of New South Wales, is, as I write, chemically 'digesting' part of the brain in an attempt to recover these precious Miocene memories.

Devils, Dugites and 'dirt brains' may not be everyone's stuff of dreams. But for those whose life work is fathoming Australian prehistory, the slippery slopes of caves, ancient and modern, have stuffed the skin of the continent with the most extraordinary and comprehensible ghosts of our past. Riversleigh's AL90 promises centuries of revelations—and all of it, fortunately, without the need to eyeball a desperate Dugite. ■

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

Perfect, uncrushed skulls of small, beautiful diprotodontids turned up one after another.

skeleton. Other trains of bones were visible heading into the untouched layers of limestone. As important as Encore Site was, interest in that locality promptly evaporated. Riversleigh, for all its delightful prehistoric diversity, had produced few articulated skeletons of anything larger than a bandicoot.

As we worked, understanding about the site grew. It appeared to be the remnant of a limestone cave whose roof and walls had long since eroded away, leaving part of the entrance and a thick, vertical fill of bone-rich floors. To 'carve' out neat rectangular blocks of the fill, we drilled holes for light explosives, which cut the rock like a knife. Before each block was removed, it was marked with 'North' and 'Up' arrows so that the orientation of the bones it contained would be known. Each block was individually labelled and mapped with respect to all others so that chains of bones passing through adjacent blocks could later be reunited. Gradually, as blocks were removed from one small area, the sloping floor of the original entrance began to reappear.

Down this slippery passage, into what we think may have been in a chamber intermittently filled with water, had slid many delightfully distinctive creatures. Among others whose bones had come to rest on the lower slopes were small diprotodontid marsupials, kangaroos and other as yet unidentified animals, their partially articulated skeletons often lying near their skulls. Equally surprising were slabs of cave floor sprinkled with isolated fossil bat brains. What happened to the skulls that once

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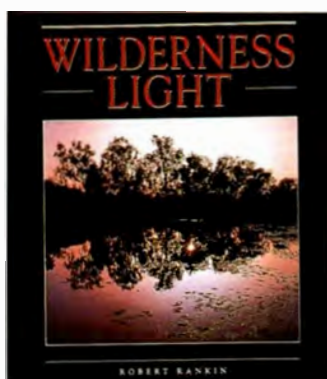


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REVIEWS



Wilderness Light

By Robert Rankin. Rankin Publishers, Qld, 1993, 159pp. \$39.95rrp.

At first glance *Wilderness light* appears to be just another coffee-table book of pretty Australian scenes. But nature and photography enthusiasts who believe this will miss out on a valuable essay on the creative process of landscape photography. The text is the *raison d'être* for this book. Robert Rankin's beautiful photographs do not cram the pages. They exist to illustrate and justify his views on natural light, pictorial composition and his philosophy of art and aesthetics. You won't find the mind-numbing repetition of indifferent photographs that so often substitutes for intelligent content in picture books.

Yet this is no dry technical reference manual either. Technicalities are touched upon lightly enough to be informative without frightening the technophobes or sensitive artistic types. Nor is it a detached anthropological analysis of photography like Susan Sontag's *On photography*. Rankin analyses photography because he loves it; his personal photography is proof of that.

Robert Rankin is a physi-

cist who became interested in "the visual aspects of scientific concepts and their presentation". So interested in fact that he gained a PhD in this field. He must have realised very early in his studies that photography had developed a society-wide reputation for veracity. Artists, advertisers, even the CIA might fake a photograph, but lovers of nature have used photography as an honest witness of the splendour of the environment; to convince stay-at-home people of the need to preserve and protect the natural world. T.H. O'Sullivan and Carelton E. Watkins pioneered wilderness photography in America, taking their cameras off the main roads almost as soon as photography was out of the studio and on any road at all. Ansel Adams perfected its form, his works becoming icons to nature and photography enthusiasts worldwide. Olegas Truchanas and Peter Dombrovskis introduced Australia to the increasingly symbiotic movements of landscape photography and environmental awareness.

Rankin is clearly following these pioneers. He is a purist in this most pure of disciplines, the landscape photographer who may not alter the scene before him but instead must select the best season, time of day and vantage point to record it at its finest. This is the talent of the landscape photographer—he hunts, he stalks, he waits, and he pounces on the shutter release at the moment of perfection. That is the ideal of these hunter-gatherers of nature's truth.

But what if photographs were no longer regarded as an honest account of people, places or events? Film scan-

ning has teamed up with computer databases and become digital imaging technology. Computer software and ancillary hardware can invisibly alter images or combine several scenes into one new but entirely fictional scene. The best of these systems can do it so well that a 'revised' original photograph is indistinguishable from a 'genuine' original photograph. Anyone could snap any scene, make it sharper, zap up the colours, remove power lines and tourist coaches, turn a dull sky blue or perhaps add some dramatic storm clouds. Everywhere could be 'virtually' beautiful in our holiday snapshot album while in reality it may be ugly and overdeveloped. Who would believe that any natural beauty still existed in the world? Who would be moved to defend it? Committed photo-environmentalists will have lost the ability to affect anyone with the honest beauty of their landscapes.

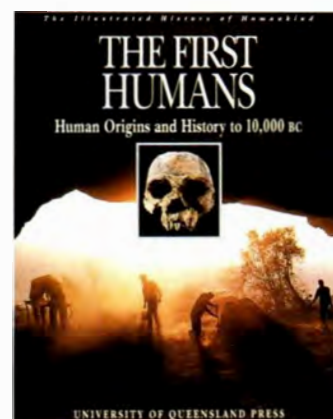
And that would be a shame indeed. Photographs as fine as those in *Wilderness light* should be valued and respected. Rankin has used his visual guiles well, not just to capture the outer visage of Australia's wilderness but also to reflect upon its fragile, often transient nature.

Wilderness light can be learned from as well as admired. We are introduced to every picture's secrets, guided through the whole creative process of landscape photography. How maps can reveal when a mountain will look its craggiest or when the colour of its cliffs will be most vivid. How colours work in a picture and in the minds of viewers. How composition can lead viewers on a journey back and forth through what is, after all, a flat sheet of paper. How a photograph's boundaries can give true or false impressions of the environment beyond. Every lesson is illustrated, every photograph explained. The artist is our teacher.

Robert Rankin's *Wilderness light* has my endorsement. It is an unusual synthesis—a picture book with brains. It is not perfect, not every photograph is a great

work. Serious students of photography could feel that some aspects of theory have been overlooked but that would be missing the point. This book is about how the search for truth can reveal beauty.

—Anthony Farr
Farrsight Photography



The Illustrated History of Humankind: The First Humans: Human Origins and History to 10,000 BC

Ed. by Göran Burenhult. University of Queensland Press, Qld, 1993, 239pp. \$49.95rrp.

This is the first of five volumes in the series *The illustrated history of humankind*, a series "conceived and produced by Weldon Owen" of Sydney, and Bra Böcker of Sweden. The volume reviewed here is the Australian edition, released after the series was launched overseas. This is evident in the American spelling that has been retained for the Australian edition. This does not detract, however, from the quality, content or significance of the series.

Many years ago, I experienced the excitement of the unmasking of the Piltdown hoax. Later, as an undergraduate, I sat in a crowded lecture room listening to Louis Leakey expound on the latest hominid finds from Olduvai Gorge. In Leakey's view, these finds threw perceived wisdom about human origins into the intellectual melting pot once more, and placed Africa firmly on the evolutionary map. More than three decades later the

debates about the origins and development of our human species continue. Yet little of this debate is accessible to those not professionally immersed in the subject. Most publications on the subject are beyond the reach of the general reader, couched in the arcane language of palaeoanthropology and appearing in journals of limited popular circulation. This volume is a welcome correction to this situation.

This is a multi-authored work with 38 papers by 28 authors from 19 institutions in six countries. Little known to the general Australian public, there is a significant group of Australian-based scholars who are contributing to world knowledge about our early ancestors, both within our region and beyond. No fewer than 11 of the authors are from Australian institutions, two of them, Tim Flannery and Paul Tacon, at the Australian Museum, and a third, Peter White, is a Research Associate and former staff member of the Museum. In this sense, Australians can be especially proud of this volume.

It is impossible to comment on each contribution in the volume. It is sufficient to state that the book is compelling reading, well written, and beautifully and extensively illustrated. It is probably the broadest coverage of the topic ever published. The chapters take us through aspects of our ancestors' development, both anatomical and cultural, to about 10,000 years. This cut-off point presumably has something to do with the start of the 'Neolithic Revolution', when humans intensified their management of animals and plants.

The complexities of just what the fragmentary remains of the earliest hominids mean in terms of the evolutionary path to modern humans are presented clearly, while avoiding a reductionist editorial policy. Do you want to know how 'experts' differ in their opinions and why? Well, you can find some answers here. Conflicting views are presented in ways that reveal the differences of interpreta-

tion without losing coherence in the overall 'story line'. For example, I found an interesting opposition in the two accounts of the question on whether the Neanderthals practised deliberate burial. Colin Groves (Australian National University) opts essentially for the affirmative case. Peter Rowley-Conwy (University of Durham) presents the negative view, concluding among other things that the 'burial' at Teshik-Tash in Uzbekistan was more likely to be the remains of a hyena meal. Such opposing views are important elements of the book. Readers all too often want simple, straightforward pictures of the past, little understanding how the same data can receive different, and often equally valid, interpretations.

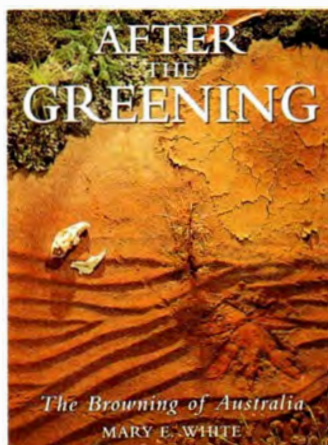
The extended chapters on each topic are interspersed with 'feature' items on specific topics. Initially I found it rather confusing and irritating to turn a page and find a new topic or an extended discussion of points raised earlier in the chapter, only to find that the chapter continues after the 'feature'. Once you get used to this quirk of organisation, you learn to skip the 'feature' until you have finished the chapter. The 'features' are, in fact, valuable commentaries on a range of specific topics, and are well worth reading in their own right.

The allocation of space to the various parts of the world is generally well and evenly done, although the uneven amount of knowledge about them is very evident. For this reason, Europe occupies a substantial part of the text, despite being described on page 84 as a "marginal stagnating region without further importance" in evolutionary terms after 200,000 years ago. South-East Asia, Australia and the near Pacific receive substantial attention.

This is an engrossing volume, one to read as well as to dip into. It does not tell the 'whole' story of how we became human, but it tells enough to provide the best popular review available at present. It is fascinating reading for anyone interested in our human past. No need for extraterrestrials

here. Even better, the price is right for a book of this quality. Thoroughly recommended. Look out for the other volumes in the series.

—Jim Specht
Australian Museum



After the Greening: The Browning of Australia

By Mary E. White. Kangaroo Press, NSW, 1994, 288pp. \$59.95rrp.

This is an impressive book. Packed into its 288 pages is a wealth of knowledge and information on the evolution of the Australian landscape and the palaeoecology of Australia's biota. In dealing with a remarkable range of topics—there are 29 chapters, each on a different topic—the quality and clarity of the text is matched by a profusion of first-class illustrations and photographs.

The topics dealt with include an exposition on the theory that the building and fragmentation of supercontinents like Gondwana occurs on a 400-million-year cycle and that this process operates in conjunction with alternating 'greenhouse' and 'ice-house' climatic regimes; an outline of the flora of Gondwana during the late Cretaceous to Paleocene (96 to 58 million years ago); the evolutionary challenge for the biota that occurred during the Miocene (23.7 to 15.3 million years ago) when the climate oscillated rapidly between warm-and-wet and cold-and-dry; an outline of the biota during the last Pleistocene (700,000 to 130,000 years ago), and Recent (18,000 to 15,000 years ago) ice ages; the 'El



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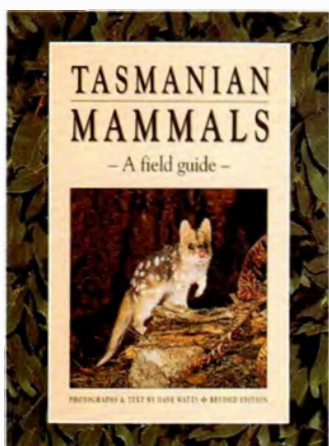


"Southern Emu Wrens"
by Ian Roberts

Nino' influence on our climate and biota today; and, finally, human impact in the last 200 years.

I don't think this book's objective could be better put. It is a plea for conservation. Mary White has eloquently achieved her objective by documenting and illustrating much of Australia that we have a responsibility to care for. And by doing this she has shown how, in the space of 200 years, our forbears and ourselves have been neglecting this responsibility.

—Wayne Braithwaite
CSIRO, Canberra



Tasmanian Mammals: A Field Guide

By Dave Watts. Revised edition.
Peregrine Press, Tasmania, 1993,
119pp. \$19.95rp.

The objectives stated for this publication are to produce a picture book of Tasmanian mammals and to promote awareness and interest in the island's mammal fauna. The book succeeds admirably on both counts. The colour photographs are consistently superb, with many being reproduced here for the first time. In addition to the four photographs of representative habitats, there is a photograph for each species of native mammal in Tasmania, as well as for three species of introduced rodents. To further promote awareness of Tasmania's mammals, four species of seals are included; this expands the coverage from the first edition published in 1987.

The bulk of the book is taken up by the profiles of 42

species of mammals. Each profile comprises a one-page written account that includes a description and measurements of each species as well as notes on habits, habitats, food, breeding and status. A map is provided to show the distribution of each species in Tasmania, with notes indicating distribution beyond the island. Helpful appendices are provided to distinguish the four genera of Tasmanian bats, to identify selected terrestrial species from their footprints, and also on where to see mammals in national parks.

Factual information is usually accurate, with some attention having been paid to detail. For example, very recent changes of nomenclature have been acknowledged; bats in the genus *Eptesicus* are given correctly as *Vespadelus*, and *Mastacomys* is subsumed properly within *Pseudomys*.

There are, however, some minor oversights. Descriptions of species' distributions outside Tasmania are sometimes inaccurate. Neither the Common Ringtail Possum nor Little Forest *Vespadelus* occur, as stated, in Western Australia, whereas the distributions of the Dusky Antechinus and White-footed Dunnart extend into Queensland. There is also some inconsistency in the provision of body measurements for related species. For example, separate body weights, tail and head-body lengths are given for male and female Spotted-tailed Quolls, but only body weights are shown separate-

is mentioned, although both species have been recorded (rarely) from Tasmanian waters.

These are minor quibbles. Both the format and presentation of the book make it easy to read and ideal to use as a field guide. At \$19.95 it represents excellent value for money, and should surely achieve its aim of increasing awareness of Tasmania's native mammals.

—Chris Dickman
University of Sydney



The Action Plan for Australian Reptiles

By H.G. Cogger, E.E. Cameron,
R.A. Sadler and P. Egglar.
Australian Nature Conservation
Agency, Canberra, 1993, 254pp.
\$25.00rp.

At last, reptiles seem to have made the grade. What herpetologists have been preaching for years has caught on. Australian reptiles are popular. If sales of the major identification guides to our incredibly diverse array

What herpetologists have been preaching for years has caught on. Australian reptiles are popular.

ly for the two sexes of the Eastern Quoll. Uneven reporting is given likewise for body weights of the two species of Antechinus and for head-body lengths of seals. Finally, coverage of species is not quite complete. Neither the Crab-eater Seal nor Australian Sea-lion

of species are any clue, many thousands of people here and beyond our shores are rapt in reptiles. That many (some 25 per cent of terrestrial and freshwater species) are classed as poorly known, rare, vulnerable or endangered has become a matter of surprise and concern.

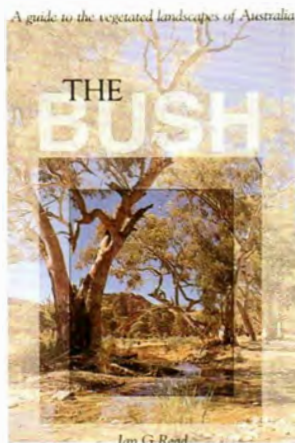
Although a decision on how best to preserve biodiversity is yet to be agreed upon, there is general agreement about the first steps to achieving this ideal—review the *status quo*, look at causes of declines in range or population, and develop strategies to undo the damage and protect suitable habitat.

The action plan for Australian reptiles is just that. It is a very clear list of steps towards conserving species currently most at risk—those classified as vulnerable and endangered. The action plan takes the problem out of the airy-fairy world of conservation philosophy and into the cold, hard world of facts and figures. It provides exact locations, precise data on destructive impacts and, most importantly, costs in terms of manpower and money. If we are prepared to invest about five million dollars in their future, recovery plans for the endangered and vulnerable reptile species can be implemented. Some of the base data can, of course, be debated, but we now have an excellent starting point. We now know how much we don't know about many of these species.

The authors, all from the Australian Museum, have done an excellent job with this publication, as has the funding body and publisher. The action plan is thoroughly researched. It is presented concisely and clearly, and is thus easily referenced and read. Very appropriately, this book does not have a flash cover or a bevy of colour photographs, and it is presented on inexpensive paper, in soft cover. This keeps costs down. I highly commend this approach. Presentation of accurate data at minimum cost ensures maximum distribution and use; and the money that might have been consumed in publication costs may now be available to save the species.

The action plan for Australian reptiles is an incredibly useful tool for anyone with a passion for reptiles, and for every natural resources manager and conservationist.

—Jeanette Covacevich
Queensland Museum



The Bush: A Guide to the Vegetated Landscapes of Australia

By Ian G. Read, University of NSW Press, NSW, 1994, 184pp. \$22.95rrp.

This is the type of book you should have for your trip around Australia. Unfortunately, once you have browsed through it you may be left

dithering. The preface and part of the introduction venture into spirituality, rather a surprise in what appears to be a practical book. Following this the author tries to reduce the endless variety of vegetation into some order for the beginner.

The reader starts optimistically with a simple introduction to plants and their habitats. The main influences, such as climate, soil and topography, are discussed. Surprisingly, only one paragraph is devoted to the land management practices of Aborigines and this is under the heading of "Another Influence". Confusion is also added when "Climatic Zones" appears separately to "Climate".

Chapter 3, "The Classification of Vegetation", again starts off well but concerns soon resurface. The Classification of Vegetation table, surely the most crucial information in the book, is in small print and only one

aspect of the classification system is discussed clearly.

The two key maps illustrating the vegetation of Australia are too small and do not give easy access to the different plant formations in the text.

The occasional use of common names is unacceptable as they are usually localised. How many eucalypts are

called 'scribbly gum'? The chapter on Australian plant life, a chat about dominant genera and families, is a useful addition but lacks spark.

The best way to use the book is to browse through the photos, mostly clear and coloured. You will then find what you are looking for.

—Robin Buchanan
Ryde College of TAFE

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Biodiversity. By Andrew Beattie. Reed Books, NSW. \$29.95.

Mammals of Papua New Guinea (Revised Edition). By Tim Flannery.

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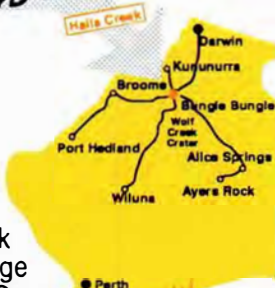
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Q & A

Puzzling Platypus

Q: I read with interest your article on the Platypus in ANH Autumn 1990. The Manning River has many Platypus that I have often observed. Regarding their reputed large appetite, recently one surfaced five metres away in a small pool. The nest pools were approximately 60 metres away on each side and only connected by very shallow rapids. I guess this Platypus was a resident and didn't travel from one pool to the other. If they did, then foxes and dingos would get an easy meal and I have seen no evidence of that. It just seems impossible for such a small pool to provide more food than would sustain a couple of small trout. Also, any

Platypus that I have seen at close range has submerged and not reappeared. Does the electroreception theory explain how they have sensed me because I am almost certain they did not see me?

—L. Outram
Warners Bay, NSW

A: It is always interesting to hear of observations on Platypus in the wild. You have raised two points that I will try to answer. One is about how the Platypus can survive in a small pool. My answer is, I don't know.

It would require a survey of food resources in the Manning River to properly answer your question. But do remember that Platypus will feed on a range of different animals including small fish, earthworms, leeches, shrimps, yabbies, dragonfly larvae and water beetles. They typically fossick on the stream bottom, turning over stones and debris looking for food. Presumably the pool in which you observed the Platypus contains more food than you think. Alternatively the animal may, unbeknown to you, have moved into other pools during the night.

Your second question relates to your observation that the Platypus disappears on submerging. The obvious possibility is that it has a burrow somewhere on the edge of the pool. The entrances to burrows are often very carefully hidden and so may be easily missed. They may even be under water. There is no possibility that the electric field created by your muscle contraction can be picked up by the Platypus. The field extends through only very short distances, especially in air. It has been calculated that the Platypus may detect a swimming shrimp at a distance of ten centimetres. That is in water; the distance in air would be much less.

—Dr Uwe Proske
Monash University



DAVE WATTS/INPAW

The mysterious Platypus (*Ornithorhynchus anatinus*).

Scorpion or Spider?

Q: I found an insect walking across my dining table that I have never seen before in all of my 80 years. It was 15 millimetres long, could arch its tail forwards over its back in the manner of a scorpion, had eight legs and could spin a web. Could you please identify it for me?

—G.M. Lindeman
Armidale, NSW

A: Often simply called tailed spiders, these strikingly shaped spiders belong to the genus *Arachnura*. They are common in open forest and heathland regions of eastern Australia. Their small angled orb webs with a haphazard network of supporting threads above are usually built on the low foliage of trees or shrubs and are often seen in gardens. The spiders vary from reddish brown to yellow or cream with the 'tricorn' tip of the elongate tail (part of the abdomen) a darker brown or black.

In the web the spider sits head down (occasionally head up) at the centre with its tail section either curled forward much like a scorpion in stinging mode, or extended in line with the rest of the body. The spider's repertoire of colour, shape and posture makes it look like a flower or



S. WILSON

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Do you recognise this? If you think you know what it is, then send your answer to Pic Teaser, ANH Magazine. Please don't forget to include your name and address. The first correct entry will win a \$20 gift voucher from the Museum catalogue.

Summer's Pic Teaser was the aerial roots of mangroves.

seed head that has blown into the web. This disguise is thought to help it escape the attention of predators like insectivorous birds and parasitic wasps. The tactic of arching the tail tip forward when disturbed probably represents a more active 'scare' defence as well. In summer and autumn the females construct greenish-yellow egg sacs that are suspended in a row in the upper part of the web. The spider, sitting at the bottom of its row of seed-like egg sacs, is almost indistinguishable to the casual observer.

—Mike Gray
Australian Museum



A female Scorpion-tailed Spider (*Arachnura higginsii*).

sex (asexually dimorphic). Some gibbon species do in fact change colour with age and it appears this colour change can be related to changes in social status and role.

—Linda Gibson
Australian Museum

Gibbon Colour

Q: An episode of "Wildscreen" shown on the ABC featured gibbons from Northern Thailand. The narrator seemed to imply that only the male gibbons were black. He then mentioned that, although the father of the first family group was black, the rest of the family were all blonde (including an adolescent male). I found it a bit confusing that later in the

episode a male, obviously younger than the adolescent, was shown and was also black. Do gibbons change colour as they mature, or is the colour just randomly blonde or black? Also, do other apes have more than one colour within a species?

—Toni Marsh
Dulwich Hill, NSW

A: Pelage colour is highly variable within the genera *Hylobates* (gibbons) and *Nomascus* (siamang), from jet black to nearly white. Some species are sexually dimorphic, that is, the sexes are different colours, or the pelage colour is either light or dark irrespective of

Answers to Quiz in Quips, Quotes & Curios (page 18)

1. Dark matter
2. Kirki
3. Australian Nature Conservation Agency
4. Swiftlets
5. Vinegar
6. Echidnas
7. Shoemaker-Levy 9
8. Byron Bay
9. Three
10. Palynology



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BY MICHAEL ARCHER

AS OUR PLANE DESCENDED, I asked the chap in front of me if he could see any habitat destruction from his window. "A bloody big hole!" he said, pointing out a stone quarry that from here looked like a pin prick on a bald pate. Funny, I thought, having expected that answer, how we've become blind to the biggest eyesore in sight—the leprous lesion of cleared land that goes on without end, a vacuum of missing life that bridges horizons. If this were a plague or an infestation of an introduced plant, we would clutch in horror at the sight of such vast devastation. Instead, we take it for granted because it is everywhere. What invites attention are breaks in the incessant monotony of agricultural land, whether cities, vestiges of once vast forests, or the pin pricks of mines.

Over the whole of the continent, the mining industry affects a minuscule 0.02 per cent (1,520 square kilometres) of Australia. Contrast this with the cost of agriculture: 70 per cent (5,320,000 square kilometres) of the continent damaged by land clearance and/or grazing, destruction of 49 per cent of Australia's original forests, and annual land degradation costs of \$1.5–2.5 billion dollars per year. If we rank financial return for land abused, the figures are even more disquieting. For abuse of 0.02 per cent of the land, the mining industry provides ten per cent of Australia's GDP (gross domestic product). Agriculture (grazing plus crop industries), despite alienation of 70 per cent of Australia's land, provides only three per cent of Australia's GDP. In relative terms, mining is three times as financially rewarding and 3,500 times less ecologically destructive than agriculture. It is thus clearly an abuse of reason to suggest that the two industries, mining and agriculture, can be talked about in the same breath when it comes to land degradation.



Mining versus agriculture: which one is better for Australia?

Agriculture is a one-way path to financial as well as environmental disaster for this country. At the rate at which its gruesome spin-offs are blossoming into national disasters such as soil acidification (from fertilisers), salination (from clearing of trees and irrigation), destabilisation of land surfaces (introduced hard-hoofed animals), loss of topsoil and loss of nutrients (erosion), eutrophication of waterways (run-off of fertilisers) and widespread extinctions following habitat destruction, we should consider carefully the warning of Rick Farley, Executive Director of the National Farmers' Federation: "...land degradation must remain at the top of the public consciousness as the number one environmental issue in Australia". If we are serious about healthy environments, we must consider alternative paths for the future.

The healthiest alternative begins with recognition that ecotourism is the fastest growing 'big' industry in Australia (ANH Spring 1993). For practical purposes it is limited only by the extent of agricultural land. It brings in 5.1 per cent of Australia's GDP (versus

three per cent from agriculture) and provides a growing 5.7 per cent of Australia's jobs (versus a declining five per cent for agriculture). Further, ecotourism thrives on the health and expansion of natural environments; agriculture survives at their expense. If ecotourism is to grow and be more profitable, it needs more space for natural environments—space currently locked up and degrading as agricultural land.

If we don't want to cough up the \$2 billion per year needed to deal with the mushrooming disasters of land degradation, we must start to phase out sheep and cattle, ideally in favour of an economically viable, self-sustaining, environmentally friendly and far healthier kangaroo industry. At the end of this road, the same graziers who are finding their land less profitable would become the custodians of healing land and in the process earn more money through a combination of maintained subsidies, kangaroo farming and a percentage of profits from the growth of ecotourism.

The overriding goal should be to establish Australia as the 'environmental Riviera of the world'. In an overpopulating, more urbanised world that has lost the incentive and/or capacity to control destruction of its rapidly dwindling natural resources, a wilderness-enriched Australia will pull tourists like no other magnet on Earth.

If other countries, such as New Zealand, are prepared to ignore similar opportunities in the pursuit of export dollars for agricultural products, that's fine—they can probably do it more efficiently than we can. Australia can import wool and other agricultural products if need be; a small trade-off for the increase in profits from tourism and restoration of lands now disintegrating under the cloven hoof.

Could an expanded mining industry be compatible with restoration of wilderness in Australia? Most current arguments for restricting mining are based on concern that the tiny amount of Australia that remains undamaged by agriculture is too precious to subject to further risk. If, however, the amount of environmentally restored land were to increase several fold or more, the threat from mining would diminish to negligible levels. Even if it increased by 100 per cent, it would be using less than one twentieth of one per cent of Australia's land.

If we can reel in profits from an expanded mining industry without compromising the quantity and quality of our expanding, economically valuable natural habitats, wouldn't it be irresponsible not to consider this as part of an alternative, economically more viable path for Australia? ■

Professor Michael Archer lectures in biology and geology at the University of New South Wales.

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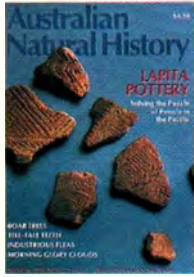
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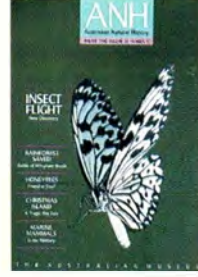
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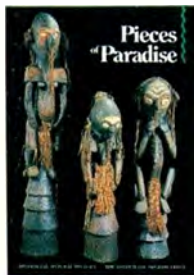


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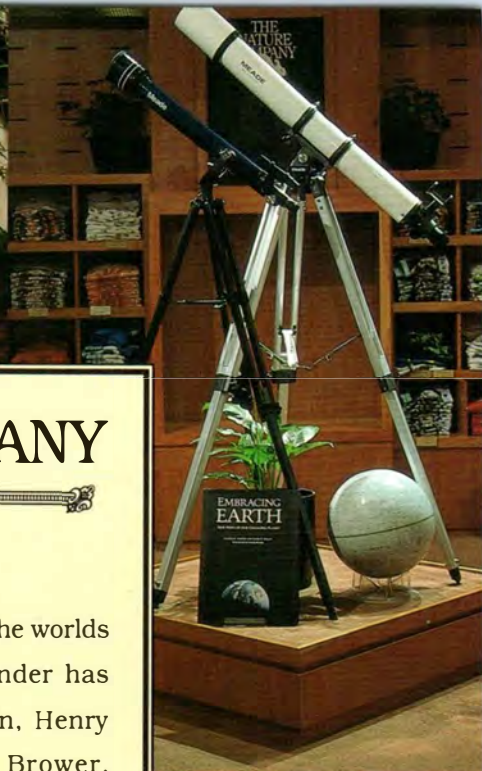


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